How the science of plasma will transform humanity's understanding of its place in the universe

A NEW SCIENCE OF HEAVEN

ROBERT TEMPLE

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How the science of plasma changes our understanding of physical and spiritual reality

Robert Temple

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This book is lovingly dedicated to
Lily Ashley
Elodie de Bosmelet
Flora Wallace Sheldrake
and Beatrix Williams

concerning whom the following definition
may be thought appropriate:
DIVINE [from Latin, divinus]:
of or pertaining to the heavenly

Special Note to the Reader

At the request of the publisher, the author has removed all footnotes and endnotes from the book and placed them onto this book's dedicated website:

www.newscienceofheaven.com

The notes contains a great deal of additional supplementary material and information of potential interest to readers, and are not just bare references. They are therefore recommended by the author to readers wishing for further information.

The website also contains a large number of illustrations and photographs that could not fit into the book, including photos of many of the heroic scientists who battled against herd thinking and blind prejudice over the past century and a half to found and develop plasma physics as a discipline, and those who are still struggling to extend its boundaries.

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Acknowledgements

I wish to acknowledge the remarkable and unswerving support of my editor, Mark Booth, who believed in this book from the beginning. Having recently retired from publishing, Mark is now lost to all the other authors who might have benefited from him as I have. I can only regret that the armies of worthy authors to come will not be able to have his firm but friendly guidance towards that ultimate end: making the book work. We authors can only repay him with our words. And these are mine.

I must thank as always my wife Olivia for her continual and devoted involvement in this book, reading it, making suggestions, expressing doubts when necessary and giving encouragement when doubts would be misplaced. I have never written a book without her help, and never more so than with this one.

I wish to thank also my very dear friend of many years, Chandra Wickramasinghe, for his vision and encouragement in exploring this exciting area of science and for co-authoring the astrophysical paper reproduced in the Appendix.

But if there be a fifth nature, such as is introduced by Aristotle, this is the essence of gods and souls –

Marcus Tullius Cicero, *Tusculan Disputations*, Book I
(Anonymous translation of 1715)

1

The Discovery of the Clouds

In October 2019 a momentous event took place, but as sometimes happens in these cases, no one noticed at the time. This event could have consequences for humankind's view of its place in the Universe for what remains of human civilization. It could entirely change the 'job description' of Planet Earth. It means that the Earth–Moon system is significantly different than we thought it was. And it may well change everything.

So why did nobody draw the obvious conclusions? People did eventually notice the discovery, for the findings came to be widely reported as a news item, as may be seen from googling the subject. And there appears to have been an unchallenged acceptance of the existence of what was reported. But still there is a lack of any grasp of what it means. No one seems particularly concerned about it. It has been one of those news items that is exciting for a day and then forgotten, as new stories appear and 'the news caravan moves on'. The implications of this anomaly remain unnoticed, and the strange fact's potential to lead to great things is apparently unsuspected.

History often works in this way. Who could have known that a failed and penniless artist in Vienna could end up starting the Second World War? Who could have predicted that a spoiled six-year-old rich boy, who had continual temper tantrums and pounded the floor screaming insanely that his parents must obey him, would end up calling himself Lenin and creating the Soviet Union? Who could have predicted that a New York property developer who likes gold doors and had no political background would become the American President?

But what happened in October 2019 was not political. It was far more important than that.

What happened was that some astronomers saw something.

I happen to have a roving eye for anomalies; I am always on the lookout for things that don't fit with present scientific understanding. And so, in October 2019, I noticed that something anomalous had been observed by three Hungarian observational astronomers (who actually looked through optical telescopes, as so many astronomers today rarely do).

In fact, what they observed had first been seen by a Polish astronomer named Kazimierz Kordylewski in 1961. Kordylewski claimed to have seen a strange cloud at a particular location in the night sky, and he worked out that there must be two of them, another at a corresponding location in relation to the Earth and Moon. (See Figure 1.) So these soon became known as 'the Kordylewski Clouds'.[1] However, no one else could see them, and that, everyone presumed, was that.

Fifty-eight years went by and then the Hungarian astronomers, to their great joy, observed the same cloud that Kordylewski had seen. Because it is extremely fine and emits no light it is extremely difficult to see, but they studied it as closely as they could.[2] It was at the exact location that Kordylewski had indicated.

This is a cloud between the Earth and the Moon, though not in a direct line of sight. It is very high above the atmosphere of the Earth and several times larger than our planet.

I was fortunate to spot the paper that the Hungarians published summarizing their research. I contacted the lead astronomer of the Hungarian team through the website www.researchgate.net, on which I am listed as she is, and asked whether they had considered any of the plasma aspects of the cloud? The answer was that they were studying the cloud 'only from celestial mechanics point of view, not from plasma perspective'.

Plasma is what this book is about. To put it very simply, plasma is matter that is made of 'incomplete or partial atoms', known as ions, and the much smaller particles known as protons and electrons. Plasma has sometimes been called the fourth state of matter, after solid, liquid and gas, but finer even than gas. We call the physical matter that is familiar to us 'atomic matter' because it is made of whole atoms, whereas plasma can also be described as non-atomic or subatomic matter.

Plasma is very familiar to us even though we may not realize it, for the Sun is entirely composed of plasma, and the stars are plasma too. Plasma also manifests itself in lightning, including ball lightning and other mysterious phenomena we will examine later. But plasma is otherwise and for the most part invisible, and we will be going into that unseen aspect of plasma a great deal as we go along.

As someone who keeps a keen eye on what is happening in plasma research, I realized that I must publish something quickly to alert people to the true significance of this cloud, since the Hungarians were not dealing with the plasma aspect.

I phoned my friend Professor Chandra Wickramasinghe, who as a retired Professor of Astrophysics is an expert on all such things, and told him about the cloud and asked if he would co-author an article for a scientific journal discussing the Kordylewski Clouds' importance from the plasma perspective. We then wrote an article together, which was published in the journal *Advances in Astrophysics* in November 2019.[3] It is reprinted at the end of this book as an appendix.

The fact that the Earth–Moon system contains two giant clouds that together are nine times the size of the Earth means that we might be more accurate in describing it as the two-cloud system, with the Earth and a moon thrown in. These two clouds are made of plasma.

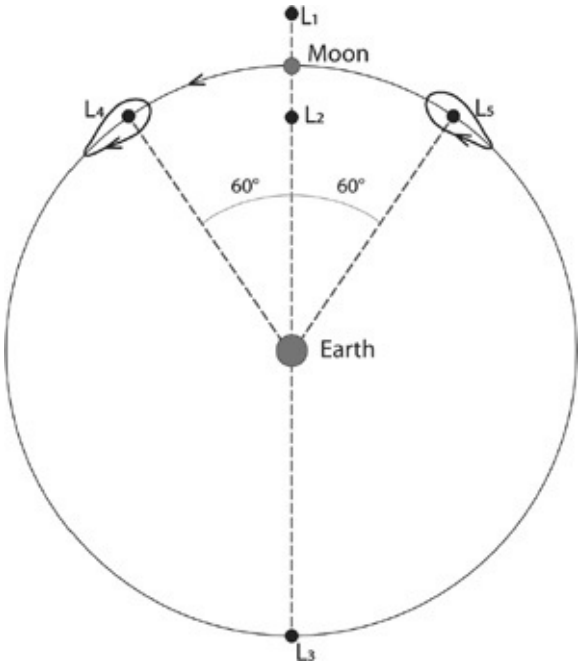


FIGURE 1. This diagram shows the locations of the ‘Lagrange Points’ known as L4 and L5 of the Earth–Moon system, indicating the positions of the two clouds. In this diagram, the Earth is at the centre, and the Moon is directly above it. Although distinct, bounded balls of plasma can form anywhere at modest scales (as for instance, and as we shortly see, the tiny balls of ball lightning on the Earth), for really big ones in space it is helpful for them to come to rest in spaces free of gravitational pulls, and when such a niche appears it is pretty certain that it will soon be filled by plasma which will form a ball as big as the niche allows. And that is why the L4 and L5 points are perfect homes for huge plasma clouds, for they are the only two points between the Earth and the Moon free of gravitational pull from either the Earth or the Moon. This image is not drawn to scale and the relative sizes of the bodies shown here bear no relation to their true sizes; this image is intended solely to show the geometrical spatial configuration. Seen at this scale, the Earth and the Moon would be extremely tiny or perhaps even too small to see, and as the main text explains, each of the Clouds is four and a half times the size of the Earth. (Image drawn for the author by Eric Wright)

This matters because, as I will show, there are good reasons to believe that plasma, with its ordering properties, can in certain circumstances be in some sense alive and can evolve intelligence. Because plasma is made up of charged subatomic particles, it is volatile and displays a tendency to form complex, constantly evolving patterns. This is particularly true of discrete bundles of plasma that we will call plasmoids, such as the Kordylewski Clouds. (What a plasmoid is will be explained fully later.)

Though this may surprise or even shock many readers, who may find this implausible on the face of it, I will also show that nearly all scientists in the field believe that the Universe is more than 99 per cent made of plasma – although this too has not yet filtered down to the general reading public.

And if the Kordylewski plasma clouds are examples of an inorganic life that has existed for billions of years, they may, as I hope to show, have had a role in forming this planet throughout its long cosmic history. They may even have helped create organic life. Clearly these ideas taken together open up vast new and very fruitful areas for speculation on the origins of the cosmos and the role of intelligence within it.

In fact, I will be arguing that life in its basic state is inorganic, and is not made out of atomic matter. I suggest that it is made out of pre-atomic matter, namely the atomic particles, electrons and protons, and ions – plasma. Thus, I am suggesting that we and all living things in the Universe, whether organic or inorganic, arise from this plasma, and that the organic state is secondary to our fundamental nature as plasma beings. I believe that we can now start to articulate ‘a new science of heaven’. That is what this book is about, and that is what I propose to do.

I will also show that as well as being very new, these ideas are also in another sense very old; ancient religions and philosophers in the classical world including Aristotle formulated very similar ones. They might not have been able to apply mathematical measurement to assess the levels of complexity necessary for life and intelligence that modern physicists can now apply, but a shift in perspective caused by the new physics of plasma will cause us to reassess many ways of understanding the world previously dismissed as discredited or even cranky.

I will not enter into theological discussions and will confine myself to the new science, with the exception of a brief historical review in Chapter 6 of some early religious texts that have relevance to our subject. I believe that much of what we have previously called spiritual is really plasma, and that it exists all around us and in us. Many spiritual experiences reported throughout human history are really encounters with plasma phenomena or plasma entities. What does this mean for religions? I believe it leaves them all untouched. My primary purpose is to reconcile the ‘spiritual’ with the ‘material’, and thereby to show that the dispute between them is false. There is in fact no contradiction between them when one digests the teachings of the New Science.

2

Exploring the Nature of Plasma Clouds and their Energy

I first got to know Professor Chandra Wickramasinghe in the 1970s along with his colleague, mentor and former teacher, Sir Fred Hoyle. It is appropriate that this should be the case, because Fred Hoyle was famous not only for being one of the world's leading astrophysicists and theoretical astronomers, but for writing the science fiction classic *The Black Cloud*, which is about an intelligent cloud in space. I will refer to that book again later.

The Kordylewski Clouds are not clouds in the usual sense of being made of water vapour and being within our atmosphere. There are two of them, as we have seen, roughly centred round two precise points in space between the Earth and the Moon.

What kind of clouds could possibly exist at these points? After all, they are in what we used to call 'outer space', so what could be there to make a cloud?

The clouds are composed not only of the subatomic particles already mentioned, but also of dust particles. That may not sound very exciting, but that is because you may well not yet know how important, complex, and incredible a dust cloud in space is.

Space dust is described thus in a 2008 technical paper:

> Dust is a generic name for minute solid particles with diameters less than 0.1 to 0.5 mm. The use of a range [of size] rather than a specific number for the cut-off indicates that this upper limit for dust size is somewhat arbitrary and scientifically insignificant. A plausible argument for the range is that particles greater than these sizes are unlikely to float in the air by themselves … There is also a somewhat arbitrary lower limit of a few nanometres to distinguish dust grains from more fundamental particles,

> such as electrons, protons … Therefore, this choice of the ‘lower’ limit includes small clusters as dust.[1]

It is useful to read this, but it is not entirely satisfactory for us, because it speaks of dust floating in air, and there is no air in space. However, it can act as a kind of approximate guideline for us about sizes of dust particles, whether single or clustered. Astrophysicists also sometimes like to speak of dust in space as ‘grains’. And although much dust is spherical, in space much of it is elongated and hence grain-shaped. Also, there is a lot of lumpy, clumpy and irregular dust in space.

Not all dust contains atoms, but that will have to be explained later, when I tell how plasma makes its own dust of itself. Plasma is essentially made up of two subatomic particles: electrons that have a negative charge, and protons that have a positive charge and ions (‘incomplete atoms’), which also have a positive charge. In whole atoms there is a balance between the negative and positive charges. ‘Physical matter’ is really atomic matter, because in order to be ‘physical’ it has to be made of whole atoms.

However, an atom can be turned into an ion by the simple means of stripping it of one of its electrons. It is important to realize that ions are not considered to be physical matter and that they are charged.[2] And to give some idea of the relative sizes, it is usual for a charged dust particle to have 10,000 electrons sticking to its surface. Because protons are larger than electrons, they do not stick to dust particles in quite so high numbers.

Contrary to what we might assume, living as we do in a material world, particles only very rarely come together to form whole atoms, and non-atomic plasma is the main constituent of the Universe – more than 99 per cent of it. As I say, we will see shortly why scientists think this, but the important point here is that from this perspective atomic matter is exceptional, and hard, rocky planets are very rare indeed.

It is because there is more plasma than there is atomic matter that I view ions, protons, and electrons as primary, and whole atoms as secondary. This way of looking at things will, I hope, become clearer as we go along.

We will see later that our Sun spews out huge quantities of positively charged protons and ions and fills the whole solar system with them. So our entire solar

system, including the Kordylewski Clouds, is constantly being inundated with a never-ending flood of ions and protons.

Since space is full of furiously racing and whizzing particles, of both negative and positive charge, it is not possible for a dust cloud to exist without each single dust particle within it being massively bombarded with thousands of subatomic particles (which as we have seen are much, much smaller than the dust particles) and thus becoming charged itself. It is well known by all scientists working in this field that the surfaces of dust particles (or ‘grains’) are continuously being charged by a relentless rain of thousands of electrons and positive ions striking them. When those are equal in number and the positive and negative charges balance out, the dust particle is said to have a ‘net zero charge’.

However, this is a rare event, and even when it occurs it is likely to be transient and exist for only a few instants. In our own solar system the Kordylewski Clouds are exposed to this relentless and never-ending hurricane of positive charge coming from the Sun in the form of the solar wind. The Sun also emits some filaments or streams of negatively charged electrons as well, but they are far less important components of the solar wind than the positively charged ions and protons. There are such things as negatively charged ions, and they can exist within a plasma, but they are not important for our discussions in this book, and we will not refer to them again.

One might well ask, if there are sustained streams of positively charged particles being emitted by the Sun, why does the phenomenon not have a name in the way that streams of negatively charged particles (known as electrons) are called electricity? It was Peter Mitchell (1920–1992), a very dear friend of mine, who took steps to fill this gap in our language, naming such flows of positive currents proticity. Peter won the Nobel Prize for Chemistry in 1978. He even built a mechanical motor that operated on proticity! He called it a protic motor, and he built it to show that proticity could be a source of energy to drive a motor sitting in front of you in the same way as electricity can do.

So I shall use the word proticity from time to time to describe the flows of positively charged currents, even though the word is still used only rarely by others. Because Peter worked in a highly specialized and closed branch of bio-energetics, not enough people ever knew of his terminological innovation for it to spread to the wider public. Peter is so little known to the general public that his obituary (which I wrote) is included here as Appendix 2. (My efforts to

locate Peter’s protic motor in recent years have drawn a blank, alas. I just hope it is still preserved somewhere, though if so, it is possible that no one knows what it is.)

Because the Kordylewski Clouds and others like them are bombarded from without by charged particles, the particles inside them and the dust interact with great intensity and complexity, evolving, as we shall see later, highly complex patterns. Such a large charged dust cloud in space is known as a ‘dusty complex plasma’.

One of the things which distinguishes such an entity is that all the processes inside it cannot be described by physicists using simple linear equations. Everything taking place inside this kind of plasma operates in a manner described by non-linear equations.

When something is linear, it means there is a direct and identifiable connection between cause and effect, so that one can predict behaviour. But when linearity breaks down, everything becomes unpredictable and immensely complex.

It is important to bear non-linearity in mind, because it is a feature of quantum mechanical super computers now in development, and analogy with these will play a part in arguments later in the book to show that these clouds may be highly intelligent.

Quantum computers break their information down into a different kind of bit, now called ‘qubits’. (The ‘qu’ stands for ‘quantum’.) Because quantum theory is a bit weird, a qubit can have the values of 0 and 1 at the same time. Very much like ‘having our cake and eating it’. Some say that qubits can even have any value between 0 and 1.

Meanwhile, the more restless and thrusting of the computer developers look upon qubits as being ‘so yesterday’. They now say the future lies not with qubits but with ‘qudits’. A qudit can have ten or more values at once.[3] This is like having ten cakes and eating them.

One might say that the work being done today on quantum computers is an attempt to construct computing devices that can do ‘non-linear reasoning’. Direct causation is linear. But some circumstances allow all sorts of unpredictable outcomes and unexpected influences. Direct causes that might take

place in an ideal world get interrupted and blocked, and things come at you from the left and the right and they change things. This, as we will see later, is the inescapable and fundamental non-linearity of dusty complex plasmas.

One useful definition of dusty complex plasma in a single sentence is by physicist Osamu Ishihara:

> Complex plasma, also known as a dusty plasma, is a plasma with micron-sized (a micron is a millionth of a metre) dust particles in which charged dust particles interact with a background plasma.[4]

This definition dates from 2008, and things have moved on since then, and the people working in the field now just say ‘dusty complex plasma’. Also, it is no longer necessarily seen to be the case that the charged dust particles and the ‘background plasma’ should be viewed as separate things that ‘interact’. It is probably more accurate to view the dusty complex plasma as a unified entity, which happens to contain not only those two components or states, but many more besides. I will be elaborating on this last point as we move along in the discussion. And it is also not the case that the dust particles must be micron-sized. They can be much smaller than that, namely nano-sized (one billionth of a metre).

It is surprising how many scientists, including distinguished professors and experts, still do not understand what is a dusty complex plasma. Science has fragmented so much that they do not even know what the people down the hall in the next lab are doing.

There are some developments that tend to make research into plasma better known. Very fine plasmas are used to deposit circuits onto micro-chips, so there are large numbers of people working for the huge corporations making these semiconductor chips. And one of their greatest concerns is the various types of plasma. Indeed, there are huge profits to be made by getting a new and useful angle on this subject. Many new developments are therefore understandably subject to close corporate secrecy. In addition to these corporate considerations, the military and security people are hard at work on plasma, and they do not shout from the rooftops either.

The number of advanced plasma scientists who do openly publish new findings, and are free to do so, is very small. When one of them dies, such as

Padma Kant Shukla (1950–2013), all of his colleagues in the field feel as if a whole wing of a mansion has been closed down, such was the vastness of his knowledge, and such is the sense of loss of both himself and of his wisdom and experience.

We will see later that heroic free thinkers and researchers have suffered from the attempts of the Nazis, the Soviet military and security complex, the CIA and others to control their work.

3

A Brief History of Plasma Research

If plasma research is little known even in many academic and scientific circles, it is pretty much unknown to general readers. In fact, many of the greatest and most brilliant scientists of the age have been involved in researching the area, including several Nobel Prize winners. I am proud to have counted some of them as my good friends, to have corresponded with them and discussed their ideas.

This book includes a historical view of plasma research. I have written it partly because its implications for our understanding of extraterrestrial intelligence and indeed our own intelligence are astonishing.

I will start with a brief account of how the terminology of plasma evolved, and this chapter will also introduce some of the eccentric personalities, mind-blowing ideas and amazing discoveries that feature later in the book.

In 1879, Sir William Crookes (1832–1919), an English scientist, discovered in his laboratory in London something strange, which he called ‘the fourth state of matter’.

Crookes was a chemist as well as a physicist; he discovered the element thallium, for which he is also famous. In 1895, he identified the first known sample of helium. But it was the discovery by Crookes of what he called ‘radiant matter’, which we now call plasma, that changed the whole of physics and chemistry. He had been studying cathode rays, which are rays of electrons. He established that they travelled in straight lines, that they could cause fluorescence, and generate heat in a Crookes tube [the vacuum tube, or valve, which was first invented by him]. He had opened the door and let in subatomic particles.[1]

I have Crookes’s first published report of it in front of me as I write, since I own an original copy of the *Proceedings of the Royal Society of London* for 1879–80, which contains it. It is on page 469, and it is entitled ‘On a Fourth

State of Matter'. Perhaps it is worth my quoting one of Crookes's astounding concluding remarks in that paper, which I believe has never been reprinted until now:

> These considerations lead to another and curious speculation. The [general view is that the] molecule – intangible, invisible, and hard to be conceived – is the only true matter, and that which we call matter is nothing more than the effect upon our senses of the movements of molecules, or, as John Stuart Mill expresses it, 'a permanent possibility of sensation'. [But in Crookes's view] the space covered by the motion of molecules has no more right to be called matter than the air traversed by a rifle bullet can be called lead. From this point of view, then, matter is but a mode of motion; at the absolute zero of temperature the inter-molecular movement would stop.

This statement of 1879 certainly gives us something to think about at the subatomic level, and it can readily be seen also that Crookes was anticipating the phenomena later to be known as superconductivity (here) and superfluidity (here), phenomena we will return to when we come to consider quantum mechanical qualities in plasma that may help give rise to intelligence.

The great genius Nikola Tesla (1856–1943), who invented alternating current and thus likewise played a huge part in bringing about the existence of the modern world through making it possible for everyone to have electricity, describes frankly in his autobiography that he only decided to study electricity and commence his electrical inventions, such as the Tesla Coil, because of inspiration from Crookes.

In his 1919 account of his life, Tesla wrote:

> Two or three months before I was in London in company with my late friend, Sir William Crookes, when spiritualism was discussed, and I was under the full sway of these thoughts. I might not have paid attention to other men, but was susceptible to his arguments as it was *his epochal work on radiant matter* [my italics], which I had read as a student, that made me embrace the electrical career.[2]

Later in life, Crookes became so interested in the possible existence of a 'spirit world' that he attempted to apply scientific techniques to psychical research. He

became something of a hero to the general public of Victorian and Edwardian England for his boldness in that, but many scientific colleagues pulled their longest faces and accused him of losing his senses and betraying science. However, as we shall see in Chapter 6 when we consider plasma and matters spiritual, Crookes's intuition may have been well ahead of his time and may have been amply justified.

Today we call matter in this fourth state 'plasma', the name given to it by the American scientist Irving Langmuir (1881–1957), who would win the Nobel Prize for Chemistry in 1932.

He coined the word because the way a charged gas carries electrons and ions reminded him of the way blood carries red and white corpuscles, so the plasma seemed to him to be 'alive'. His historic introduction of 'plasma' as a new word in physical science appeared in print for the very first time – together with the word 'sheaths' for the 'skins' of plasmas – in an article entitled 'Oscillations in Ionized Gases', which was published in August of 1928 in a scientific journal, where he wrote these memorable words:

> The word 'plasma' will be used to designate that portion of an arc-type discharge in which the densities of ions and electrons are high but substantially equal. It embraces the whole space not occupied by 'sheaths'[3]

It was then that the science of plasma physics was truly born; all the work that had been done since 1879 on what had been called 'ionized gases' or 'radiant matter' became known retrospectively as plasma research.

- 1941: Lyman Spitzer (1914–1997) suggested that interstellar dust particles might be acquiring charge from electrons in the form of 'ionized gas' (Spitzer's preferred name for plasma, 'ionized gas' was, as we have just seen, later abandoned). We now know that all interstellar dust is probably charged. But in 1941, this was an astonishing new idea.

- 1954: the Swedish scientist Hannes Alfvén (1908–1995) suggested that planets and comets in our solar system might have been formed as the result of the coagulation of dust particles in the solar nebula that had been charged by plasma. He won the Nobel Prize for Physics in 1970.

- 1955: Winston Harper Bostick (1916–1991) created the first artificial

plasmoid (blob of plasma) in his laboratory.

- 1955: Peter [Pytor] Leonidovich Kapitsa (1894–1984) suggested that ball lightning was really a spherical plasmoid, a type of plasma. Between 1930 and 1934 he was the first Director of the Mond Laboratory at Cambridge.

- 1958: Eugene Newman Parker proposed the existence of a ‘solar wind’. This proposal was first made by Peter A. Sturrock, with whom I carried on a correspondence on other subjects many years ago, and James Hartle. We now know the solar wind to be two different kinds of plasma wind emanating from the Sun. One is called ‘the slow solar wind’, which travels at speeds below 450 km s-1 and the other is called ‘the fast solar wind’, which travels at speeds of between 700 and 800 km s-1. But because the Sun is rotating clockwise, the beams do not go straight, they swirl with the rotation and form an Archimedean spiral shape in space, and hence swish across us rather than blasting straight at us, as illustrated in Figure 2.

  Inherent in them is a powerful magnetic field. The Ulysses spacecraft, launched towards the Sun in 1990, detected and thus confirmed the existence of these separate solar wind components in 1994/5. The space between the Earth and the Sun is completely filled with solar wind plasma. But prior to 1958, the ‘establishment scientific opinion’ said that ‘outer space is empty’ and was composed solely of vacuum.
- 1958: the Van Allen Radiation Belts – two doughnut-shaped belts made of plasma surrounding the Earth – were discovered, which we now know to be made of plasma: these will be considered in Chapter 4, (here).

  Also in 1958, the United States exploded a ten megaton atomic bomb in the high atmosphere (at 75 kilometres, or 46.6 miles) in order to produce an artificial aurora and study the plasma regions above the planet. (The follow-up studies were still going on a year later, so lasting was the damage to the high atmosphere.) Many more such atomic blasts followed. It is now believed that all of these atomic explosions, apparently about one hundred of them, and other crazily ill-advised military ‘tinkering’ with the high atmosphere by both sides in the Cold War, contributed to the instabilities of worldwide climate that we see today.

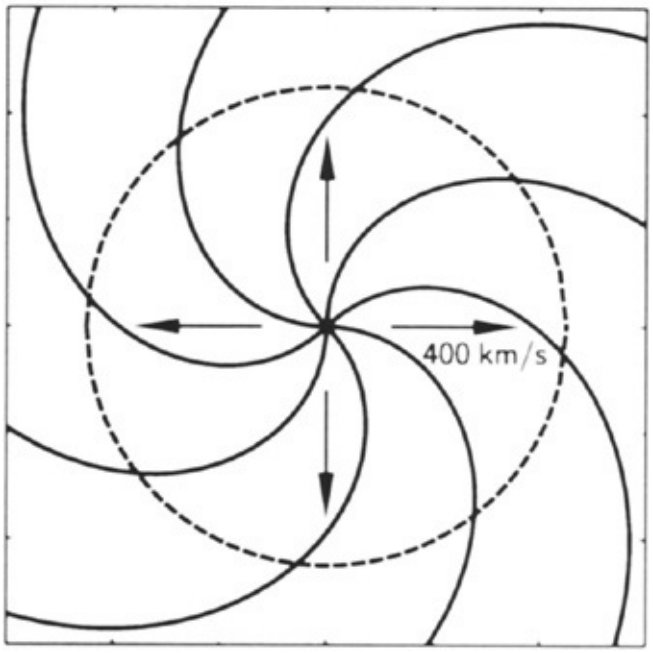


Figure 2. The central dark spot is the Sun. The dotted line is the orbit of the Earth, intentionally simplified here to look like a circle. The solar wind is not blasting straight at us, but is swirling in this way, with the swirls sweeping across us. This drawing is taken from Alexander Piel's excellent book *Plasma Physics* (2nd edition, Springer Verlag, Heidelberg, 2010). He does not give his source for it, and the speed has been indicated wrongly by the unknown artist, nor is the rotation taken into account for the speed indication. But the basic idea is clear, namely the Archimedean spiral form of the solar wind which fills our solar system.

- 1959: my friend Thomas Gold (1920–2004) coined the term 'magnetosphere' to describe a tear-shaped region of magnetized plasma surrounding the planet, which protects it from harmful aspects of the Sun's solar winds. Tommy also conducted important research on the Universe's continuous creation of matter, an important area of study that is very relevant to complex dusty plasmas, as we will see later.

- 1960: Theodore G. Northrop and Edward Teller (1908–2003) provided the theoretical explanation for the existence of the Van Allen Belts.

- 1961: in the Soviet Union David Albertovich Frank-Kamenetsky (aka Frank-Kemenetskii, but also mistakenly aka Kamenezki or Kamientsky) (1910–1970), suggested in an article for a technical journal that plasma may

exist within living organisms.[4] He thus anticipated much of the subject of the latter part of this book.

- 1962: Chandra Wickramasinghe, while still a PhD student of Sir Fred Hoyle (1915–2001) at Cambridge University, proposed that the dust known to exist in interstellar and inter-galactic space, until then thought to be ice grains, was really made of carbon. This entirely revolutionary idea – important to this book, because as we have seen, complex dusty plasmas contain such dust – was accepted by the astronomical community five years later.

- 1963: David Pines laid the foundations for quantum plasma physics and collective behaviour in 'solid-state plasmas' by his studies of 'the properties of electron plasma oscillations in high-density low-temperature quantum plasmas', in other words, the wobbles that happen in plasmas at extremely low temperatures. This may sound very obscure and technical, but we will see later that it was fundamental to the advance of plasma physics, including with regard to plasma's capacity for bringing some of the weirder quantum phenomena into the macro world.

  At the same time, my friend Peter Mitchell (1920–1992) published his full 'chemiosmotic theory' explaining that the energy functions of biological systems are based upon subatomic currents. This explanation came to be known as 'vectorial metabolism', because it describes the directions in space of energy usage within the body. In 1972, Peter introduced the term proticity, as already mentioned. He was awarded the Nobel Prize for Chemistry in 1978.

- 1982: Jay Hill and Devamitta Asoka Mendis suggested that the 'spokes' (so called by astronomers because they resemble the spokes of a wheel) found in the rings of Saturn the previous year by Voyager 2 consist of dust that has been charged in a plasma.

- 1986: Hiroyuki Ikezi predicted that plasma could exist as crystals. He called them 'Coulomb Crystals', named after Charles-Augustin de Coulomb (1736–1806), a pioneer of studies of electricity. He said these crystals could be formed by dust particles in a plasma. This is one of the key discoveries concerning the subject of this book, because crystals can play a vital role in storing information in ways necessary for the evolution of intelligence and for communication. As we will see later, it would be seven years before

Ikezi's prediction was proved to be correct.

- 1989: Gary S. Selwyn and his team at IBM published his discovery that plasma actually manufactured dust, and that the dust found inside fusion reactors and other sources was not dirt or contamination, as had been assumed, but was created by the plasma itself.[5] In his dramatic experimental discovery, Selwyn was able to show by laser light scattering that, starting from single molecules, dust grew naturally from nanometre sizes up to micrometre sizes within the plasma.

  This changed the whole of the science of plasma research. Until then plasma dust had been viewed as 'dirt', and how to avoid the 'contamination' by the dust or dirt was the focus of research attention. But once it had been demonstrated by Selwyn that plasma made its own dust, everything changed, and it was at this point that it became possible to envisage what we now call dusty complex plasma as a unique and very special type of plasma.

- 1993: Hubertus M. Thomas and Gregor Eugen Morfill announced at a plasma conference that they had discovered that the plasma crystals predicted in 1986 by Ikezi do really exist. In 1994 they published their research. At about the same time two other teams published papers making the same claim, one by Jiun-Haw Chu and Lin I, and the other by Yasuki Hayashi and K. Tachibana. As I will explain later on, dusty complex plasmas tend to contain plasma crystals, but it was only in 1993 that it became possible for scientists to make this assumption with confidence, to begin searching for them in earnest, and to include the crystals in their models of the complex interior structures of the plasmas.

- 1997: Jesper Schou, Philip Scherrer, and their team at Stanford University discovered gigantic plasma rivers flowing beneath the photosphere (commonly called the 'surface') of the Sun. A NASA press release from the Goddard Space Flight Center at Greenbelt, Maryland (Release 97-184, dated 28 August 1997) announced the discovery of '"jet streams" or "rivers" of hot, electrically charged gas called plasma flowing beneath the surface of the Sun'. The press release quoted Jesper Schou: 'Moreover, in what is a completely new discovery, we have found a jet-like flow near the poles. This flow is totally inside the Sun. It is completely unexpected, and cannot be seen at the surface.'

  Schou's colleague Philip Scherrer was quoted as saying:

> These polar streams are on a small scale, compared to the whole Sun, but they are still immense compared to atmospheric jet streams on the Earth. Ringing the Sun at about 75 degrees latitude, they consist of flattened oval regions about 17,000 miles across where material moves about 10 per cent (about 80 mph) faster than its surroundings. Although these are the smallest structures yet observed inside the Sun, each is still large enough to engulf two Earths.

> Schou and Scherrer also discovered that these rivers of plasma extend at least 12,000 miles below the Sun's 'surface' (i.e., the photosphere). Even more extraordinary, Schou and another colleague, Alexander G. Kosovichev (known as 'Sasha'), also discovered six additional plasma belts flowing beneath the 'surface', each of which is more than 40,000 miles across. If you add the widths of these flowing plasma regions together, they come to 257,000 miles total width of flowing plasma streams beneath the Sun's 'surface'. Just to put this number in perspective, it is greater than the average distance of the Earth from the Moon, which is 238,855 miles. (The orbit is not a perfect circle, hence the 'average'.) This discovery showed that dusty complex plasmas can contain fantastically intricate internal structures consisting of gaseous, liquid, and solid crystal plasma components, and that the crystals can liquefy and the liquids can crystallize.
>
> Dust and dusty plasmas are ubiquitous in nature, occurring in interplanetary and interstellar clouds, dust rings around planets like Saturn, on the surface of the moon, noctilucent clouds [night-shining clouds] in the mesosphere [the third layer of the atmosphere, just above the stratosphere], or thunder clouds.[6]

The ways in which charged dust forms 'self-organized systems' in plasma is key to this book. But because dust can be so varied, we might well ask if we need special kinds of dust in order to have self-organization take place, or will any old dust do? On this point there has been a surprising recent discovery, announced on 28 November 2019 in *Nature*. It was a news story about a paper just published in *Physical Review Letters*, whereby some scientists at Northwestern University in America had shown that 'tiny plastic beads wandering aimlessly through water can spontaneously form organized swarms and clusters – just like

swimming bacteria.’ The polystyrene spheres ‘artificially replicate bacterial swarming’.

This was accomplished by putting the microspheres in oil and subjecting them to pulses from an electric field. As a result of this, the spheres became electrically charged and began ‘to suddenly spin and propel themselves through the fluid’. By altering the pulses, the spheres were made to cluster together into large clumps. After this, by shortening the pulses, the result was ‘the formation of one continuous, roiling swarm of beads’, which resembled the swarming of bacteria.[7]

When confronted by this kind of behaviour in inanimate particles, simply as a result of the influence of electrical fields, one realizes that what seems to be ‘informed behaviour’ or ‘self-directed behaviour’ can manifest without life in the conventional sense even being present, much less in charge. This is a rather sobering realization. If the same behaviour exhibited by bacteria can also be seen in inanimate plastic spheres, then what does this really mean? At a fundamental level, we see here with the lifelike behaviour of inanimate particles so precisely mimicking living things that even the very definition of ‘life’ is threatened.

We need to keep uppermost in our minds that the question ‘What is life?’ is not going to go away, and we will need to bring it to bear when we consider the question of whether or not plasmas can be said to be living, intelligent and conscious.

The phenomenon of the patterned clustering of micro-particles is fundamental in dusty complex plasmas. When it happens, the clumps are known either as ‘Coulomb Balls’ (once again, named after the scientist Coulomb, as with the earlier case), or as Yukawa Balls. The latter are named after Hideki Yukawa (1907–1981), the Japanese Nobel laureate physicist.

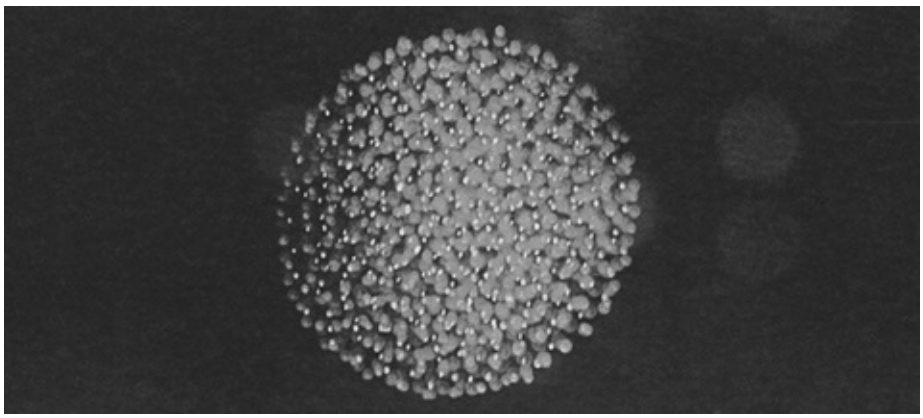


Figure 3. A Yukawa Ball, which consists of several hundred dust particles clustered together. The ball, which is a ‘strongly coupled’ (a term for describing elements of a system, such as particles, which have powerful interaction energies holding them together) dusty complex plasma structure, is approximately 7 mm across. The spherical cluster has a nested shell structure and is not just random inside. These balls are self-assembled. Such Yukawa Balls can form even at room temperature and do not need to have an exotic environment of very high or very low temperatures.

From Torben Ott, et al., ‘Molecular Dynamics Simulation of Strongly Correlated Dusty Plasmas’, 2010.[8]

Turning back to the question of where the dust comes from, in addition to the discovery that plasma manufactures its own dust, in 2017 Hamish Gordon and his collaborators revealed that the atmosphere also manufactures its own ‘new particles’ spontaneously from gas within the air itself. The new particles are nano-sized and they form in clouds in the Earth’s atmosphere from condensable vapours.[9]

The authors of this report in the *Journal of Geophysical Research* state: ‘New Particle formation has been estimated to produce around half of cloud-forming particles in the present-day atmosphere.’ They define new particle formation as ‘the process by which gas molecules collide and stick together to form atmospheric aerosol particles [particles floating in the air]. Aerosols act as seeds for cloud droplets …’

A paper later in the same year by Robert Wagner and his collaborators, which included Gordon, reported further: ‘The formation of secondary particles in the atmosphere accounts for more than half of global cloud condensation nuclei.’

They went on to say that their experiments at CERN revealed that the formation of these particles was aided by ions in a positively charged plasma:

> Our results indicate that ions enhance the nucleation process [the formation of nuclei around which particles can grow] when the charge is necessary to stabilize newly formed clusters.[10]

In the autumn of 2018, a further paper appeared on this subject by Dominik Stolzenburg, Paul M. Winkler and their collaborators.[11] They said:

> Nucleation and growth of aerosol particles from atmospheric vapors constitutes a major source of global cloud nuclei …

And further work on this subject was published in *Nature* in October of 2019, when Christina J. Williamson and her collaborators reported crucial new findings about the subject.[12] This team of researchers has discovered that new particle formation in the atmosphere 'persists at all longitudes as a global-scale band in the tropical upper troposphere, covering about 40 per cent of Earth's surface.' They say that global climate models do not take account of this and the existing climate models 'underestimate both the magnitude of tropical tropospheric NPF [new particle formation] and the subsequent growth of new particles to CCN [cloud condensation nuclei] sizes.' Accordingly, all public climate change discussions at the moment are deeply flawed because they rely upon inaccurate models.

This team says: 'New particles form in the atmosphere when condensing gases form stable clusters with diameters of more than 15 nm [nanometres] or so.' They then say that these particles are too small for detection by satellites, which are unable to detect particles smaller than 100 nm. That is why this important phenomenon has been missed, because it is so difficult to detect by our existing technology. As a result of these new findings, NASA has recently set up a programme to try to obtain more detailed information about these new particles in the atmosphere, so that we can know how they affect our climate models and, of course, our climate itself.

The formation of these tiny particles out of 'nothing' in our atmosphere is very similar to the formation of tiny particles out of 'nothing' in plasma, as both are a result of clustering processes within the two separate media of plasma and air. And both processes are quite recent discoveries: the plasma processes have been known for several years now, though not widely so, and as we have just seen, the atmospheric processes are an even newer revelation. The similarities of 'appearing to get something out of nothing' in both plasma and in air suggests that a universal process is being manifested in the two different cases.

And considering that, it is perhaps not surprising there is also another way of getting 'something out of nothing', which has been known since the 1990s, and it operates at an even more fundamental level. I am referring to the creation of a type of subatomic particle known as a baryon.[13]

Experiments have verified that the creation of baryon particles can occur when whirling vortices are created in a fluid medium such as Helium 3 (3He), a form of helium with the quality of ‘superfluidity’. This phenomenon is an important part of some of the weird quantum effects associated with plasmas, as we shall see shortly, and it arises where liquids can flow without resistance. A key article revealing a particularly important finding about this was published in *Nature* in 1997, and I have kept that issue of the magazine folded over to that article to remind me ever since its publication in the spring of that year.

It was the group led by T.D.C. Bevan who published this key article about what they called ‘baryogenesis’ (baryon creation).[14] Bevan went on to publish much more about this type of thing over the succeeding years, but this particular article was the first time that the creation of baryons by this method had been demonstrated in a laboratory:

> Here we describe experiments on 3He that demonstrate the creation of excitation momentum (which we call momentogenesis) by quantized vortices (flows around an axis at a quantum level of smallness) in the superfluid … our results provide quantitative support for this type of baryogenesis [creation of baryons].

I cannot take space to explain this fully or do justice to the details, especially as it involves discussing quarks, chirality, ‘spectral flow’, and all kinds of things of that sort which are not necessary in this book, but may be found by consulting the many papers of Bevan and his teams directly.

The main thing to come out of all this is the demonstration that those nuclear particles known as baryons have been created in the laboratory, and that they are also being created in a similar manner throughout space in superfluids, such as those to be found – as we shall discuss later – in dusty complex plasmas.

So we see clearly and repeatedly that it does not take something to create something, as it can just as readily be created by nothing.

So what is existence, if it can suddenly appear like that?

The plasma physicist who has done the most to call attention to the creation of matter within dusty complex plasma clouds is without question the Russian scientist Vadim Nikolaevich Tsytovich (born 17 March 1929 in St Petersburg, then called Leningrad, died 2015). For many years he published articles and

books reporting on advanced findings from dusty complex plasma research showing that something which looks very like life can be produced in charged dust clouds.

In one article in 2007 he stated clearly:

> It is concluded that complex self-organized plasma structures exhibit all the necessary properties to qualify them as candidates for inorganic living matter that may exist in space, provided certain conditions allow them to evolve naturally.[15]

Tsytovich and three colleagues including Sadruddin Benkadda were very specific about the self-organization within dusty plasmas of life-like phenomena, especially in an article that they published in 2000 and which I shall quote in a moment. But one technical word – dissipative – needs to be explained first. It does not refer to the common use of the word ‘dissipation’ to describe overindulgence in sensual pleasures. ‘Dissipative’ in this sense was first introduced into science in 1972 by the Belgian mathematical theorist Jan Camiel Willems (1939–2013), and became widespread because of its adoption and development by Ilya Romanovich Prigogine (1917–2003), the Nobel Laureate for Chemistry in 1977.

Prigogine entirely revolutionized the science of thermodynamics, which is essentially the study of the actions of heat and all that follows from them. Until Prigogine, it was widely believed that the Universe was steadily running down, that things slow down and fall apart, as the Second Law of Thermodynamics says they will.

What Prigogine discovered and proved was that energy brought into a chemical system, instead of always contributing by a process known as the increase of entropy (‘the progressive increase of disorder’), could be dissipated away into other directions and purposes that were productive and could form open, interactive structures such as life forms, known technically as ‘dissipative structures’. These structures, being like isolated islands of positivity in a sea of increasing entropy and hopelessness, could instead become increasingly complex and self-organizing systems.

Prigogine built upon these discoveries his concepts of self-organization, which are now at the heart of what we are finding in dusty complex plasmas. So what

Prigogine did was no less than explain the central role of life in the Universe. Although this was by no means heard by everyone, it was the philosophical death knell for the mechanical Universe.

And so we return to Tsytovich and his colleagues, and to plasma. Here are further comments made by Tsytovich and three colleagues in 2000:

> Self-organization processes in dusty plasma are expected to be very important since the latter is an open system with a high rate of dissipation … a high rate of dissipation provides rapid development of self-organization processes and formation of long-lived dissipative structures … Dusty plasma is an open system where the rate of dissipation is high and there is a tendency to self-organization. New types of nonlinear interactions are possible in dusty plasmas.[16]

The importance of dusty plasmas being 'open systems' is that they can absorb energy from outside, which then fires the growth of complexity. The Kordylewski Clouds undoubtedly 'feed' on energy from the Sun in this way.

The next year, in 2001, Tsytovich published a paper 'Evolution of Voids in Dusty Plasmas' on the important subject of voids, or empty spaces, inside dusty complex plasmas. 'It is shown that formation of dust voids is a general phenomenon in dusty plasmas.'[17] Voids are of immense importance in general, though rarely recognized. He went on to explain that whereas both dust structures and dust voids are formed in some plasmas, this cannot happen in a purely homogenous dusty plasma. There can be no internal architecture if the dust structures are not separated from one another by voids. A structure must be separated from the rest of the mass by a space, for otherwise it is no longer a distinct structure.

It is surprising how rarely people think of this. The human body is full of voids, and if it were not, you could not differentiate the kidney from the liver or the stomach from the lungs. Technically, these voids within our bodies are known as body cavities. And if the Kordylewski Clouds are to have the complex internal structure that we know dusty complex plasmas to have, then they too must contain voids, or cavities.

In 2004, Tsytovich and his friend Gregor Eugen Morfill (another of the world's most distinguished plasma scientists) published a paper making clear

that it is the non-linear character of the dusty complex plasmas which makes the self-organization of the internal structures possible:

> Dusty plasmas are unusual states of matter where the interactions between the dust grains can be collective and are not a sum of all pair particle interactions. This state of matter is appropriate to form non-linear dissipative collective self-organized structures.[18]

They pointed out that such findings were compatible 'with recent results of structure observation in the experiments on the Inter-national Space Station.' There were numerous plasma experiments carried out on the Space Station, because scientists were eager to see how plasmas behave in a gravity-free environment. Many results have come from this work.

In 2014, a major paper was published by Tsytovich with Alexey Ivlev, Andreas Burkert, and his old friend and colleague Morfill. It was a long and important review article entitled 'Compact Dusty Clouds in a Cosmic Environment'.[19]

In this paper, Tsytovich and his colleagues pointed out that in order to be stable, a dust cloud must self-organize and fill itself with 'clumps' and internal structure. If a dust cloud remains smooth, it will be destroyed. They also said that such stable clouds can be as small as one-thousandth the size of the Earth and still cohere. So we have their assurance, therefore, that the Kordylewski Clouds must contain internal structure and be self-organized in order to have survived. And they further add that this is all possible while remaining 'optically thin', in other words, being invisible.

The authors also say that within dusty plasmas dust can confine itself into stable spherical clusters:

> Spherical dusty clouds can be formed … suggesting that this process of dust self-organization might be a generic phenomenon occurring in different astrophysical media. We argue that compact dusty clouds can represent condensation seeds [in other words they can provide the necessary conditions] for a population of small-scale, cold, gaseous clumps in the diffuse interstellar medium. They could play an important role in regulating its small-scale structure and its thermodynamic evolution … Self-

> organization of dusty (complex) plasmas has been observed in numerous experiments. Different types of structures formed in dusty plasmas under microgravity conditions (in experiments performed on the International Space Station) as well as on the ground include compact clusters, voids surrounded by dust shells, vortices, etc … We predict that this process can occur in a broad range of plasma parameters, which indicates that such self-organization might be a generic phenomenon operating in different astrophysical media.

The giant spherical cosmic clouds discussed by Tsytovich and his colleagues, having between ten and a hundred times the distance of the Earth to the Sun as their diameters, are much bigger than our Kordylewski Clouds. And the giant ones he is discussing are also seen as forming in interstellar space between the stars, in a far thinner medium, whereas the smaller Kordylewski Clouds are in our own solar system, with a much denser medium, and with the constant feeding of energy into them by the solar wind.

Sergey Vladimirov, another of the most famous plasma scientists, has written:

> The dust-plasma system is an open system. Strong interactions of dust particles and the openness of the system lead to self-organization and 'structurization' of initially homogeneous dust clouds into a complex aggregate of dissipative dust structures. These structures become quasi-stationary within short time scales [in other words, they very rapidly become almost stationary] …[20]

In another paper, Tsytovich, Morfill and four other colleagues stressed how plasma crystals inside the dusty complex plasmas could spontaneously form helical structures resembling DNA:

> Complex plasmas may naturally self-organize themselves into stable interacting helical structures that exhibit features normally attributed to organic living matter. The self-organization is based on … physical mechanisms of plasma interactions … As a result, each helical string composed of solid microparticles [dust] is topologically and dynamically controlled by plasma fluxes leading to particle charging … These interacting complex structures exhibit thermodynamic and evolutionary features thought to be peculiar only to living matter … We examine the

> salient features of this new complex ‘state of soft matter’ in light of the autonomy, evolution, progenity and autopoiesis [autopoiesis refers to a system capable of reproducing and maintaining itself] principles used to define life. It is concluded that complex organized plasma structures exhibit all the necessary properties to qualify them as candidates for inorganic living matter that may exist in space provided certain conditions allow them to evolve naturally.[21]

This outspoken declaration could almost constitute a manifesto for the Kordylewski Clouds (though it was published twelve years before their existence was confirmed). Of course helical structures in humans have functions of storing and communicating information, so the crucial question raised here is: could helical structures in plasma have the same function? And could these be the seeds of an alternative, evolving form of life?

The authors go on to say:

> Memory and reproduction are necessary for a self-organizing dissipative structure to form a ‘living material’. The well-known problem in explaining the origin of life is that the complexity of living creatures is so high that the time necessary to form the simplest organic living structure is – ‘seems’ – too large compared to the age of the Earth … Can faster evolution rates be achieved for non-organic structures, in particular, in space consisting mostly of plasmas and dust grains, i.e., of natural components spread almost everywhere in the Universe? If yes, then the question to address is: are the above necessary requirements of self-organization into a kind of ‘living creature’ present in plasmas containing macro-particles such as dust grains?
>
> Here, we discuss new aspects of the physics of dust self-organization that can proceed very fast and present an explanation of the grain condensation into highly organized structures first observed as plasma crystal … Our analysis shows that if helical dust structures are formed in space, they can have bifurcations [instances of splitting] as memory marks and duplicate each other, and they would reveal a faster evolution rate by competing for ‘food’ (surrounding plasma fluxes). These structures can have all necessary features to form ‘inorganic life’.
>
> This should be taken into account for formulation of a new SETI-like program based not only on astrophysical observations but also on planned

> new laboratory experiments, including those on the ISS [International Space Station]. In the case of the success of such a program, one should be faced with the possibility of resolving the low rate of evolution of organic life by investigating the possibility that inorganic life ‘invents’ the organic life.

The passage specifically says that helical dust structures can replicate, in other words, like helical DNA molecules, inside dust clouds. Inorganic living entities are then formed that ‘compete for food’ in the form of sources of incoming plasma, which they eat. (As we have seen, in the case of the Kordylewski Clouds, most of their ‘food’ consists of the solar wind coming from the Sun.) All of this happens at a far faster rate of evolution than is the case with organic life, and in its development would outpace organic evolution by billions of years, hence clearly gaining dominance.

From this point of view, we as organic humans are rather primitive latecomers to a fantastically ancient tradition of inorganic life forms. And as they say, ‘a new SETI-like program’ should be started. SETI, as many readers know, stands for Search for Extraterrestrial Intelligence. After all, who needs little green men when you’ve got gigantic intelligent clouds on your doorstep, which are billions of times more intelligent than any little green man could ever be, billions of years older than any possible organic life form, and the entities who must in effect be the true Masters of the Universe?

Throughout this book we will be looking at research from around the world, particularly America, which complements and reinforces the work of Vadim Nikolaevich Tsytovich and his colleagues.

With ‘dust’ made by the plasma itself replacing ‘atoms’ as the building blocks, living bodies can be formed. We might consider the charged dust to be ‘dust atoms’, or perhaps more accurately, ‘dust molecules’. And from them, charged plasma entities can emerge by the process called self-organization. That means that no outside source needs to create them, as they can create themselves.

By this means, plasma people can exist, who are imperceptible to the optical nerves of the ‘physical people’ who are made not of plasma but of flesh and blood. Because we are incapable of directly perceiving the plasma people, we do not know they are there. And furthermore, they may be of such diffuse matter that they can pass through our dense physical matter and emerge intact.

Scientists know that ball lightning does this, as we will discuss in Chapter 4. Spiritual beings such as angels are also said to have this capability, which we will come to in Chapter 6.

If what these scientists are showing – and I for one think they are – is that the internal structures of the two clouds could be so complex, and at such a vast scale, then they surpass any possible human knowledge at this time. The storage capacity for information would easily include the ability to retain full knowledge of everything that has ever happened in our local cosmic environment for four billion years. Everyone who has ever lived will be recorded. Every creature that has ever roamed the surface of the Earth will be recorded. Every plant which has ever grown will be as well. The presiding consciousnesses, or what psychologists call ‘the executive ego states’, of the two clouds will have personalities so alien from our own that we cannot conceive of them. Since the clouds evidently exist as a pair, they may be ‘married’. (Or at least in a civil partnership?)

The questions are only just beginning.

4

The 99 Per Cent

One accepts those incompatible things which, only because they coexist, are called the world
– Jorge Luis Borges

In this chapter, I want to discuss a very surprising assertion that is not at all well known to the general public and perhaps not well known even by scientists who work in other fields, but is universally accepted by scientists who do work in the field of plasma research. Alongside our atomic, visible world is the subtler universe of plasma. It is in our understanding of that ‘other kind of matter’ that ground-breaking progress has been made recently.

Some will no doubt say there is no ‘other kind of matter’, and that I must be talking nonsense. But the fact is that the existence of other kinds of matter, several of them, has been now proved. In fact so much has recently become known about them that we can now begin to have some proper understanding of them.

Let us start by talking about the most basic ‘other kind of matter’, which is called plasma today, and which was first properly ‘discovered’ as long ago as 1879, though not named until 1928 by Irving Langmuir, as we have seen.

We have already seen, too, that plasma is very different from ‘physical matter’. ‘Physical matter’ is very rare in the Universe. At least 99 per cent, and some say more than 99.99 per cent, of the Universe is composed of plasma. We therefore live in a plasma universe, not a physical matter universe. But what does this mean?

What it means is that everything familiar to us on Earth is abnormal. What we call ‘physical matter’ exists in three familiar states: solid, liquid, and gaseous. These are, of course, exemplified in the three states of water: ice, liquid water,

and steam. And until 1879, those were thought to be ‘the three states of matter’, beyond which there were no others.

Nowadays the fact that the Universe is made of at least 99 per cent plasma is accepted by all astronomers, astrophysicists, cosmologists and the other scientists concerned with those subjects, but the implications of this remain obscure.

And the fact that new kinds of plasma keep being discovered does not make it any easier. The latest forms of plasma are so extraordinary that they are frankly baffling. And the very small community of plasma scientists at work on these problems, some of whom I quoted in the previous chapter, are making an astonishing amount of progress, but are doing so largely without the knowledge of other physicists and astrophysicists.

Here is what some of the leading scientists in the field have to say:

> Nearly all the matter in the universe exists in the plasma state, occurring predominantly in this form in the Sun and stars and in interstellar space.

(Anthony L. Peratt, *Physics of the Plasma Universe*, 2nd edition, 2015, p. 2.) Peratt was Scientific Advisor to the United States Department of Energy between 1995 and 1999. He was Acting Director of National Security, Nuclear Non-Proliferation Directorate, in 1998. Since 1981 he has been associated with the Los Alamos National Laboratory.

> All but an infinitesimal part of the universe appears to be made up of plasma, probably all of it magneto-plasma. Thus in most problems in cosmic electrodynamics we are dealing with a non-rigid and electrically conducting medium extending to infinity … the remainder of the universe is made up of various plasmas … The plasmas with the lowest degrees of ionization are the lower parts of the ionospheres of the Earth and other planets. These regions are really boundary regions between the universal plasma and the small insulating, atmospheric shells.

(John Hobart Piddington, *Cosmic Electrodynamics*, 1969, pp. 24–5). ‘Jack’ Piddington (1910–1997) was Chief Research Scientist at the National Measurement Laboratory in Sydney, Australia, from 1966 to 1975.

> It is likely that 99 per cent of the matter in our universe (in which the dust is one of the omnipresent ingredients) is in the form of a plasma. Thus, in most cases a plasma coexists with the dust particulates. These particulates [matter in the form of minute separate particles] may be as large as a micron. They are not neutral, but are charged either negatively or positively depending on their surrounding plasma environments. An admixture of such charged dust or macro-particles, electrons, ions, and neutrals forms a 'dust plasma'.

(Padma Kant Shukla and Abdullah al Mamun, *Introduction to Dusty Plasma Physics*, 2002, p. 1.) Shukla (1950–2013) was Distinguished Professor and Director of the International Centre for Advanced Studies at Ruhr-University Bochum in Germany. Mamun is Professor of Physics at Jahangirnagar University, Dhaka, Bangladesh.

> The three states of matter which occur at the surface of the earth are however not typical of matter in the universe. Most of the … matter in the universe exists as plasma …

(Marcel Goosens, *An Introduction to Plasma Astrophysics and Magnetohydrodynamics*, 2003, p. 1.) Goosens is Professor of Applied Mathematics at the Catholic University of Leuven in Belgium.

> Scientific interest in high-energy plasmas has also been rekindled along with pragmatic interest, because the great bulk of matter in the universe is in precisely this exotic state. For about 95 per cent of the mass (neglecting dark matter), according to modern estimates, is the plasma of ordinary and neutron stars, pulsars, black holes, and giant planets of the solar system, as well as the recently discovered hundreds of planets beyond the solar system.

(Vladimir Yevgeyevich Fortov, *Extreme States of Matter on Earth and in the Cosmos*, 2011, p. ix.) Fortov is one of the leading scientists in the world in his field, and is currently President of the Russian Academy of Sciences.

> … in most of the universe, plasma is actually the 'first' state of matter, and by a very large margin. Out there, fully intact atoms are abnormal in the extreme. Practically all the visible contents of the cosmos – not just stars,

> but even regions of rarefied interstellar dust containing barely a million particles per cubic metre – are in a plasma state.

(Curt Supplee, *The Plasma Universe*, 2009, p. 1.) Supplee is a science writer who has won the Science Journalism Award from the American Association for the Advancement of Science, and other such awards, and has been nominated twice for the Pulitzer Prize. At one time he was Director of the Office of Legislative and Public Affairs at the National Science Foundation in the USA

> Plasma physicists know that … the universe is not made up of 'invisible matter' but rather of matter in the plasma state … electric plasma … fills more than 99 per cent of the universe.

(Donald Edward Scott, *The Electric Sky*, 2012, p. 3.) 'Don' Scott is retired Professor of Electrical Engineering at the University of Massachusetts/Amherst.

> Among all objects observed in nature, about 90 per cent exist in ionized form. Plasmas, often considered the fourth state of matter, span a huge diversity of parameter scales and exist throughout the universe.

(Michael Bonitz, et al., *Introduction to Complex Plasmas*, 2010.) Bonitz is Professor and Chair of Statistical Physics at the Institute of Theoretical Physics and Astrophysics at Christian-Albrechts-University at Kiel in Germany.

> Under ordinary terrestrial conditions the plasma state of matter is quite rare and unusual. But in the universe, cold solid bodies such as our Earth appear to be a rare exception. Most of the matter in the universe is ionized, i.e., it exists in the plasma state … In our own solar system the Sun consists entirely of plasma, its mass being three hundred and thirty thousand times larger than the mass of the Earth. The upper layers of the Earth's atmosphere are ionized by the Sun, i.e., they consist of plasma … Many plasma phenomena are evident on a colossal scale in deep space … In our opinion mankind is entering into the space age which, to a considerable degree, is also a plasma age. This new stage in the growth of science and technology imposes increasing requirements on the youngest branch of physics, plasma physics.

(David Albertovich Frank-Kamenetskii, *Plasma: The Fourth State of Matter*, 1972, pp. 2–8.)

> … space is not empty. A percentage of atoms in space are positively charged due to the loss of one or more electrons. The resulting exceedingly thin medium, containing positive ‘ions’ and negative electrons, is plasma, sometimes called ‘the fundamental state of matter’ since it constitutes more than 99 per cent of the visible universe. The electromagnetic behaviour of plasma clearly distinguishes it from solids, liquids, and gases.

(Wallace Thornhill and David Talbott, *The Electric Universe*, 2008, p. 6.) Thornhill studied physics and electronics at the University of Melbourne and subsequently became an independent scholar. Talbott is an independent scholar.

> The properties of plasmas are of paramount interest in cosmical physics because most of the matter in the universe is in the plasma state. In the interiors of stars the gas is almost completely ionized … Vast regions of interstellar space around the stars … are highly ionized …

(Hannes Alfvén and Carl-Gunne Fälthammar, *Cosmical Electro-Dynamics: Fundamental Principles*, 1963, p. 14.) Hannes Alfvén won the Nobel Prize for Physics in 1970. Fälthammar is Professor Emeritus at the Royal Institute of Technology in Stockholm, where he succeeded Alfvén as Professor of Plasma Physics.

> Most of the universe is plasma … As astronomers began to realize that the universe is mostly plasma, they also came to the conclusion that plasma physics might help to explain many of the unanswered questions about how stars are created, and how they die out. Plasma physicists began making important contributions to astronomy and cosmology in the 1950s. Then, in the 1960s, startling discoveries burst upon the astronomers. Quasars and pulsars, exploding galaxies and disappearing stars all clamoured for explanation. In all of these exciting and strange new phenomena, plasma physics plays a key role. For there are cataclysms exploding in the heavens of a violence undreamed of even a few short years ago. And only plasmas are energetic enough to undergo such shattering catastrophes. To understand what’s happening in the heavens – to understand how our own Sun and Earth were born and how they will die – we must understand plasma physics … The ‘emptiness’ between Sun and Earth, then, is actually a rich domain of plasmas and electromagnetic energies.

(Ben Bova, *The Fourth State of Matter: Plasma Dynamics and Tomorrow's Technology*, 1971, pp. 28–31, 90.) Bova is a popular science writer, former editor, and former President of the National Space Society in the USA.

> It is often said that 99 per cent of the universe is in the plasma state … The Earth's atmosphere, too, becomes a plasma beginning about 100 km above the Earth's surface.

(Atsuhiro Nishida, *Atmospheric Plasma Physics*, Vol. 4, 1982, p. vii.) Nishida is Professor Emeritus of the Institute of Space and Astronautical Science in Japan.

From the range of authoritative comment shown here, we can see now that there is an overwhelming consensus among scientists researching in this area that the Universe is mostly a plasma universe, and that what we call 'physical matter', or what I prefer to call 'atomic matter', since it is not plasma, must be very rare indeed. And plasma is the fundamental building block of atomic matter:

> … a plasma is the first state of matter out of which all the other states of matter originated … Nature began with the plasma.

(Vinod Krishnan, *Introduction to Dusty Plasma Physics*, 2014, pp. 1, 2.) Krishnan is Senior Professor and Dean of Sciences at the Indian Institute of Astrophysics, Bangalore, India.

> Nature began with the plasma. Cooling of the plasma converted it into a gas. Cooling of the gas converted it into a liquid. Cooling of the liquid converted it into a solid … That plasmas are the first state of matter out of which arose the other three states of matter has been amply demonstrated. The ubiquity of plasmas in the universe needs no demonstration. The phenomenal diversity of plasmas is there all over the universe for all to see.

(Vinod Krishnan, *Plasmas: The First State of Matter*, 2014, pp. 1, 40.) See above.

Turning everything upside down

Anyone who thinks he or she has never seen plasma hasn't been outside lately. As we have mentioned, the Sun and stars are made entirely of plasma. It seems likely that the giant planets Jupiter, Saturn, Uranus and Neptune are also made largely of plasma. There is a sphere of plasma surrounding the Earth, called the ionosphere. Above that is the magnetosphere, which was given its name in 1958 by Professor Tommy Gold.

The magnetosphere contains huge regions of plasma within the Van Allen Radiation Belts, which were named after their discoverer, James Van Allen, who found them in 1958. (Later we will learn the details of how that occurred.) We see plasma in thunderstorms, because lightning is plasma. Fluorescent lighting occurs when you turn on the switch and electricity shoots through a tube containing a gas such as neon; during the time it is turned on, that tube contains plasma. When you turn it off, the contents of the tube revert to ordinary neon again, which no longer emits light, and all the plasma is gone. Your flat TV screen contains plasma when it is turned on. So you see, plasma is everywhere and we see it every day that the Sun shines or when we are watching television. It is simply a matter of knowing what you are seeing (or not seeing).

In light of what we now know about the predominance of plasma in the Universe, we really need to turn our physics on its head. Instead of trying to model the Universe on the basis of the very rare and specialized form of dense matter found on our planet, we need to treat dense 'physical matter' as an exceptional form of the true 'universal matter', plasma. There is no use in our trying to establish universal laws on the basis of a tiny sample of far less than one percent of what exists. We need to establish physical laws on the basis of plasma and specify what we call 'physical matter' as a very special and limited case, which has no justification for being used as a basis for describing the majority constituents of the Universe.

So drastic does our rearrangement of science need to be that we can take our present physics, shrink it and plonk it into a tiny corner of the representation of the wider truth, where it can describe those minority conditions appertaining to planets and other such 'solid' bodies, as a kind of footnote or addendum to a true universal science. None of our human scientific work so far need be wasted, for it can all provide a very useful account of what goes on in those rare, small 'solid' bodies where dense matter predominates and where such atypical conditions apply.

Scientists residing in the plasma realm could read and study this with the greatest of interest, in the way that we study the strange conditions found in deep-sea thermal vents, astonished that such life forms can exist. Indeed, we as humans might even attract some useful attention to ourselves and find ourselves becoming a niche attraction, like bearded ladies in a circus.

We cannot therefore draw conclusions about universal truths based upon a highly divergent, atypical, and almost infinitesimally small percentage of what exists. We cannot be certain that any of our physics is universally applicable and hence ‘true’ in the sense that we have complacently assumed.

Before I begin the history of human encounters with and understanding of plasma, I want to return to the subject of a seemingly naturally occurring manifestation of plasma which, although relatively rare, is dramatic and may help us understand the descriptions of various religious phenomena in ancient history, as well as helping us to understand a way that plasmas such as the Kordylewski Clouds might interact with us.

5

Great Balls of Fire

Ball lightning has been puzzling people for thousands of years. It is surprising that, despite the fact that numerous photos and film of ball lightning exist, and the fact that it can even be artificially created in the laboratory (this was first achieved in St Petersburg in 1753 by Georg Richmann, though it killed him), there are still people who grumble and complain that it doesn't exist.

Ball lightning is a 'plasmoid', which is to say a blob of plasma. There are several fascinating books about ball lightning. One of them, *Ball Lightning* by Mark Stenhoff, published in 1999, has however the ominous subtitle *An Unsolved Problem in Atmospheric Physics*.[1] Ball lightning is indeed still an enigma, and it may have some connection with the Kordylewski Clouds, as I shall also explain later.

Very briefly, ball lightning is generally a spherical or nearly spherical glowing ball of fiery light that rolls along the ground or flies through the air, and sometimes passes through solid walls and emerges intact on the other side. It has sometimes been seen rolling down the aisles of passenger planes and frightening people.

The first book on ball lightning ever published in Britain, and the first I ever saw, was *The Taming of the Thunderbolts: The Science and Superstition of Ball Lightning*, by C. Maxwell Cade and Delphine Davis.[2] It was published in 1969, and I came across it and bought a copy in the very early 1970s. They used the word 'thunderbolts' to describe ball lightning, because that is what it was called in ancient times, and the early part of the book traces the history of accounts of what was probably ball lightning in the Bible (Ezekiel) and the classical authors Pliny and Lucretius up until modern times. They collected 107 case history accounts and in their Acknowledgements they said that they spent five and a half

years researching the book and wrote ‘almost 1000 letters with correspondents in sixteen different countries’.

At the time the book came out and in the years immediately following, there were derisory reactions, and the authors were assailed by many scientists as having written about something that did not exist and was a mere fantasy. There are now hundreds of scientific publications about it, it has often been photographed, and there are many films of it easily available on YouTube. There is no doubt that it not only exists but has existed throughout the whole of recorded human history, and doubtless for the whole period of existence of our planet.

Ball lightning is indisputably electrical in nature (whatever theory one has for how and why) and has several characteristics in common with traditional descriptions of ghosts. For instance, if there is a high wind and a sphere of ball lightning appears in the air, it can move steadily against the wind as if the wind were not blowing. In other words, the wind does not appear to effect it in any way, even though the glowing sphere is generally rather small, so that it should be so light in weight that the wind would blow it away very fast. Spheres of ball lightning can also, as I say, sometimes pass through solid walls and emerge intact on the other side as if the walls had not been there. This is what ghosts are often claimed to do.

I am not necessarily suggesting that most ball lightning of the usual sort is intelligent, but it is also possible that some ball lightning phenomena are associated with intelligent entities, and are even ‘plasmic drones’. I say this because a minority of reports describe their behaviour in such a way that suggests intelligent control of their movements, as they seem to be inspecting people and things, and also spotting, pursuing, and entering aircraft in flight, which presumably would be impossible for a mindless entity, or one that was not remotely controlled by an intelligent entity as a probe.[3]

Considering the existence of the Kordylewski Clouds, and my suggestion that they are intelligent, it makes sense that they would want to monitor what is going on here on Earth. And so what would make more sense than to have plasmoid reconnaissance? I therefore suggest that many of the balls of lightning and similar phenomena, and hence also many UFOs, are scouts and surveillance drones operated by the clouds. The sudden movements observed in so many glowing UFOs, the right-angled turns, the rapid disappearances, the vast speeds,

the ability to go underwater and re-emerge, and so on, all make instant sense if one assumes that they are probes from the plasma clouds.

The storage capacity for information of the two clouds, which together are nine times the size of the Earth, means that the entire history of humanity could be stored in them, as suggested earlier, and that the US National Security Agency's super-computers in Utah, which store all the telephone and internet communications on Earth, are ridiculously puny by comparison. It is impossible to resist the suspicion that the clouds know so much more about Earth events than all the security agencies in the world combined that any attempt to equal their surveillance powers would be futile. Plasmoid reconnaissance and surveillance drones would not need to be operated by anyone, but the clouds may have created robotic physical entities to act for them.[4]

In considering ball lightning further, there are certain fundamental texts that must be consulted. There is, for instance, a group of three inter-related books by three different authors who all assisted one another. Two of them were Americans with access to extensive files of defence contractors, NASA, and the US Air Force and US Navy, and the third was a British friend of theirs. The three books are:

The Nature of Ball Lightning by Stanley Singer (1971)
Ball Lightning and Bead Lighting: Extreme Forms of Atmospheric Electricity by James Dale Barry (1980)
Ball Lightning: An Unsolved Problem in Atmospheric Physics by Mark Stenhoff (1999).[5]

The authors of all three of these books shared the same basic bibliography, which is a truly enormous one. Singer's book (which lists 594 references in many languages) was largely funded by defence sources. As he says in his Preface: 'A major portion of the work was supported by the Office of Naval Research.' It was clearly through these defence contacts that many reports, translations of foreign works, and publications that have never been made available to the public were included in the bibliographies and apparently shown to the authors for personal consultation.

These include, for instance, private reports or translations on ball lightning commissioned by the private defence contractors Raytheon Corporation and

Avco Corporation. (The latter company in 1960 built an experimental aircraft for the US Air Force that was shaped like a flying saucer or ‘flying disc’. As for Raytheon, ‘everyone knows about them’, by which I mean that one is continually reading and hearing that they are part of the ‘military and security establishment’.) By looking through the bibliographies of these three books, we can see how seriously the American and Soviet governments were taking research into anything to do with plasma.

Numerous researchers thought ball lightning might be harnessed for weapons, such as the directing of balls of lightning at enemy tanks and planes. So, of course, when there is any possibility of devising new and improved ways of killing people, the money always pours in to support research. A very large proportion of the research that was carried out in America and the Soviet Union on ball lightning remains secret and will probably never be released.

Singer and Barry, mentioned above, collaborated on a joint paper delivered to the First International Symposium on Ball Lightning, which was held at Waseda University, Tokyo, on 4–6 July 1988. Singer was also an advisor to the Organizing Committee of the conference. The conference was attended by fifty-four scientists from eight different countries, under the Chairmanship of Professor Yoshi-Hiko Ohtsuki. The conference was held outside of government sponsorship or control, and was sponsored by a group of nineteen major Japanese corporations, including Fuji, Honda, and Sony. The Proceedings of the conference were published in 1988 and contain a great deal of important information, and although I have a copy myself, these Proceedings are now unobtainable for sale.[6] Anyone interested in ball lightning should try to find library copies of these important Proceedings.

Skimming quickly over some of the strange ball lightning phenomena that have been discussed at such length in numerous books and articles, with hundreds of case reports, we find that ball lightning can enter closed rooms and buildings; it appeared frequently inside Second World War American submarines running along the floor; and it has often occurred in airborne planes. It also goes up and down chimneys, and it sometimes appears to ‘inspect’ things such as patterns on carpets; it can explode, it can be dangerous, and it can even kill people on rare occasions. Usually it is harmless, but sometimes it is deadly.

Another more recent book on ball lightning is *Ball Lightning: Paradox of Physics* by Paul Sagan (2004).[7] This interesting book concentrates on classifying

the bizarre phenomena associated with ball lightning, which the author often calls ‘fireballs’. The author has headings such as ‘fireballs endanger Hill Air Force Base’, ‘fireballs defy gravity’, ‘line rollers’, ‘flyers and bouncers’, ‘airplane crashes’, ‘dazzlers and hissers’, ‘mechanical damage’, ‘electrical and heat damage’, ‘electrical effects’, ‘trees emit fireballs’, ‘atop cooling towers’, ‘fireballs eat lightning’, ‘colliding fireballs’, and ‘shrinkers and expanders’.

These things are not made up, they are real phenomena. All of these bizarre events represent intrusions of plasma into our world of dense physical matter. Sagan has an important section called: ‘Do Flying Fireballs “Think”?’ This is not as fantastic as it sounds. Here is some of what he says:

> But fireballs possess sensory, energy generation, navigation and propulsion systems. Since ball lightning is buoyant, how come some fall rapidly from clouds like falling cannonballs, rebound before hitting the ground, and then float lazily against the wind or rapidly shoot back up to the clouds? How does a ball ‘know’ where an aircraft is, follow it closely and not be affected by the 500 miles-per-hour airflow and turbulence, and not just tumble or be swept away in the wind and turbulence? What possible detection, sensory, energy generation, navigation and propulsion system do fireballs possess? No other natural or man-made control feedback system matches their incredible behaviour.
>
> A microprocessor-based system or fireball with sensors that can materialize and fly, then detect electromagnetic, electrostatic, metal, solid objects, chimneys from a distance, distinguish a standing person from a post, and so on, would be an amazing feat of technology. But, for a supposedly hot ball of gas – it is not made of semiconductors and wires – to do these tasks of sensing, control and navigation is not a question for technology, but a mystery of physics.[8]

Paul Sagan has made one major error in this passage from his book. He implies that these ‘balls of gas’ are not made of semiconductors and wires. On the contrary! As we will see in Chapter 11, plasmoids can indeed have the equivalent of semiconductors within them, and as for ‘wires’, Sagan is referring to copper wires no doubt, but much more efficient means of carrying directed current exist than ‘wires’! We have to stop thinking in terms of physically dense matter. As we will see shortly, semiconduction does not require physically dense

substances like silicon and germanium microchips, and the transmission of current does not require wires of any kind!

Plasma equivalents of both semiconduction and wires are fundamental to complex plasmas, especially to plasma crystals. And it appears that some fireballs, or lightning balls, are indeed complex plasmas, and as we will see later, the ones that are of that kind can be full of internal ‘cells’, semiconductor regions, and filamentary current carriers galore. We have begun building the argument to show that internal structure self-organizes and ‘emerges’ from dusty complex plasmas, and some of the lightning balls are probably of that category of plasma.

There are so many fantastic aspects to ball lightning, recounted at great length in the various books and hundreds of articles, that it would be pointless for me even to begin to try to summarize them all here. Ball lightning has clearly often been responsible for some UFO sightings, and that is something that requires no imagination to understand. More troubling are the connections of ball lightning with poltergeist phenomena and spontaneous combustion of human beings. There are accounts of people having been burnt alive, but their clothes left unharmed by the ‘fire’, and sometimes even their skin has been left unharmed.

And as for poltergeist connections, lightning balls have been associated with strange incidents where the contents of closed rooms have been smashed as if by angry ghosts. Psychical researchers have often been called in to cases of apparently paranormal phenomena, which are associated with lightning balls, just as UFO researchers have often had reports of UFOs that turned out to be ball lightning.

Two other major efforts to deal with ball lightning in book form need also to be mentioned. The first is an entire volume on the subject issued by the Royal Society in London in 2002. This was edited by John Abrahamson.[9] It formed an entire theme issue of the Philosophical Transactions. This was a remarkable breakthrough for ball lightning research, because it showed that the highest levels of Scientific Establishment respectability were being accorded to the subject within the civilian context (as opposed to the secret military and security contexts). In short, ball lightning research had now ‘come out of the closet’. No longer were stuffy scientists going to say that only cranks and lunatics could discuss this subject, and treat those scientists who dared to do so as renegades.

The Royal Society volume included a contribution by Stanley Singer, whose important book on the subject of 1971 (supported by the US Navy) I have already mentioned. At last he could come fully out of the shadows on this subject! The volume also included contributions by the Russian scientists Alexander Vladimirovich Bychkov and Vladimir Lvovich Bychkov, who have major international reputations. (Vladimir Bychkov is a co-editor of the book *The Atmosphere and Ionosphere: Elementary Processes, Discharges, and Plasmoids*, published in 2003 by Springer Verlag, which also contains some material about ball lightning.) The other publication deserving of attention, by the Torchigins, for reasons of space is described in a footnote.[10]

Going back a bit in time, in 1943, the Mexican scientist Manuel V. Cerrillo was the first person to suggest (in a report written in Spanish for the Mexican Government) that ball lightning is a ‘standing wave’ or ‘soliton’ phenomenon. We will come to an examination of these in Chapter 11. What is important here is that lightning balls are, as I have already suggested, an example of extremely fine structures that are able to move through space and also through denser objects while keeping their shape and internal structure. In this way one of the weird phenomena at the subatomic level described by quantum mechanics – called solitons – can also happen at the macro level in plasma.

On the other hand, ball lightning sometimes seems to shatter when it strikes a surface. It can hit you with a whammy and electrocute you, or it might strike you and be harmless. The subject is still mysterious and there is a lot to learn. One thing does seem sure, namely that plasma is involved.

I have seen ball lightning only once. My wife and I were driving one night during the 1970s on the road north from Banbury in England. Olivia was at the wheel and I was in the passenger seat, and I saw a strange light sitting in a tree about fifty feet away to the left of the road. It was an eerie glowing sphere of mixed red, white, pink, and orange light. My estimate of the size of the sphere is that it must have been about four feet across (about 1.3 metres). It did not move, it sat motionless on a tree branch.

Because my wife was driving very slowly on a dark two-lane road in our old Morris Minor, I was able to observe the ball for a minute or two clearly. It seemed to consist of a luminous gas, which was effervescent and fiery. If it gave out a sound or smell I could not have detected either, because of the noise of the car engine and my distance from the ball. (Ball lightning often hisses and gives

off smells of sulphur or brimstone.) There was no thunderstorm activity going on at the time, and it was a quiet evening. So that is the sum of my limited personal experience!

My sighting was unusual in only two senses, first that the ball was motionless, and second, that it persisted for longer than usual, as ball lightning often vanishes very rapidly. I also had the uncanny feeling that the ball was ‘alive’, which I then decided could not have been true, but nevertheless, that was the subjective impression it gave, as I had a distinct feeling of being watched by it. That is the feeling one often has when being stared at from behind, and you turn around and there really is someone staring at you. And it was like the way that a barn owl perching on a gatepost seems to stare at you penetratingly in the flash of the headlights as you drive past it on a country road late at night. I wanted to go back and investigate, but there was nowhere to pull over, it was late, dark and cold, and so we did not bother.

I have on one other occasion had the impression that I was being ‘observed’ by a plasma, so I shall briefly mention the incident. During 2014 or 2015, my wife and I were asleep in a hotel room in Paris, where the usual flat screen plasma TV set was mounted on the wall. I woke up from a deep sleep suddenly, because I felt that someone was staring at me. I opened my eyes very quickly without moving, and I could see that the TV set had somehow turned itself on and had a grey screen showing visual static, with no sound at all. There was no broadcast being received, and the remote control was far from the bed and we had never touched it during our stay. I had the subjective impression that the TV set was alarmed to see that I had observed it watching me, and being on when it should not be, so it immediately turned itself off and faded to black.

That is the only time that has ever happened to me, but on a few occasions TV sets and DVD players have turned themselves on suddenly when I have been in the room, and in one case a machine spontaneously went through a sequence of three separate ‘on’ switches to start working of its own accord. However, on none of those occasions did I have the creepy feeling that someone was watching me.

One night in my office when I was working late writing something, the office printer turned itself on of its own accord and spewed out an A4 page with a photograph of my very close friend Michael Baigent, who had died not long previously. I had not touched anything but my keyboard as I worked on a

document, and the printer had been turned ‘off’, remaining only on standby (i.e., the electric power was still on but the machine was off). The photo had been stored in my computer amongst hundreds of other photos and I had not looked at it for months. I took this as a ‘Hello!’ from my friend Michael.

When I told his wife Jane about it the next day and emailed her the photo that had self-printed, she was shaken, but very cheered up to think that he might have sent a message letting us know he was still alive, though ‘dead’. But just so that we could not possibly misunderstand from whom the message came, there was Michael staring up at me from the paper with that mischievous look which he often had whenever he was telling me something especially provocative or unusual.

My own theory is that ball lightnings are charged plasma crystals containing a massive amount of microscopic dust particles, which become visible under certain conditions.

As early as 1955, the famous Russian physicist Peter [Pyotr Leonidovich] Kapitsa suggested that ball lightning was a spherical plasma.[11] He began his article of that year by saying: ‘The nature of ball lightning is not yet understood.’ That’s for sure! His main question here is ‘where does the energy for the ball come from?’ He does many calculations and makes assumptions, some of which since 1955 have become obsolete, and are entirely based upon classical physics. I shall skip his discussions of energy sources, sizes, durations, wavelengths, etc., much of which I believe to be today irrelevant, and look instead at the part of his article that is still of continuing interest.

Kapitsa believed that lightning balls were formed in the following manner: ‘Initially, there exists a volume of plasma, which is small … (and) weakly ionized …’ But then it resonates with and becomes excited by radiation, which ‘causes effective absorption of radio waves. Because of this, the ionization grows and with it also the initial volume of the sphere, which as yet has not reached a diameter (d). Eventually, the resonance characteristics of the absorption process will be determined only by the geometry …’

This may sound a bit confusing, but what I want to stress is his bringing in the essential matter of geometry. To my knowledge, nobody had ever done this before. He is referring to the geometry of radiation coming from ‘a source of energy still unknown to us’, which is ‘outside of the volume of the lightning ball’ and has created an electric field. In other words, he conceives of the electric field

that supplies the energy for the lightning ball as having geometry.[12] (See the footnote for some further details of very great interest.)

It is not necessary for the reader to know any more of the complicated technical details than this. Kapitsa is invoking what we can now see is a crystalline structure of an electric field. Electric fields always have structure of some kind, which can be suggested by drawings of shapes of the fields using the device known as ‘lines of force’ as visual aids. But a crystalline structure is a different matter. It is a rigidly fixed pattern, which is a more ordered kind of structure, a higher level of order for a field. Such phenomena had never been imagined before.

Of course, Kapitsa did not think of it like that or ‘see’ that. He was (as my footnote makes clear) thinking of nodes, antinodes, and resonance points in the sense of their being action points or foci. He did not conceive of them as being joined in a structural entity. I look at this differently, and I see those points as vertices of a geometrical plasma crystal. But having adopted my conception of the plasma crystal, we can use Kapitsa’s scheme and other similar ones as the internal structural maps of those crystals. And such resonance phenomena as Kapitsa invokes from his ‘unknown energy source’ could even be formative causes of the plasma crystals.

Readers may wonder about what it means to call a plasma crystal a crystal. After all, we are used to holding gems and quartz and such things in our hands, turning them around, looking at them gleam, or wearing them in rings and bracelets, etc. What possible justification can there be for calling a cloud of plasma in space or a ball of plasma ‘crystalline’? Well, it is really a scientific convention, perhaps illuminated by words on ‘what is a crystal’ from an essay by Eugene Wigner, who won the Nobel Prize for Physics in 1963:

> X-ray studies have revealed that most of the solid bodies in our surroundings are crystalline. This does not necessarily mean that they are formed by one single crystal – although even this can be true for bodies of such enormous size as icebergs. More commonly, they are polycrystalline, like the metal parts of ordinary tools, i.e., a conglomerate of microscopic crystals of various sizes. Crystalline in this connection does not mean a regularly shaped body of the kind we see in our crystallographic collections [such as museum crystal mineral specimens], but only that the grains have a

> regular inner structure arising from the arrangement of the atoms in surprisingly regular lattices …
>
> The crystalline and polycrystalline substances constitute by far the greater part of all solid bodies found in nature. Practically all rocks are conglomerates of crystals, ice is crystalline, and so are all metals. The grains of sand are minute crystals and loam also is crystalline. Apart from the glasses and substances of organic origin, like wood, there are very few non-crystalline solids …
>
> The enormous differences between the physical properties of different kinds of lattices make it evident that the forces holding the atoms or molecules together are very different … in the ionic lattices [the constituents] are charged particles. The electric forces between ions are very strong … These lattices are always so constructed that the positive ions are surrounded by negative ions, the negative ions by positive ones … Since opposite charges attract each other, there are considerable forces holding these lattices together.[13]

Wigner thus explains crystals in the wider sense to his readers: the constituents of a crystal (which for a plasma crystal means positively and negatively charged ions and particles) form a lattice.This means that the crystal has an ordered inner structure. As we will see later, this inner structure can be very useful in the storage of memory, computation and other faculties of intelligence.

And in space, plasma clouds that are crystalline are undoubtedly polycrystalline and consist of myriads of smaller crystals. If you or I were able to stand in space next to a plasma crystal we could only ‘see’ it if we had magic powers. Its constituent particles are far too small for the human eye to see, even with our microscopes. So there might appear to be nothing there. And such plasma crystals, especially if they are polycrystalline, can extend for gigantic distances. As Wigner pointed out, an iceberg can be a single crystal. And they can be huge. So we must never assume that a plasma crystal, or a plasma polycrystalline cloud, need have any size restrictions such as a non-scientist might otherwise imagine. And frankly, there is no reason why such clouds cannot be the size of a whole galaxy.

From such a perspective, our local Kordylewski Clouds are tiny and verging on being insignificant. They only seem large to us. I will add one more thought: try and imagine the intelligence of a plasma cloud the size of a galaxy. People

are always talking about ‘intelligent life in space’ and wondering where ‘they’ are. But ‘they’ may be hiding in plain sight. Considering that our sun is made of plasma and that stars are therefore also made of plasma, it is entirely possible that everything you can see in the night sky that is not one of our own satellites is alive and intelligent. Big red, white, yellow, and blue stars may really be the ‘little green men’. Time to rethink.

In 1975, the British mathematician and scientist Harry Jones published a brilliant book about electrons.[14] The gist of it is that free energy in the form of electrons that are bouncing around in a crystal will form complete spheres.

This helped me to understand in more depth what Kapitsa said in 1955 and to develop my own ideas. When I read this, it became immediately apparent to me that if we visualize ball lightning as charged dusty plasma crystals, the fact that the surfaces of crystals containing constant energy form complete spheres when freely suspended in a medium, explains the spherical shapes of lightning balls, which has been puzzling scientists forever.

Convincing graphic evidence of the crystalline structure of ball lightning may be seen in an astounding photo taken in 1955 by a Swiss amateur photographer named F. Goepfert, which was published for the first time in 1965.[15] I reproduce a section of this black and white photo in Figure 4. The full photo shows three successive images of ball lightning flashes side by side, which because they took place within 40 to 100 microseconds of each other all appeared on the same photo (which had an exposure time longer than that).

The portion reproduced here (reduced from three to two images because of space) shows two of them side by side. They are essentially identical. (The third, not shown here, was the same.) What this demonstrates is that the visible electric charges were following the same complex paths repeatedly within the same crystalline structure. Otherwise, the flashes would have been random and would have varied, but they could not have replicated themselves.

We need to think in terms of three dimensions when looking at this two-dimensional image, noting that some of the lines cross one another when seen on the flat, but that is an illusion because of flattening the three-dimensional image. The electricity was in fact flowing along surfaces, points, and interstices and turning at vertices within the crystal. A clever geometer could probably even reconstruct the crystal from the path of the electric current. This kind of behaviour is typical of the phenomena studied in a new discipline known as

‘topological physics’, where currents run along edges and hinges of solid geometrical forms. Plasma crystals have geometrical configurations, with surfaces (called ‘boundaries’ when speaking of plasma), edges (or ‘hinges’), and vertices (or ‘nodes’).

Figure 4. A portion of Goepfert’s photo taken in 1955 showing two of the three identical current paths of arc-mode current flashes travelling through the same lightning ball and occurring microseconds apart so that they all appeared on the same photograph side by side. This evidence substantiates the theory of ball lightning being charged dusty plasma crystals. If plotted in three dimensions, the current path would help us to reconstruct the invisible host crystalline structure. If the current paths had been randomly created, they could not have been the same like this. Just to be clear, this is a photo not of a lightning ball itself but of current flashes travelling through part of a lightning ball, showing only a portion of that ball, which is why the image itself does not look like a ball!

We have just seen Eugene Wigner’s helpful explanation of crystals that are not the solid objects with which we are all familiar. Plasma crystals are not solid and they are made of charged particles and ions, containing a crucial admixture of microscopic dust particles that make the crystalline structure possible. Most of them are invisible to our eyes and weigh essentially nothing.

As I explained early in this book, when I stressed that the Universe is made of 99.9 per cent plasma, so that solid dense matter is very rare and atypical, so I

must now stress that it follows that plasma crystals are very common and pieces of quartz and gems are very rare. We must not take what is familiar to us in daily life as the basis for trying to understand the Universe, as that gives us a wholly distorted picture of reality. Let's put it like this: no one living in the plasma universe would have any interest in our quartzes and gems made of atoms of dense solid matter. They are only important to us. We need to stop being flat-Earthers and 'get real'.

This means that there may be 99.9 per cent more plasma crystals in the Universe than there are dense matter crystals like quartz. So if we can get our heads around that, we can begin to see the light. We simply have to keep struggling to pull ourselves out of an Earth-centric view of things and get a plasma-centric one instead, if we want to understand the Universe properly.

This has all kinds of implications. Plasma crystals are capable of being fantastically complex, and complex in an ordered and dynamic way needed for intelligence.

In this chapter we have seen that ball lightning, made of plasma, has the ability to move through solid objects with its form unchanged. In this it exhibits the same weird behaviour that is observed in the quantum realm in the form of what are called solitons. We have seen that complex dusty plasmas contain crystals that give them form, and we shall see later are crucial to understanding why plasmas may develop intelligence.

In the next chapter we will look at human experience of the intelligent behaviour of plasma phenomena in ancient times, some of which seem much like experience of lightning balls.

In Chapters 7–10 we will look at the observations, research, calculations and theories of astronomers and astrophysicists regarding plasma in space in modern times.

In Chapters 11–13 we will see how work on plasma in laboratories has confirmed and intertwined with the work of the astronomers and astrophysicists.

In Chapter 14 we bring all this together to summarize the arguments that complex plasma can be intelligent. We will see that intelligence of complex plasmas such as the Kordylewski Clouds may not be exactly like ours, and speculate that it may be more like the artificial intelligence and quantum computers now in development.

Then in the last section of the book, Chapters 15–17, we will look at the plasma inside our bodies and ask what the implications are. Is our own intelligence in some way dependent on this plasma?

6

When Heaven Was Young

For the whole of recorded human history, many traditions and tales have survived where humans in a state of meditation or reverie have encountered glowing balls of fire of a divine nature. Let us take a look now at some of these ancient accounts. They provide historic evidence of great importance to us.

About two thousand years ago, there was a very widespread religious tradition in the Middle East and Mediterranean based upon what we would now call plasma entities. It was a ‘light-theology’ called Gnosticism. There were many ‘schools’ and groups and churches of Gnosticism, somewhat similar to the way in which there are many Protestant sects today. The word ‘gnostic’ is a modern invention, which scholars use to describe them collectively. It comes from the Greek word *gnōsis*, which means ‘knowledge’, but amongst the people we now call the Gnostics, the word took on a deeper meaning of ‘sacred knowledge’, or of ‘higher knowledge’.

The Gnostics believed that an elect group of people of spiritual inclinations who pursued sacred knowledge would constitute the section of the human population, who would survive the vicissitudes of the corrupt world of physical matter, and after their physical deaths would enter a Kingdom of Light, in which resided a variety of plasmic deities culminating in ‘the Father’. This was a name they used for the highest god of all. Jesus used this very term himself and instead of speaking of the Kingdom of Light, he spoke of the Kingdom of the Father. The light emitted by ‘the Father’ is described in Gnostic texts as being stronger than 10,000 times 10,000 suns. ‘The Father’ had no physical body, but was essentially what might perhaps be called a light-ball, or plasma-ball. Those who were ‘saved’ would themselves put on ‘vestures of light’ and become mini plasma-balls and would live forever in a heavenly plasma world.

In the lengthy and well-preserved Gnostic text known as the Pistis Sophia, the following conversation between Mary Magdalene (who in the Gnostic tradition

was one of the main disciples of Jesus) and Jesus is recorded:

> Maria came forward. She worshipped at the feet of Jesus and said: 'My Lord, be not angry with me, that I question thee … For thou hast once said to us: "Seek and ye shall find …" … My Lord and my Saviour, of what kind are the twenty-four invisible ones, and of what type, or what form are they, or of what form is their light?'
>
> Jesus answered however and said to Maria: 'What is there in this world that resembles them, or rather, what place is there in this world that is comparable to them? … Truly, truly I say to you, the twenty-four invisible ones are lighted ten thousand times more than the light of the sun which is in this world, as I have already said to you at another time. For the light of the sun in its true form is not in this place, because its light passes through a multitude of veils of places. But the light of the sun in its true form, which is in the place of the Virgin of the Light, is lighted ten thousand times more than the twenty-four invisible ones and the great invisible forefather and also the triple-powered God, as I have already said to you at another time.
>
> 'Now at this time, Maria, there is no kind in this world, nor light, nor form, which compares with the twenty-four invisible ones, but yet a little and I will take thee with thy brothers, and fellow disciples to all the places of the height … And you will look forth upon the whole world of mankind, and it will become the size of a speck of dust before you as a result of the great distance …'[1]

Gnosticism was strong in both Judaism and in Christianity, though we know that it existed in Judaism long before Jesus, so was earlier than the earliest forms of Christianity. We should bear in mind that Jesus was not a 'Christian' but a Jew. 'Christianity' had not been invented yet. It was named later, based upon his sayings, after the Greek word *christos* meaning 'anointed', which was itself a direct translation of the Hebrew word *messias* that we pronounce Messiah, which also means 'anointed'.

The Jewish Gnostics had an esoteric and secret reinterpretation of the Old Testament texts, maintaining that the Book of Genesis was an allegory. Some extremely strange interpretations are put forward in their writings. For instance, they maintained that Noah did not really build an Ark at all, but that he hid inside a glowing light-cloud, which we would call a plasmoid.[2]

The Gnostic texts are full of descriptions of plasma and plasmoids, often in surprising detail. When gathered together from the many texts that we now have (vastly expanded by the discoveries at Nag Hammadi in 1945, the finally edited, annotated and translated texts of which became available at last towards the end of the twentieth century), a whole world of plasma entities is revealed. Gnosticism conceived of an entire Plasma Universe. It seems that ancient seers were able to perceive clearly what we are only now able to demonstrate scientifically and recreate in advanced modern laboratories.

Manichaeanism, founded by a prophet called Mani, once stretched from Europe to China, though it has now vanished. It too was a ‘light-religion’ describing plasma phenomena, its origins lying partly in the earlier Gnosticism. Gnosticism itself survived as a mass movement until the extermination of the Cathars in southern France during the Middle Ages, and the fading away of the Bogomils of Bulgaria and the Messalians of Slavic Europe at some unknown time, apparently by the sixteenth century.

The most famous example of an intelligent glowing plasma in ancient ‘Western’ religious literature is probably ‘the burning bush’ encountered by Moses on the top of Mount Horeb in Sinai. I should point out to all the modern tourists who mistakenly climb Mount Sinai that it is the wrong mountain, Mount Horeb being further south and rarely visited because there is no easy way up it; at its summit is a magnificent Temple of Hathor, whose cult image was the face of a calf. A golden Hathor calf of that temple was the ‘golden calf’ of the Bible, though no one has realized this yet.

The Moses story is well known to all Christians and Jews, and to Muslims as well (since Muslims are ‘Abrahamic’ by tradition, and Moses preceded Abraham). The account is to be found in the book of Exodus (3:2), the second book of the Old Testament of the Christian Bible as well as of the Jewish Torah. Moses encountered this brilliantly shining and burning plasma, which spoke to him, and he described it as being like a burning bush that was however not consumed by its own flames. In other words, it was not a real bush but was round and ‘burning’ as if it were a bush, which is the only way a person of that early pre-scientific time could hope to describe it.

The voice may have been audible to the ears or it may only have been ‘mentally audible’ (telepathic). Although many deeply religious people who do not necessarily study the texts carefully believe that the burning bush was ‘God’,

or Jehovah, the text is not clear on that point. It says actually that ‘the Angel of the Lord’ appeared to Moses as a burning bush, not that the Lord himself appeared to Moses. That is very different! In one of the translations, the English Standard Version, we are told: ‘And the Angel of the Lord appeared to him [Moses] in a flame of fire from the midst of a bush …’[3]

The Septuagint is also confused, because although the apparition is said to be ‘the Angel of the Lord’, the Lord himself is also apparently watching, and when he sees Moses approaching, he too cries out from the bush himself and calls Moses by name, telling him not to approach closer. So who was it, the Angel of the Lord or the Lord himself? As I say, this is not at all made clear by the text.

This confused story seems to have only one reliable element to it, in the absence of the original Hebrew text, which was lost more than two thousand years ago, and that element is the bush-like burning apparition that ‘did not consume itself’ but continued to burn apparently without any fuel. In other words, this seems to be a description of an encounter with a glowing plasma ball, or blazing plasmoid, which spoke. And encounters with such apparitions are to be found throughout the religious and sacred literatures of many countries over the millennia, and are also recorded by the more mystically inclined ancient Greek philosophers.

In fact, what is described as happening to Moses is something that has happened countless times to sages, shamans, meditators, yogis, and holy men throughout the ages. An analysis of many of these encounters could shed a great deal of light upon the interactions throughout history between ‘spiritual’ plasma forms of beings, whether ‘higher entities’ or deceased persons.[4]

Figure 5. The Angel of the Lord speaks to Moses from the Burning Bush (top left corner). The snake may refer to the transformation of Moses' staff. This image is from an illustrated Latin Bible of 1567.

The great scholar of Judaism, Gershom Scholem, argues that the figure known as Moses (whether mythical, real, or partially real and partially mythical) seems to have been responsible for changing the religion of the Jews into a monotheistic religion, and for treating the earlier Jewish ideas as 'heretical'. But those 'heresies' persisted nevertheless for centuries, and today we describe them as 'Gnostic Judaism'. They were in turn taken over by 'Gnostic Christianity', which was as ferociously persecuted by the Roman Catholic Church (self-styled 'Christian orthodoxy') as the Pharisees were by the Sadducees (self-styled 'Jewish orthodoxy'). But now we turn away from Moses to consider another early Jewish prophet, Enoch.

Here is an encounter of the prophet Enoch with divine radiance as recounted in the Book of Enoch, in which we must note the mention of an entity called 'the Great Glory', which is reminiscent of 'Angel of the Lord', who was called 'the Glory' by the Samaritans:

> And the vision appeared to me thus; behold in the vision clouds invited me … I drew nigh to a wall which is built of crystals and surrounded by a fiery

flame: and it began to affright me. And I went into the fiery flame and a flaming fire surrounded the walls of the house, and its portal blazed with fire. And I entered into that house, and it was hot as fire …

And lo! There was a second house, greater than the former, all the portals of which stood open before me, and it was built of flames of fire … And its floor was fire, and above it were lightnings … and its ceiling also was flaming fire. And I looked and saw therein a lofty throne … as a shining sun … And from underneath the great throne came streams of flaming fire so that it was impossible to look thereon. And the Great Glory sat thereon and His raiment shone more brightly than the sun and was whiter than any snow … A flaming fire was round about Him, and a great fire stood before Him … And until then I had had a veil on my face, and I was trembling.[5]

Later Enoch also relates: 'And they took me away to a place where there were forms like flaming fire, and when they wished they appeared as men.' In other words, he is describing higher beings who normally had the forms of plasma entities, but who could take on human form for interactions with humans. It should be noted that the Book of Enoch is an ancient Jewish work, dating from before the time of Jesus, which clearly discussed divine beings capable of incarnating as men. The Book of Enoch is regarded as a canonical work of scripture by the Ethiopian Orthodox Church, which is one of the earliest Christian churches.

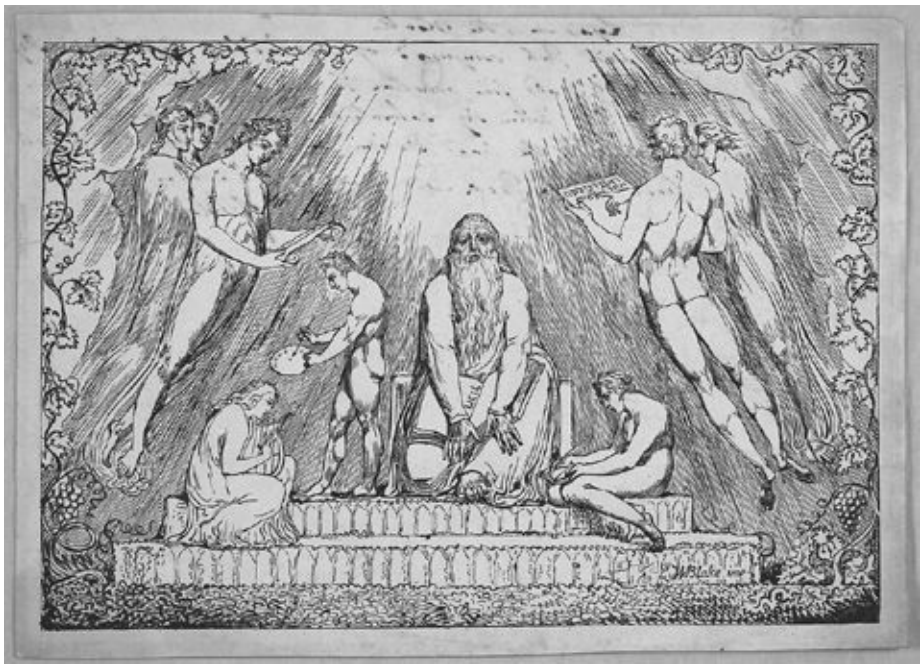


Figure 6. William Blake's 1807 lithograph of Enoch in Heaven.

The Platonic philosopher Damascius (458–550 AD) believed that the human spirit was 'a radiant body filled with heavenly radiance, a glory that streams through its depths, and lends it a divine strength; but in lower states, losing its radiance, it is dirtied, as it were, and becomes darker and darker and more material.'[6]

The philosopher Philoponus of Alexandria (490–570 AD) believed that this spirit was a higher soul attached to the basic soul. In other words, he believed, as did the ancient Egyptians, in more than one level of soul for each person. He wrote: 'There is, moreover, beyond the soul another kind of body, that is forever attached to the soul, which they call radiant or starlike … (and) it forever keeps its radiant body, which is of an everlasting nature.'[7]

The Jewish Gnostic treatise discovered at Nag Hammadi in 1945, *The Apocalypse of Adam*,[8] features Adam speaking to his son Seth and saying that before he and Eve were thrown out of the Garden, they had gone about in a radiant and glowing condition. He says that when the descendants of Seth return eventually from Earth to the divine regions, they will all become clouds of great light. And he also speaks a great deal in general about radiant clouds of glory.

In the early Christian Gnostic text discovered at Nag Hammadi in 1945, entitled *Marsanes*,[9] the narrator says: 'The third shape of the soul is spherical.' There is considerable unanimity amongst many of the mystical texts of antiquity that men and higher entities alike have souls that are radiant and glowing spheres. Men who become too attached to Earth cease to radiate light and go dark, thus resembling the fallen angels who have become demons of darkness.

Another Nag Hammadi Gnostic text, *The Paraphrase of Shem*,[10] is full of descriptions of heavenly 'clouds of fire', 'garments of light', 'luminous spirits', 'images of light', 'the power of the restless fire', 'the light of spirit', 'the exalted, infinite light', 'clouds of power', 'clouds of light', 'the cloud of silence which is a majestic fire', 'garments of fire', 'a power of fire and light', 'thought that comes forth from the light', and says: 'The righteous spark is the cloud of light that has shone in your midst.'

Ideas such as the garments of light and fire seem as if they might allude to the presence of plasma in and around the human body, which we will return to in the

final chapters of the book.

One of the most famous and impressive of the Nag Hammadi texts is *The Apocryphon of John*,[11] which is dated to the early part of the third century AD. It is full of descriptions of ‘luminous clouds’. Such a luminous cloud is mentioned in particular in the text’s alternative story of Noah. The text says that the story of Noah and the ark ‘is not as Moses said’ [Moses was here presumed to be the author of the Book of Exodus], but the true story is very different. We are told that Moses was wrong in saying of Noah that ‘He hid himself in an ark’ because he had been warned that the flood was coming. The text insists that it was ‘not Noah alone’, but ‘also other men’. And we are told that ‘They went into a place and sheltered themselves within a luminous cloud.’

The text also speaks of angels as being ‘lights’. However, it is not only the good entities, but also the bad entities who reside in luminous clouds. The Gnostic name for the Devil is the Chief Archon, also called Samael, Yaldabaoth, and Saklas (which means ‘the Fool’). The text tells us that the Chief Archon ‘created for himself an Aeon [a special place] that burns with a luminous fire, the one in which he exists now’. (The Gnostics altered the meaning of the ancient Greek word *aiōn* and used it in their own peculiar way. The term ‘Aeon’, the Latin form that we use in English, occurs constantly in their texts.)

In other words, the Devil himself lives in a fiery plasma cloud. So consequently, both the powers of Good and the powers of Evil dwell in or consist of plasma clouds. The War in Heaven is thus a war between good and bad plasmas, and the extent to which they can recruit humans on their respective sides is assumed to have a bearing on how long the world will last before it reaches its ultimate climax when the final reckoning occurs. At that time, the ‘elect’ amongst humanity, who have remained good despite all temptations, will rise up to the Kingdom of Light, and the powers of Darkness will be annihilated.

Humanity has been inundated with such accounts of what we would call, using the terminology of science, divine plasma entities, for millennia, but most people have tended to disregard them as either fantasies, or the enthusiastic reveries of people who were not entirely sane. But they constitute massive evidence of phenomena experienced by sensitive and meditative persons in all cultures round the world. Now at last science has caught up with mysticism, and modern physicists are seriously suggesting that intelligent plasma beings can exist after all.

Are plasma entities to be regarded as helpful or harmful to us? The traditions are explicit that they can be both. But the helpful ones are radiant with light, whereas the harmful ones are dark and perverse, as their light has been contaminated and made obscure with the dirt of corruption. It is time that humans were given a proper briefing on this ‘material world of the spirit’.

This is a short survey of some of the myriad descriptions of light phenomena in ancient religions. Of course, key events in the New Testament, such as the Transfiguration – where Jesus appeared radiant in glory and the Pentecost – where tongues of light appeared hovering over the heads of the Apostles – also seem suggestive of plasma and plasmas.

Aristotle’s pneuma

Although the word ‘plasma’ was only coined in 1928, some thinkers in the ancient world had an idea of it. For reasons of space, I am going to confine myself to two examples where the ancient examples are startlingly close to our modern ideas.

Something very strange was going on in the fourth century BC, and I call it Aristotle’s Anticipation of Plasma Physics and Bioplasma. Aristotle (384–322 BC) is often thought of as a rather dry character, who wrote profound philosophical tomes that only very serious-minded people try to read. However, the real Aristotle was very different; he published two books of poems – and three of his poems actually survive. Another thing is that he freed all his slaves, some during his lifetime and all the rest in his will.

One of the reasons he had to flee Athens for his life when he was sixty-two years old is that he had written an ode to his deceased wife, and the high view he had of women was considered offensive to the male chauvinists of ancient Athens, who liked to keep women in their place, i.e., either on their backs or sitting at the spinning wheel, and not allowed out of the house without chaperones. Furthermore, Aristotle was that horrible and despised thing, a foreigner; he was born in the north of Greece and he was a resident alien in Athens.

Significantly for this volume, Aristotle was the first Western thinker to postulate the existence of a rarefied form of matter entirely separate and wholly different from physical matter. He named it *aithēr*, which we spell ‘aether’ or

‘ether’ today in English (and the old-fashioned English spelling was ‘aethre’, though no one uses that spelling anymore). Since physical matter was then conventionally spoken of as made of ‘earth, air, fire, and water’, Aristotle called his new form of matter ‘the fifth element’. In Latin this is *quinta essentia*, which is the origin of our English word ‘quintessence’. This was the first time in recorded history that plasma had been anticipated. I am still struck today by the startling boldness of Aristotle, who also questioned the nature of matter in such a fundamental way.

Aristotle’s aether was viewed by him as a form of matter that existed in the pure state only in what today we would call ‘outer space’, but was then called ‘the region above the moon’. Aristotle thus anticipated our modern knowledge of plasma in physics. If he were alive today, Aristotle would not be surprised to be told that the Sun was entirely composed of plasma and that the space between the Sun and the Earth was filled with a solar wind made also of plasma. For this is what he had predicted.

Aristotle went much further than only proposing that there was a higher form of matter. He actually proposed that each living physical body had a corresponding aetheric body, or what is now called by some modern scientists a ‘bioplasma body’. (We will hear much more about bioplasma bodies later on.)

His writings on this subject are mostly lost and survive only in fragments. Some of those lost writings were dialogues rather than treatises. It is little known today that Aristotle was as famous for his dialogues in his own day as was Plato. But such are the vagaries of what survives and what does not that not a single one of Aristotle’s dialogues survives in its entirety, and those fragments that do survive as quotations by Cicero and others are tantalizing in their brevity. We are somewhat luckier with what are called the ‘testimonia’, which means the descriptions of, rather than the quotations from, the lost dialogues. But even so, we get only a glimpse of Aristotle’s discussions of his theories of a fifth element.

It is worthwhile giving a bit more detail about what Aristotle believed, since few classical scholars have made a proper study of this aspect of his ideas. The scholar who has advanced a study of this subject the most is Professor A.P. Bos of the Netherlands, who publishes most of his writings in English. He has ‘cracked the code’ of many of Aristotle’s ideas, which have been only partially preserved, and this has taken him decades. Much of the information that made this possible is to be found in the philosophical dialogues of Cicero, in the

writings of Philo, of Clement of Alexandria, and in a fascinating essay by Plutarch of the first century AD entitled ‘On the Face which Appears in the Orb of the Moon’.

The original key book by Bos in which he began to discuss these questions is entitled *Cosmic and Meta-Cosmic Theology in Aristotle’s Lost Dialogues* (1989), but Bos has worked steadily on the subject since that time and continues to find out more and more about the subject.

In the book just mentioned (here), Bos tells us of Aristotle’s fifth element:

> This new element is according to Aristotle a soma [physicality] and can therefore be counted among the ‘natural somata’ [plural of soma]. But it does not share the hylē [substance] of the four earthly corpora [elements]. For this reason it is described as ahylon [possessing no hylē, or physical body], as a kind of ‘immaterial matter’ … While maintaining his belief in the divinity of the celestials [divine beings] and their eternal existence, Aristotle bases this stance on his own new theory of the fifth element … the celestial spheres [consist] of the divine fifth element.

Aristotle also believed that the divine beings as well as human spirits were made of the fifth element, and that when we die our spirits made of the fifth element return to the world of the fifth element, which he conceived of as being somewhere above the atmosphere. And of course he viewed all stars and the Sun as being made of aether. And he distinctly postulated, under the name of *pneuma*,the existence of a form of the fifth element within animal and human bodies as an animating principle, for the details of which see the footnote. These beliefs of his later had an influence on the fundamental concepts of Christian theology, especially the Gospel of John.[12]

I won’t go into more detail here about these ancient ideas, as fascinating as they are, but I want readers to know that more than 2200 years before Crookes discovered his ‘fourth state of matter’, Aristotle had predicted it. That is more than a footnote to history, it is an extraordinary fact.[13]

I say Aristotle was the first Western thinker to suggest such a thing, because the Chinese philosophers of Daoism never accepted a dichotomy between matter and spirit. Such a dichotomy is entirely a Western phenomenon. The Chinese have always maintained that ‘spirits’ were made of a very special rarefied kind

of matter like a mist. So deep do these concepts go in Chinese thinking that it is very difficult to find a Chinese person alive today who does not ‘believe in ghosts’ implicitly. They always seem to have believed that very wise people never really died, but that their physical forms were transmuted into what they call *xian* (spelled hsien in the old spelling), which is pronounced similarly to ‘shenn’.

These wise, deceased shamans were conceived of as living in remote mountains and forests and flying through the air and the clouds with the greatest of ease, thinking profound thoughts and enjoying the delights of heavenly contemplation. As for most other people, they became ghosts, which were a much lower grade of being, but also made of the same rarefied semi-matter. Psychologically disturbed ghosts were dangerous, and they haunted people and places. The female ones were the most dangerous of all, and were known as ‘fox fairies’. They would lure men to their doom and destroy them like vampires.

A very large proportion of Chinese fiction over the ages has taken the form of ghost stories, because of the Chinese preoccupation with rarefied entities made of what we today would call plasma. Anyone who enjoys atmospheric ghost stories should read those by the most famous Chinese author of them, Pu Songlin (1640–1715), one of my favourite authors, and whose house I have visited in Shandong Province.

However, living in the Western world as we do, I do not propose to write a history of the Chinese beliefs in ghosts through the ages, or even the various texts that discuss such matters, or how they also anticipated modern plasma in a somewhat vague manner. I thought it important to mention it, for the history of the world does not consists solely of the history of the West. But I will pass over the Chinese sources, because it would require a lengthy account indeed to explain the differences between Chinese and Western thinking, which is a vast chasm of incomprehension, alas, and impossible to explain in a short space. Suffice it to say that a plasma world would be less surprising to the Chinese than to Westerners.

As for genuinely proto-scientific speculations anticipating plasma, I am not aware of the Chinese having produced any. It was the Daoists (old spelling: Taoists) who promoted these ideas. They were well aware that the physical sense of sight was incapable of perceiving certain forms of matter, which were invisible. Liezi (Lieh Tzu, fifth century BC) says that rarefied matter ‘eludes the

senses of sight, hearing, and touch, and is therefore called by the name of Yi.' The Chinese character for this Yi is the same as is used in the title of the famous divination book called Yi Jing (old spelling: I Ching, 'The Book of Change'), and therefore also has the meaning of 'change', or one might better say, 'what changes'.

Laozi (Lao Tzu, uncertain whether sixth or fourth century BC), the founder of Daoism, speaks of the invisible primaeval matter in this way: 'The likeness of things unseen: the form of that which is without body.' And he says: 'What you cannot see by looking at it is called Hi (rarefaction, or vacancy) … That which eludes the sense of sight is called Hi.' He also says that Hi and Yi are the same.[14]

However, we must resist the temptation to investigate Chinese Daoism further, as it is an endless subject. The point to note here is that Laozi attributed bodiless form to what we now call plasma. He was thus not simply speaking of some primaeval sludge invisibly sloshing around us like an undifferentiated sea, but he was aware that it must be structured. One could stretch a point and say this is the ancient prehistory of the concept of a plasma crystal!

Before we leave ancient teachings on plasma, I want to return briefly to recent discoveries, which we discussed in Chapter 4, that plasmas precipitate matter and that matter is also otherwise precipitated out of 'nothing'. These recent scientific discoveries also resonate with ancient wisdom.

Various religions from different parts of the world suggest the creation of matter as coming from 'speech'. In Christianity, we are told: 'In the beginning was the Word (*logos*), and the Word was with God and the Word was God … all things were made by Him and without Him was not anything made that was made.' In the earliest form of Hinduism, the Universe was said to be created by Brahmā, who is an all-embracing universal spirit. He opened his mouth to speak and he spoke the four Vedas, which are the ancient collections of sacred hymns that the Aryans brought with them from Iran when they invaded India from the West circa 1500 BC. The Vedas are considered the most sacred of the Hindu scriptures, and are written in an archaic form of Sanskrit known as Vedic.

In ancient Egypt, the god Ptah was said to have created the world by his speech. The wall texts of the Tomb of Rameses VII in the Valley of the Kings state of the Sun: 'His speech is light.'[15] And in the ancient Egyptian text known as the *Book of Caverns*, which was preserved in the Transverse Chamber of the Osireion at Abydos, we read of the Sun, whose name is Re: 'Re speaks to them

through his light.’[16] The ancient mystical concept of the Logos in Johannine Christianity also suggests that ‘the Word’ (of God) was light.

Sacred speech is essentially something that emerges from something else, just as our breath is emitted from us into the air around us. It seems that the ancient peoples when referring to the creative speech of the primal god were trying to convey the concept of expelled, structured breath entering into a surrounding medium but retaining its own form, and thus constituting matter.

Since we now know that the Universe is a seething ocean of plasma, and as it has now been proven that plasma makes dust, and that dust is matter, it is legitimate to consider that the ‘material Universe’ has been extruded from and created by the universal plasma. In other words, the 1 per cent is the creation of the 99 per cent. And looked at from that perspective, the traditional religious views of the creation of matter are justified. For the spontaneously formed dust and the baryons are the building blocks of the familiar world around us.

But if we look back to our ultimate origins in the world of physical matter, we are all children of plasma. The Egyptians would say we are ‘the progeny of Ptah’, the Christian view is that we are ‘the children of God’, and a Hindu might say: ‘We are all the creation of the great universal spirit, Brahmā.’ The other early creation legends of ‘in the beginning was undifferentiated chaos’ or as the ancient Egyptians said, the goddess Nut, who was a great cosmic sea, and the Torah and the Old Testament that speak of ‘the waters’, are all effectively saying the same. On this view, all physical matter did indeed emerge from the vast universal sea of plasma.

7

Kristian Birkeland's Miraculous Discovery

Kristian Birkeland (1867–1917) is famous in Norway, and his picture was until recently on their 200 kroner banknote, so between its appearance in 1994 and its withdrawal in 2018, the Norwegians were reminded of him every day when they went shopping. He was a very brave man, who spent years freezing in the Arctic wastes in the north of Norway making detailed observations of the Aurora Borealis, or Northern Lights as they are often called. He concluded that the Northern Lights (and there are southern ones too at the South Pole, known as the Aurora Australis) must be caused by streams of charged particles pouring in from the Sun towards the Earth's poles. These particles then glow and cause all the beautiful lights.

This theory caused the utmost outrage, and astronomers all over the world called Birkeland a madman. Did he not realize that space was empty? Charged particles could not pass through empty space! And so instead of facing Birkeland's carefully presented evidence, the world's 'astrophysical community' stuck with their insistence upon empty space and decided that Birkeland was a crank. He died unrecognized in 1917. His theories about the Aurora were not proved true until spacecraft verified them in the 1960s. Because Birkeland is one of my heroes, I was active in certain minor ways in helping to facilitate the 2017 Oslo Birkeland Centennial Conference to celebrate his great scientific work.

Kristian Birkeland appeared until recently on the Norwegian 200 kroner banknote. Image reproduced with the kind permission of the Bank of Norway. Copyright by Norges Bank/ artist Sverre Morken. This banknote was legal tender in Norway between the years 1994 and 2018.

Before we go into the subject of the solar winds and the Birkeland Currents, it is important to have a very brief history of how their existence came to be recognized. And that means knowing how and when the polar aurorae came to our attention and the early attempts to understand them. Naturally, it is the peoples of the North who saw them all the time, and a thirteenth-century Norwegian saga called *The King's Mirror* (*Kongespeilet*, dated to AD 1220–1230) contains a reference to them. It mentions 'those lights … which the Greenlanders call the northern lights'.[1]

Although the Northern Lights are rarely seen so far south as Greece or Rome, they were certainly witnessed by Aristotle, who described them in his lengthy book *Meteorology* as:

> burning flames in the sky … we often see a burning flame of the kind one sees when stubble is being burnt on ploughland … Sometimes on a clear night a number of appearances can be seen taking shape in the sky such as 'chasms', 'trenches' and blood-red colours … the upper air condenses and takes fire and … its combustion sometimes produces the appearance of a burning fire.[2]

It has been suggested that Aristotle may have seen the Aurora Borealis twice, in 349 BC and again in 344 BC.[3] We must remember that Aristotle was born and grew up in the north of Greece, and lived for some years in Macedonia as an adult as well, thus having spent much of his time at a higher latitude than Athens. Aristotle theorized that a vapour rose from the Earth that collided with the Sun's fire above the atmosphere, where it was ignited, and thus produced the colourful flashes in the sky. He stated that there was a layer of a strange kind of 'fire' encircling the Earth above the air, thus clearly anticipating the later discovery of the ionosphere by Balfour Stewart in 1887, 2,119 years after the death of Aristotle. The quotation from Aristotle in the footnote is truly astonishing in its anticipation of the nature of the ionosphere.[4]

Aristotle may have been influenced in his thinking by Homer. In the *Iliad* (Book 2, 412 and Book 3, 277–9), Homer describes the chief god Zeus as aether-dwelling (*aitheri naiōn*), meaning that he resides in the blazing and dazzling aether of the heavens above the sky. Much is made of this by the first-century AD Homeric commentator, Heraclitus the Grammarian (not to be confused with the famous philosopher of the same name, who lived centuries earlier). In his work *Homeric Problems*, he cites this Homeric concept specifically in relation to the Aristotelian tradition. He suggests that the name of Zeus may derive from the word *zesin*, which means 'boiling', because of the intense fiery heat of the aether. He mentions Aristotle's followers saying of aether that it is 'distinct from fire' and 'they regard it as a fifth element'.[5]

It should be noted that Aristotle made an intensive study of the variant texts of Homer and even travelled to the island of Ithaca to obtain a copy of the Ithacan version of the *Odyssey*, from which he compiled his own edition of the epic. It was well known in antiquity, though it is now lost. Indeed, it was Aristotle's editions of Homer that Alexander the Great, his pupil, carried with him on his conquests and kept under his pillow every night, as recorded by contemporary historians.

The aurorae had been witnessed in Greece prior to Aristotle ('a fiery body of great size like a burning cloud was observed in the heavens. It did not remain at rest, but moved in various directions … [with] violent swaying …'), but the earliest surviving written account of this phenomenon is found in the Life of Lysander (12, 4) by Plutarch (AD c. 46–125), four centuries after the time of Aristotle.[6] Aristotle's text is therefore the earliest surviving text in the world

referring to the Aurora Borealis, and of course he did not merely describe the aurorae, he attempted to explain them scientifically as well.

Both Seneca (4 BC–AD 65) in his Natural Questions (I, 14, 1),[7] and Pliny (AD 23–79) in his *Natural History* described the Northern Lights.[8] But after that, apparently nothing was published about them for approximately 1500 years (the Norwegian saga mentioned earlier being of course an oral saga, not a publication).

The astronomer Tycho Brahe (1546–1601) mentioned them in passing, the astronomer Johannes Kepler (1571–1630) witnessed and described them, and Galileo (1564–1642) witnessed them at Venice in 1621. It was apparently Galileo who introduced the name Aurora Borealis, in a publication of 1616, though in a descriptive sense rather than with an intention of naming them, and it is not known whether he had actually seen them yet. It is thus not clear whether Galileo should be credited for naming the Aurora Borealis, or whether that honour belongs to Pierre Gassendi, who is usually credited with it, and who had obviously read Galileo and seen his descriptive reference. Perhaps we should split the credit between them. In 1619, Galileo attempted to explain the Northern Lights, with similar ideas to those of Aristotle.[9]

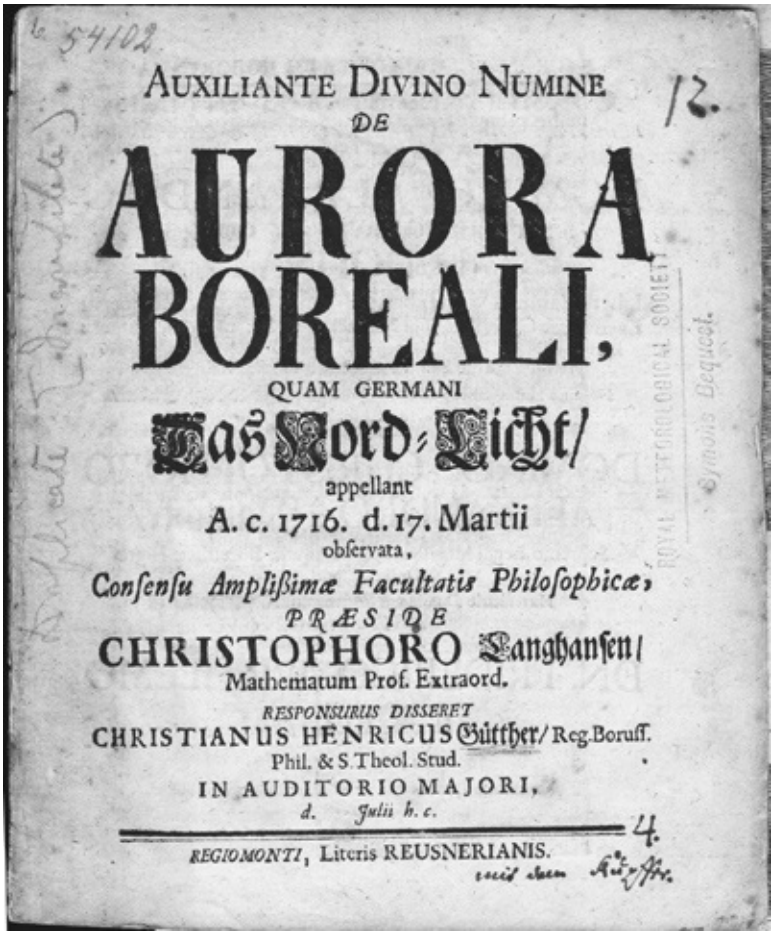
It was in the same year of the Venice auroral display, 1621, that the French scientist, scholar and philosopher Pierre Gassendi (1592–1655) formally used the name ‘Aurora Borealis’ to refer to the Northern Lights, in honour of the ancient Greek goddess of the dawn, Aurora. Gassendi was a keen observer of the heavens, including studying sunspots and observing the transit of Mercury across the Sun. He even successfully predicted an eclipse in 1654. He was only twenty-nine years old when he ‘named’ the Aurora Borealis, despite the fact that he had apparently not then seen the Northern Lights personally. It is believed he came to know of them through his early friendship with the astronomer Joseph Gaultier de la Vallette (1564–1647), and by reading the recent accounts of them by Galileo.

In 1640, Spanish colonizers in Chile recorded a large auroral display in the Southern skies, which lasted from the beginning of February to the end of April, but this remained only a locally known matter in Chile for the next 142 years, for it was only in 1782 that the Chilean Jesuit priest Juan Ignacio Molina SJ (1740–1829) became the first European to report in print this and other subsequent

Spanish accounts of the existence of a southern aurora, which was otherwise unknown in Europe.

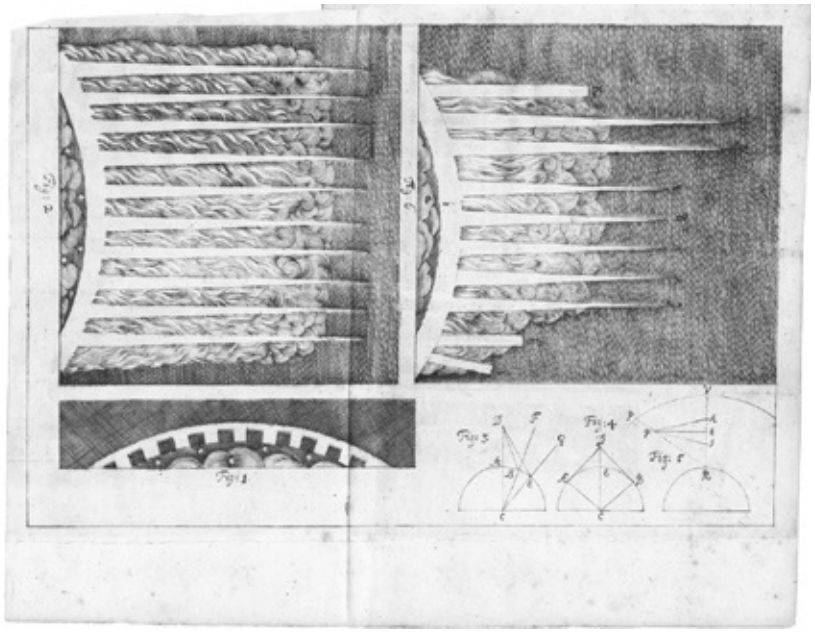
In 1716, a German professor of both theology and mathematics named Christoph Langhansen (1691–1770) published a pamphlet in Latin at Königsberg entitled ‘De Aurora Boreali Quam Germani Das Nord-Licht Appellant’ (‘Concerning the Aurora Borealis, Which the Germans Call the Northern Lights’), containing an impressive fold-out engraving of particularly bizarre auroral phenomena, which I have reproduced overleaf, along with a scan of the title page. I bought a fragmentary copy of this booklet, only the first ten pages of the extremely rare 28-page work, but fortunately the illustration was present.

The work appears to suggest that the Aurora Borealis is a spiritual phenomenon, which is hardly surprising, in that the author was not only a theologian but a practising preacher, who was five times a rector of a Lutheran church. The author refers to numerous publications by earlier authors, including Girolamo Cardano, Philippe de la Hire, Valentine Weigelius, Giovanni Domenico Cassini, Giovanni Battista Riccioli, Schmieder [unknown which Schmieder is meant], and René Descartes. Frankly, this suggests that there may have been a great deal of discussion of the aurorae going on during this time of which I have no knowledge, although it would certainly be an interesting subject to investigate for someone who cares to go into the matter in greater depth, to see what all these people were saying. This is a wonderful subject for somebody’s future PhD thesis.



AUXILIANTE DIVINO NUMINE
DE
AURORA BOREALI,
QUAM GERMANI
Das Nord-Licht/
appellant
A. c. 1716. d. 17. Martii
observata,
Consensu Amplissimæ Facultatis Philosophicæ,
PRÆSIDE
CHRISTOPHORO Langhansen/
Mathematum Prof. Extraord.
RESPONSURUS DISSERET
CHRISTIANUS HENRICUS Güttther/ Reg. Boruss.
Phil. & S. Theol. Stud.
IN AUDITORIO MAJORI,
d. Julii h. c.

REGIOMONTI, Literis REUSNERIANIS.



Figures 7 and 8. The title page and the fold-out engraving of the 1716 publication about the Aurora Borealis by Christoph Langhansen, from my

imperfect copy of this rare work.

A forerunner of Kristian Birkeland whose publications have been largely forgotten is an early French scientist, who seems to be remembered today only in France itself. His name was Jean-Jacques d'Ortous de Mairan (1678–1771). He was active in many fields of science, but even amongst the French it seems to be little known today that he was the first person in the history of science to suggest that material from the Sun was not only being transmitted across space to the Earth, but actually deposited within the Earth's atmosphere.

His magnum opus on this subject was a very lengthy book with many illustrations entitled *Traité Physique et Historique de l'Aurore Boreale*, published in 1735.[10] This material was widely circulated in Europe at the time and the book was translated into German in 1753.[11] De Mairan stated that material from the solar atmosphere crossed space, reached the Earth, and caused the Aurora Borealis in our own atmosphere. He claimed that the atmosphere of the Sun was a light and tenuous fluid, which 'reached as far as the Earth'. This is a surprisingly accurate guess for a man in the eighteenth century, since it is reasonable to describe plasma flows as 'a light and tenuous fluid'. His words, translated, are: '… the matter composing this [solar] atmosphere coming to meet the upper parts of our air … falls into the terrestrial atmosphere at more or less depth …'

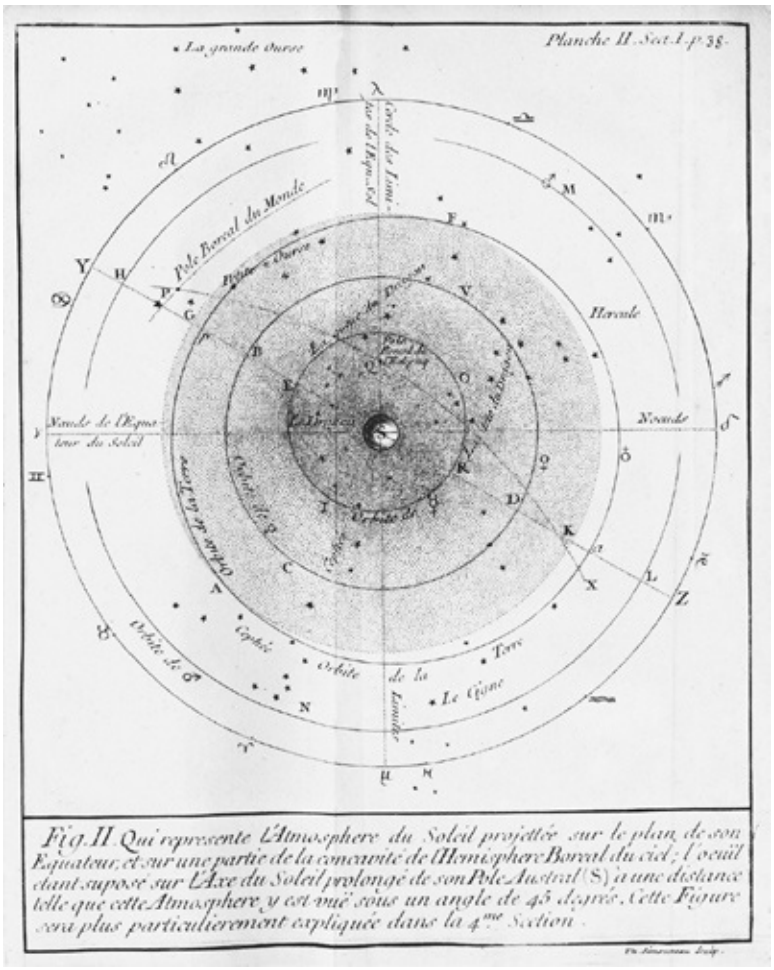


Figure 9. This engraving of 1733 shows the ‘Sun’s atmosphere’, as conceived of by de Mairan, extending from the Sun (shown in the centre and labelled with the capital letter S) to the orbit of the Earth (Orbite de la Terre). The solar atmosphere is represented in the drawing by the shaded portion, which is largely comprised within the orbit of the Earth. On p. 22 of his book, de Mairan describes the solar atmosphere as being ‘a spheroid which has been flattened at its edge into the form of a circular disc’. De Mairan’s concept of the solar atmosphere that reached the Earth partially arose from the researches by his Swiss contemporary Nicolas Fatio de Duillier (1664–1753, whom he calls simply ‘Fatio’) concerning the distance between the Earth and the Sun.

In his own caption de Mairan says: ‘This represents the atmosphere of the Sun. It is projected on a map of the Equator and on one section of the concavity of the Boreal hemisphere of the sky. The centre is superimposed upon the axis of the Sun projected onto the astral Pole at such a distance that this atmosphere is viewed at an angle of 45º.’ (From: Jean-Jacques d’Ortous de Mairan, *Traité Physique et Historique de l’Aurore Boréale* (*Physical and Historical Treatise*

Concerning the Aurora Borealis), Paris, 1733, the second folding plate following p. 32.)

Since de Mairan first announced these ideas in 1731 to the Royal Academy of Sciences in Paris, he anticipated Kristian Birkeland's first announcement of similar ideas, which also took place in Paris, in 1900, by 169 years. De Mairan also published many illustrations, including some spectacular ones of the aurorae. He may probably thus be credited with being the first predictor of what we now call the solar wind.

In 1767, Knud Leem (1697–1774) published a book in Danish entitled (in translation) *An Account of the Lapps of Finmarken*. In it, he described how the Lapps of Lapland in the far north go hunting with guns for foxes by the light of the Aurora Borealis. He said: 'This kind of sport (!) the Lapps pursue at night when the moon is up, or when there is an Aurora Borealis, which in that country, during the winter nights when the air is clear, is as intense as if the sky were on fire, and which, in a manner, shines like the most brilliant moonlight.' Leem even published an engraving of the Lapps doing this, depicting the auroral streaks in the sky behind them providing the necessary illumination.[12] This and the Langhansen illustration of 1717 are surely two of the earliest depictions of the Aurora Borealis ever published.

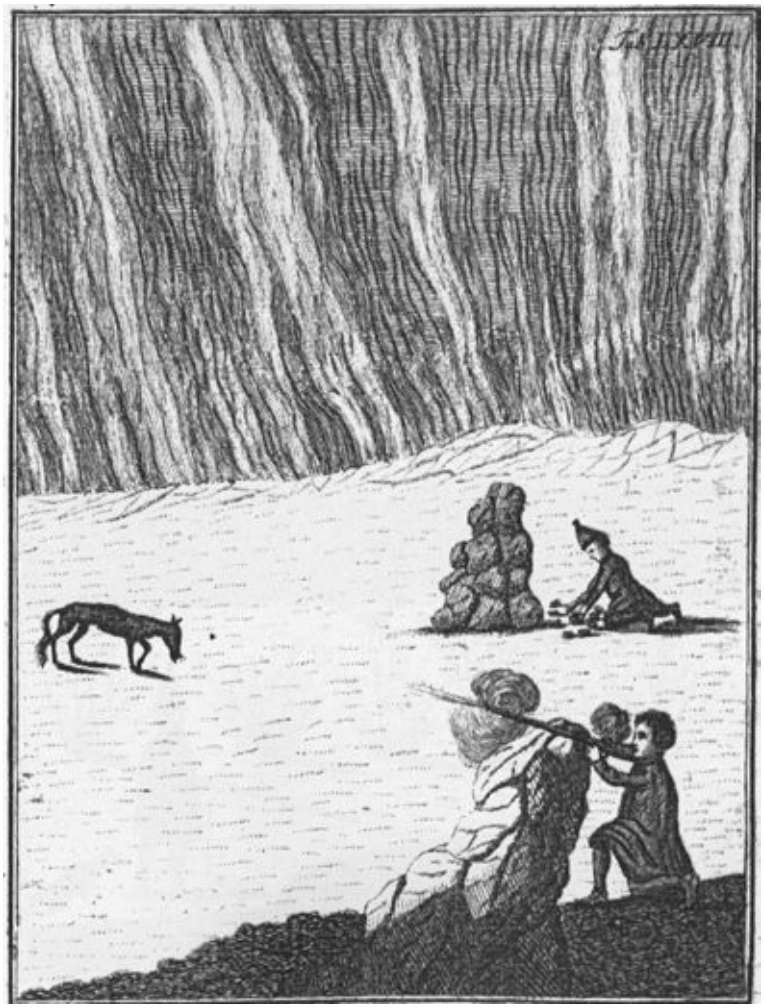


Figure 10. Knud Leem’s drawing of 1767 showing the Lapps of Lapland hunting foxes on the ice at night, by the light of the Aurora Borealis.

In 1745, long before Molina’s publication, the mariner Antonio de Ulloa y de la Torre-Giral (1716–1795) witnessed the southern aurora from his ship as he rounded Cape Horn, but his reports of this appear to have remained oral ones amongst sailors until long afterwards. In 1770, Captain James Cook (1728–1779) observed the southern aurora on his first voyage to Australia. But this seems not to have been reported in print at the time and to have remained recorded only in his log. In 1773, Captain Cook observed the southern aurora again on his second voyage to Australia, and he gave the Southern Lights the name of ‘Aurora Australis’. Cook died three years before Molina’s publication publicly reporting the existence of the Southern Lights.

In 1812, the English scientist Sir Humphry Davy (1778–1829) published his opinion, in his essay ‘Of Electrical Attraction and Repulsion, and Their Relation to Chemical Changes’,[13] that:

> The coruscation [flashing and glittering] of the Aurora Borealis, and Australis, precisely resemble strong artificial electricity, discharged through rare air … the Auroras may arise from a discharge of electricity, accumulated in the atmosphere near the poles.

In 1845, inspired by and referring back to Sir Humphry Davy, Baron Karl von Reichenbach (1788–1869) published his theory (in German, published in English in 1850) that the Aurora Borealis ‘appears to be nothing else than an electric phenomenon, caused by the magnetism of the earth’.[14] He had constructed terrelles, meaning small magnetic spheres as miniature models of the Earth, which had generated lights at their two magnetic poles.[15] In this, he anticipated by many decades Kristian Birkeland’s more sophisticated and famous experiments in Norway; Birkeland also constructed terrellas to replicate the auroral effects with miniature spheres containing an electro-magnet in their interiors.

In 1862, the Swiss physicist Arthur-Auguste de la Rive (1801–1873) published a paper concerning both the Northern and the Southern Aurorae.[16] He had been studying the aurorae since 1849.

Nearly a century passed after Molina’s publication before any major developments concerning a sound understanding of the aurorae appear to have taken place, however. In 1878, Karl Selim Lemström (1838–1904), a Finnish geophysicist of Swedish extraction, published an article in Swedish in a Finnish periodical based upon his extended observations of the Northern Lights in Scandinavia.[17]

In his article, he reported that as a result of his studies over a considerable time, he had come to the conclusion that the auroral phenomena varied with the sunspot cycle of eleven years. That is a cycle during which the Sun goes from having a maximum of sunspots to having a minimum of them, and back again. No one knows why it does that. (At the time of writing, we are at the minimum.) He said that in his opinion, the aurorae were caused by electric currents in the Earth’s atmosphere, which were stimulated by what he called ‘heat rays’ coming

from the Sun. Electric currents were still imperfectly understood at this time, and it was only in this same year, 1878, that Henry Augustus Rowland (1848–1901) carried out his famous ‘Rowland Experiment’, which showed that electric current consists of moving charges.

Not knowing about charged particles constituting the electric currents, Lemström was in no position to conceive of electric currents as charged particles actually coming from the Sun. He also still thought that space was empty, which must be why he could only conceive of ‘heat rays’ coming from the Sun. But Lemström was an important precursor of Birkeland, who took his work very seriously. Lemström published his book *L’Aurore Boréale: Étude Générale des Phénomènes Produits par les Courants Électriques de l’Atmosphère* (*The Aurora Borealis: A General Study of the Phenomena Produced by the Electric Currents of the Atmosphere*) in 1886.

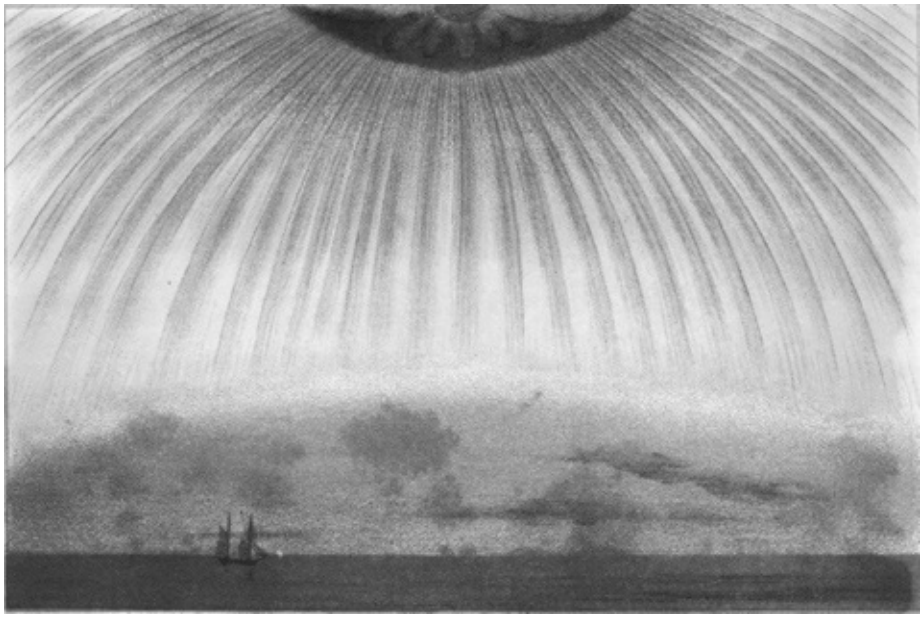


Figure 11. One of the many spectacular colour illustrations of the Aurora Borealis published by Lemström.

The next year after the publication of Lemström’s original article, in 1879, the Danish scientist and photographer Sophus Tromholt (1852–1896) noticed when he was visiting Lapland in Norway that the area of sky covered by the Aurora Borealis increased in size and spread southwards when solar activity increased in accordance with the eleven-year sunspot cycle, thus confirming Selim Lemström’s assertion of the previous year regarding the clear association of the

Aurora Borealis with some kind of solar influence, correlated with what Lemström called ‘changes in the solar surface’, i.e., the sunspots.

In 1885, Tromholt published a massive two-volume work in English entitled *Under the Rays of the Aurora Borealis*, containing 150 illustrations.[18] Selim Lemström and his work are mentioned, but the names of Kristian Birkeland and another auroral researcher, the Danish scientist Adam Paulsen, are not. (Paulsen had begun publishing, in French, his important observations concerning the Danish auroral expedition of 1882–1883 in 1884.)[19] Tromholt published a remarkable image of one of Lemström’s amazing experiments in producing an artificial aurora shooting up into the sky from a mountain top. That took place in 1882.

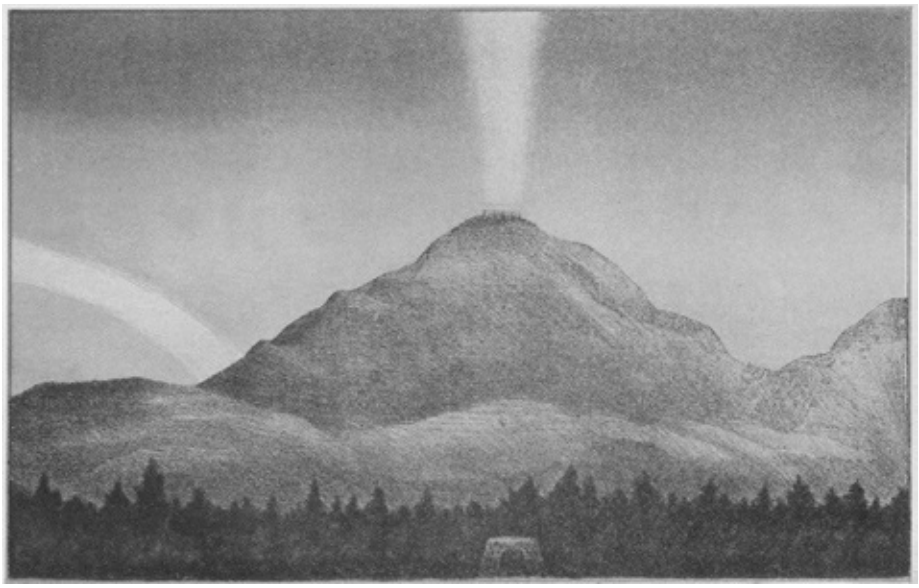


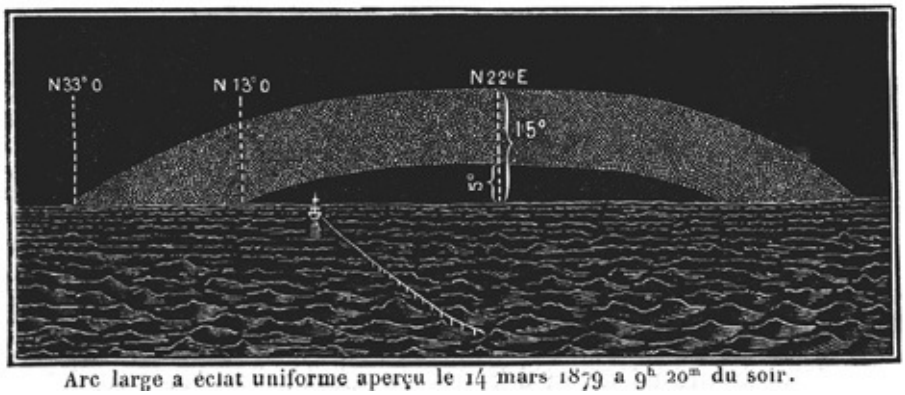
Figure 12. Tromholt’s depiction of Lemström’s experiment of 1882.

A major advance in understanding the electrical nature of the Earth’s atmosphere took place three years after this, when in 1882 Balfour Stewart (1828–1887) suggested that there was an entire electrically conducting layer lying above the air and cutting across the Earth’s vertical magnetic field, thus being the first person to suggest the existence of what we now call the ionosphere since the time when it had first been suggested by Aristotle.

In 1884, the Danish scientist Adam F.W. Paulsen (1833–1907) published his account of the Danish Polar Expedition of 1882–1883. And in the same year,

Adolf Erik Nordenskiöld (1832–1901), a Swedish Finn, published an elaborate account in French '*Sur les Aurores Boréales*' ('On the Aurora Borealis') in a French scientific journal, extracted from his account of the Vega Expedition to the North during the winter of 1878–1879, his original extract concerning the Aurora Borealis having been published two years earlier, in 1882, in Swedish.[20] (The *Vega* was the name of a ship on which he sailed in search of a Northeast Passage, and on which he got frozen into the ice near the Bering Strait. So he had plenty of time to observe the Northern Lights as he sat there trapped.)

There were many interesting illustrations published by Nordenskiöld. The accounts by Paulsen and Nordenskiöld are extremely important, and although I have their original publications (including even two personally signed by Paulsen), in the interests of brevity I shall refrain from discussing them here. A typical observation by Paulsen is that the electric currents in the atmosphere were strong in the winter and weak in the spring. The conscientious and diligent attempts by these two men to gather information concerning the Aurora were a significant part of the progress in understanding the phenomena.



Arc large a éclat uniforme aperçu le 14 mars 1879 a 9h 20m du soir.

Figure 13. An illustration shown by Nordenskiöld in scientific form, with all the angular measurements precisely given and the *Vega* stuck in the ice.

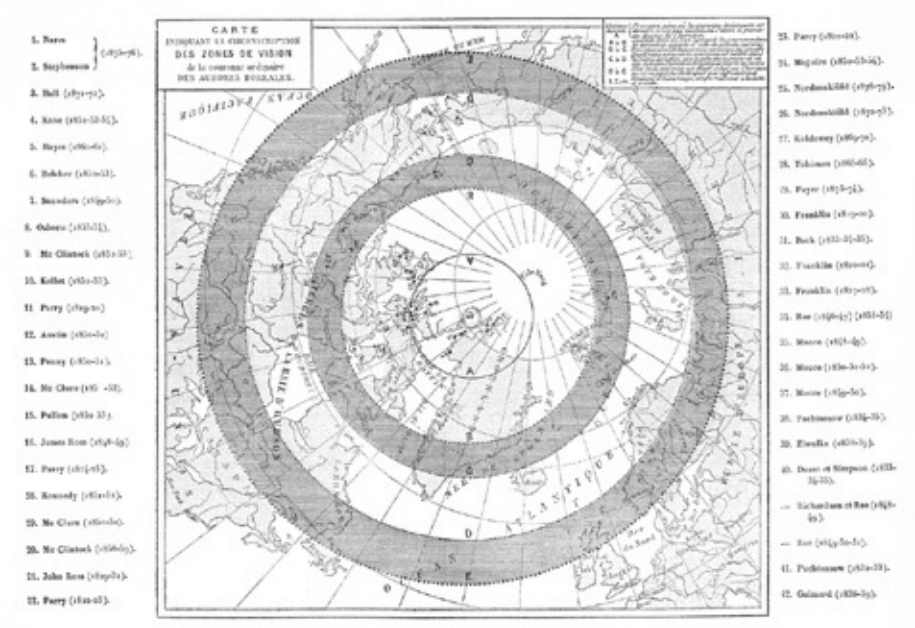


Figure 14. Nordenskiöld’s plotting of the regions of the Earth where visibility of the Aurora Borealis had been reported. The North Pole is shown in the centre.

In 1896, Kristian Birkeland, one of the most brilliant scientists of his time, began publishing the great breakthroughs. He hypothesized that the Sun emits rays of electricity (‘cathode rays’), which reach the Earth and are ‘the object of a suction’ by the Earth’s magnetic poles, and that there is a correlation between sun-spots, the Earth’s polar aurorae, and terrestrial magnetic perturbations.[21]

Birkeland’s theories as expressed in 1896 are not well known, as they are mentioned in an exceedingly rare book of his published in French in 1901.[22] I purchased a copy of this book from a book dealer in Paris. It was inscribed by Birkeland to his friend, the famous French scientist Henri Becquerel (1852–1908, winner of the Nobel Prize for Physics in 1903, who discovered radioactivity), and it had thus obviously come from Becquerel’s personal library. When I sent an email to Professor Alv Egeland in Oslo, with whom I was then frequently in touch, telling him about this find, he said it was the only one of Birkeland’s publications of which there was no known copy in Norway, and he had never seen it, although he had listed it in his bibliography of Birkeland’s publications. Alv is the biographer of Birkeland and the world’s leading expert on him.[23]

A popular book about Birkeland by Lucy Jago, entitled *The Northern Lights*, was published in 2001, but without footnotes or references.[24] In the Selected Bibliography, Jago does list the 1901 book by Birkeland, so presumably she consulted the single copy of the book that is in the British Library. (It is possible that there are only the two copies in existence today, mine and that one.) Jago begins her book dramatically with a description of events in Finnmark during the 1899 expedition.

As a result of my discovery of the little-known book, I now know that Birkeland formulated his theories of electric currents coming from the Sun many years earlier than had been thought. When discussing these theories of Birkeland, people generally cite his well-known book published in English in two instalments, in 1908 and in 1913, concerning the Norwegian Auroral Polar Expedition of 1902–3, which is widely available today in numerous print-on-demand reprint editions.[25]

But that was the third such expedition, and the book that I discovered concerns his earlier expedition of 1899–1900, and it contains sections on ‘Electric Current in the Higher Layers of the Atmosphere’ (16 pages), ‘Artificial Auroral Bands’ (20 pages), etc. It pushes back the timetable of Birkeland’s insights considerably from what we had assumed and shows how many more years he laboured at these ideas than had been thought.

As an example of how incorrect dates can spread and become accepted without question amongst the scientific community, we see this statement in Alexander Piel’s excellent book *Plasma Physics*, published in 2010:

> The space between Sun and Earth is filled with the plasma of the solar wind. This is a flow of charged particles from the Sun, whose existence was first conjectured, in 1908, by the Norwegian physicist Kristian Birkeland …[26]

But Birkeland first published his ‘conjectures’ on this subject in 1896, twelve years earlier than Piel believes, and it appears that everyone has been assuming that Birkeland’s 1908 book was his original publication of these ideas.

What is important for us here, and what makes Birkeland one of the great heroes of this story, is that having followed in the footsteps of his near-

contemporary Crookes in studying the influence of magnets on cathode rays in vacuums, he conjectured that electron beams from the Sun were being guided towards the Earth's magnetic poles in a similar way. He developed a theory in which energetic electrons were ejected from sunspots on the solar surface, directed to the Earth, and guided to the Earth's polar regions by the geomagnetic field where they produced the visible aurora.

In 1913, Birkeland also may have been the first to predict that plasma is ubiquitous in space. He wrote:

> It seems to be a natural consequence of our points of view to assume that the whole of space is filled with electrons and flying electric ions of all kinds. We have assumed that each stellar system in evolutions throws off electric corpuscles into space. It does not seem unreasonable therefore to think that the greater part of the material masses in the Universe is found, not in the solar systems or nebulae, but in 'empty' space. (Quoted on Wikipedia with no reference.)[27]

In 1916, Birkeland was probably the first person to predict successfully that the solar wind behaves as do all charged particles in an electric field: 'From a physical point of view it is most probable that these new solar rays are neither exclusively negative nor positive rays, but of both kinds.' In other words, the solar wind consists of both negative electrons and positive protons and ions. (The quote is from Wikipedia with no proper reference.)

I shall not tell the fascinating story of Kristian Birkeland's life, because that has already been done. Lucy Jago's book about Birkeland the man is a good place to start, and Alv Egeland's book about Birkeland the scientist gives all the other important information one needs. Since Birkeland was such an outstanding genius, both books are highly recommended, as more people need to know about him.

Since Isaac Newton (1643–1727), science and the world had moved towards a material mechanical view of the Universe, picturing solid objects in dead and empty space, held in orbit by gravity. It was a picture to inspire a certain cold wonder, perhaps; gravity was king here. Then Birkeland discovered that electric currents travelling from the Sun were entering Earth's atmosphere. This was a profound and important mystery because electricity can't cross empty space.

It would be another forty years before two scientific geniuses solved this mystery and began to build up a picture of the Universe filled with a web of electrical impulses like a macrocosmic brain.

8

The Cosmic Web

In 1933, the Swiss astronomer Fritz Zwicky (1898–1974) was observing the Coma galaxy cluster through the large telescope of the Mount Palomar Observatory in California when he saw an anomaly. He had been making calculations about the galaxy's luminosity and when he compared his observations with his gravitational calculations, he saw that they showed wide discrepancies. So he concluded that unseen matter must exist there to account for the gravitational forces.

He would call this unseen matter *dunkle Materie* (Dark Matter).

And as regards 'dark matter', which would eventually become widely accepted in the scientific community, my position is that one does not need to invent strange new kinds of matter, since it is plasma in different states (gaseous, liquid, solid, etc.) that is in 'the dark mode' and hence invisible to us. This fits perfectly with what we now know about the Universe consisting of 99.9 per cent plasma, bearing in mind too how hard it has been to photograph or even find the Kordylewski Clouds.

But what is important for this book and this chapter is that Zwicky produced evidence to show that space is not empty. Until then 'outer space' had been assumed to be totally empty, consisting of a perfect vacuum, with the exception of the solid orbiting bodies such as planets, moons, asteroids, etc. within the solar system and stars outside it. In other words, no medium was recognized. What happened to Zwicky after his discovery is an example of how blind and stubborn ignorance can hold back our understanding, because of the 'tactics of ignoring' new findings by the self-styled 'Establishment'.

The expulsion of solar material into supposedly 'empty' space was discovered from observation in 1936, three years after Zwicky's discovery, by the French astronomer Lucien Henri d'Azambuja (1884–1970), while he was using the

Observatory Telescope in Paris to look at the fiery material spewed out by the Sun.

After d'Azambuja's discovery of the solar wind, astronomers simply ignored it, as they had ignored Zwicky. Many famous astronomers continued to insist in the most vehement fashion that space was 'empty', and this remained very much the Astronomical Establishment's position. There is nothing like 'establishments' of all kinds to ignore advances and new findings, and try to retain the status quo! And we must never forget that there is a status quo of ignorance, which is precious to the mediocre minds incapable of original thought who make up 'the Establishment'.

During the early 1940s, Zwicky tried to publish further evidence that space is not empty, but publication of his findings was refused by every astronomical and physical journal in the world. The Establishment derided and insulted him and closed ranks to try to prevent his findings from ever being made public. Finally, in 1950, Zwicky was able to get around the boycott of his discoveries only by turning to a biology journal, *Experientia*, which extraordinarily agreed to publish his astronomical findings so that he could somehow get them into print.

It enabled Zwicky's ideas to be circulated at last, even if only in offprints from a biological journal no astronomer had ever seen or heard of. It eventually became clear that the censorship of Zwicky's findings had been illegal, especially considering that his own observatory's committee had acted to ban publication of his findings in all American astronomical journals, which they had no legal right to do. This remains one of the great scandals in American science, and also of Swiss science.

However, the situation has become even worse today, for now it is not only observatory committees that prevent things from being published, but also the organized and combined forces of military, security and corporate power. Most scientists working in astrophysics in America today have signed confidentiality agreements with military agencies, and a large proportion of their work is kept secret under various security classifications, many of which are wholly unnecessary. If the scientists try to release their findings, they can go to jail. Even when some such documents are 'released' in redacted form under Freedom of Information laws, the release is often only technical.

For instance, one relatively uncontroversial scientific report commissioned by the CIA decades ago that I wished to see, as it had been officially 'released'

some years ago, can only be seen if you make an appointment and go in person to the CIA archive in Maryland, where you cannot copy it or take notes.

It is remarkable what a short time ago it was that all the world's scientists insisted that outer space was empty. In 1961, the French physicist Alexandre Dauvillier (1882–1979) published his book *La Poussière Cosmique* in France, which appeared in English in 1963 as *Cosmic Dust*. This was certainly one of the first full-length books, and possibly the only one at that date, to devote itself entirely to the subject of cosmic dust throughout outer space. In writing his book, Dauvillier (a distinguished physicist who had worked closely with Louis de Broglie, one of my scientific heroes) felt that he needed to keep explaining and almost apologising for the fact he was writing a book about something that not long before everyone was convinced did not exist.

Here are some of his remarks:

> It was thought until recently that cosmic space was absolutely empty … (here); At the beginning of the century [1900] it was still believed that interstellar space was completely empty and transparent. (here); Twenty years ago [in 1941], the space separating the galaxies was also considered as a complete void. (here); Ten years ago [in 1951] intergalactic space was considered absolutely devoid of stellar or dispersed matter … The work of F. Zwicky with the large telescope of Mount Palomar showed that intergalactic space is not absolutely empty.' (here)

Unknown until now, there were two other scientists who clearly realized even before Fritz Zwicky did that outer space was not an empty vacuum. This information has come to light very recently from the archives of Sir Fred Hoyle (1915–2001), which have been deposited at St Johns College in Cambridge. Chandra Wickramasinghe, Fred Hoyle's former student and his closest collaborator in his later years, has been going through the unpublished portions of Fred Hoyle's autobiography. I thank Chandra for sharing with me some sections of this material that provide this unique information. And I am grateful to the Estate of Fred Hoyle for permitting their use.

We learn from these unpublished portions that Fred Hoyle and his friend and scientific colleague Ray Lyttleton (1911–1995) had together decided by 1940 that outer space was not an empty vacuum, but was full of 'gas', by which presumably Fred means ionized gas that we now call plasma. However, they

went much further than that. What follows are quotes from papers originally written for a book that would be published in 1994.

> … [In] 1940 … Ray Lyttleton and I suggested that the gas between the stars was likely in places to be clumped into much denser clouds than astronomers were then prepared to admit. We also suggested that the gas in dense clouds would be molecular rather than atomic, with molecular hydrogen the dominant component. These perfectly correct predictions never did us much good, however, because they were thought outlandish in their own time and three decades later, when observation had shown them to be correct, nobody remembered what had been said as long ago as 1940. So it goes, I'm afraid.
>
> The thought that molecules, even quite complex molecules, might be present in great quantities within dense clouds of interstellar gas never died away in my mind, although astronomical opinion through the 1950s was so firmly set against the idea that to argue for it in the scientific literature became impossible. Throughout my career I have argued fiercely against the refereeing system practised by nearly all the so-called serious journals. My opinions are admittedly coloured by an intense dislike of being told by referees what I may publish, or not publish. But this is not the whole story. The superficially plausible reasons for maintaining the system are false. The real reason for the existence of the refereeing system is that it provides the majority with a strictly applied censorship over ideas which it does not wish to hear …
>
> Because in the 1950s the seemingly respectable vehicles of publication were closed to the concept of molecules in space, I turned to the disreputable vehicle of science fiction. My novel *The Black Cloud* was written in an irascible mood immediately following an international meeting of astronomers. The novel had the effect in my mind of connecting molecules in space with life, although by imagining a life-form very different from terrestrial forms, I was unfortunately off on the wrong track.

Fred was not necessarily off track after all, as he realized much later. The sad story of Hoyle and Lyttleton being unable to publish their views echoes the troubles of Fritz Zwicky in the 1940s.

We will return to Fred Hoyle and his contribution to this story in Chapter 11.

However, for all the importance of the work of Zwicky, Hoyle and others, the scientist who probably did most to throw light on ‘invisible matter’ in space and to prove that space is not empty was Birkeland’s fellow Scandanavian, Hannes Alfvén (1908–1995).

The Birkeland Currents were given this name in 1967 in honour of their discoverer, and called then by that name in Alfvén’s article ‘On the Importance of Electric Fields in the Magnetosphere and Interplanetary Space’, which he published in that year.

Alfvén’s breakthrough was to follow up Birkeland’s speculations by identifying plasmaas the medium by which electric currents could travel through space, as he extrapolated what he discovered about the currents running between the Sun and the Earth first to the galaxy and then to whole of the Universe. This breakthrough would lead to both a radical new understanding of the contents of the cosmos and also – by coming to an understanding of the mechanisms by which plasma carried the currents and in turn the effects of currents of plasma – a greater understanding of plasma and its extraordinary properties. By studying Alfvén and his followers, and their discoveries, we can begin to see how plasma in general and the Birkeland Currents in particular are fundamental to the way the Universe works.

Because Alfvén showed that the Universe has this vast network of plasma filaments carrying electric currents, he also showed that the Universe is full of electromagnetic fields. In fact, Alfvén’s electric currents in space produce a complex and dynamic interaction of magnetic fields, magnetic currents and electric fields throughout space. The charging of particles in plasmas and space by electromagnetic fields in turn modifies the electromagnetic fields. Whereas once space was thought of as empty, we now know that at a subatomic and quantum level, space is a jungle of plasma, a highly charged, creative ecosystem – with matter in the form of particles being one of the things it creates.

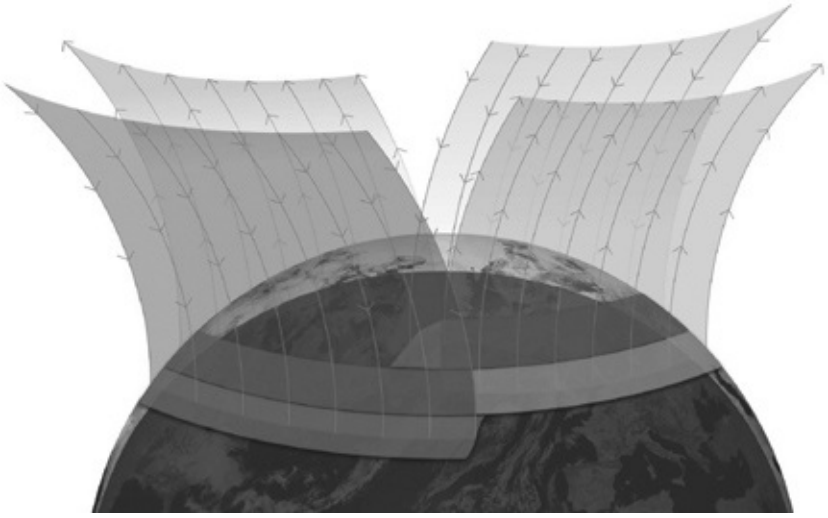


Figure 15. Upward and downward current sheets of flat electric current extending between the Earth and space, discovered in 2017. The pale current sheets show the descent onto the planet of charged particles and the dark sheets show the upwards ascent of charged particles (as indicated by the small arrows). However, it has been well known for many decades that negative current pours into the pole in a stream. It is unclear why this is not also shown, nor is it clear why the current is rising from two opposite quarters of a ring current, how that is happening (what makes it rise?), and what charge these sheets have. (The same? Opposite?) Much more clarity is needed before we can simply accept this picture, which must only be part of a much larger process which is going on and which requires much more investigation. (Image courtesy of European Space Agency).

Alfvén showed that a Birkeland Current is a stream of either negatively charged particles (electrons) or positively charged particles (protons and positive ions) that can travel for immense distances through space (many millions of miles or even billions of miles at speeds not far below the speed of light) along a ‘twisted rope’ not made of dense matter at all. The ‘rope’ is made entirely of the charged particles themselves and the magnetic fields generated by those streams of current. Scientists call these ropes ‘filaments’. When there are several of them seen at once, they are referred to as a filamentary structure. Sometimes they consist of substantial bundles of filaments, and sometimes of only two, which are literally a ‘double helix’.[1]

Superconductivity is an extraordinary phenomenon, first observed in 1911, by which a current can pass through certain materials and experience zero

resistance. Classical physics cannot explain how this works and the quantum mechanical explanation is still not complete. But in 1970, Laszlo Solymar and Donald Walsh, two particularly brilliant scientists, clarified the nature of superconductivity to a large degree by pointing out that superconductive filamentary currents consist of a central magnetic field surrounded by whirling layers of current vortices. They specifically stated: ‘Thus, in a simplified manner, we may say that there is a normal region surrounded by a supercurrent vortex. There are lots of [layers of such] vortices …’ (Laszlo Solyar and Donald Walsh, quoted in Laszlo Solyar, Superconductive Tunnelling and Applications, Wiley-Interscience, New York, 1972.)

The illustration overleaf of a cross-section of a Birkeland Current shows such layers.

Birkeland Currents are far more efficient at conducting current than any dense matter conductor could ever possibly be, and they have very little current loss despite the fact that they can extend not only across our solar system but across our entire galaxy, and even beyond. Indeed, galaxies themselves seem to be linked by Birkeland Currents. There are many photographs of Birkeland Currents in space, and there are many on the internet and in books to which I shall refer in a moment.

The ‘loops’ that are seen extending upwards and outwards from the Sun’s surface and from the solar corona (which is far above the surface) are also Birkeland Currents. They are sometimes called ‘magnetic field lines’ by astrophysicists, which is incorrect; they are actually the glowing traces of the charged currents themselves, and there are many photos of these currents taken from the International Space Station, which show a kind of eerie glowing green river running along beside the space station, and encircling the Earth.

The charged particles that reach the Earth from the Sun are mostly positively charged, made of protons and ions emitted by the Sun, and they stream along Birkeland Currents towards the north and south poles of our planet. They are literally space rivers of positive current streaming into our planet, and into all other planets in our solar system as well. What this means is that there are ‘threads’ connecting the Sun with all of the planets, which is thus in continuous direct communication with all the ‘small fry’ by means of these rivulets. Of course, the rivulets get all twisted up because of the revolutions of the planets, and sometimes the rivulets are shut off and then new ones start up again.

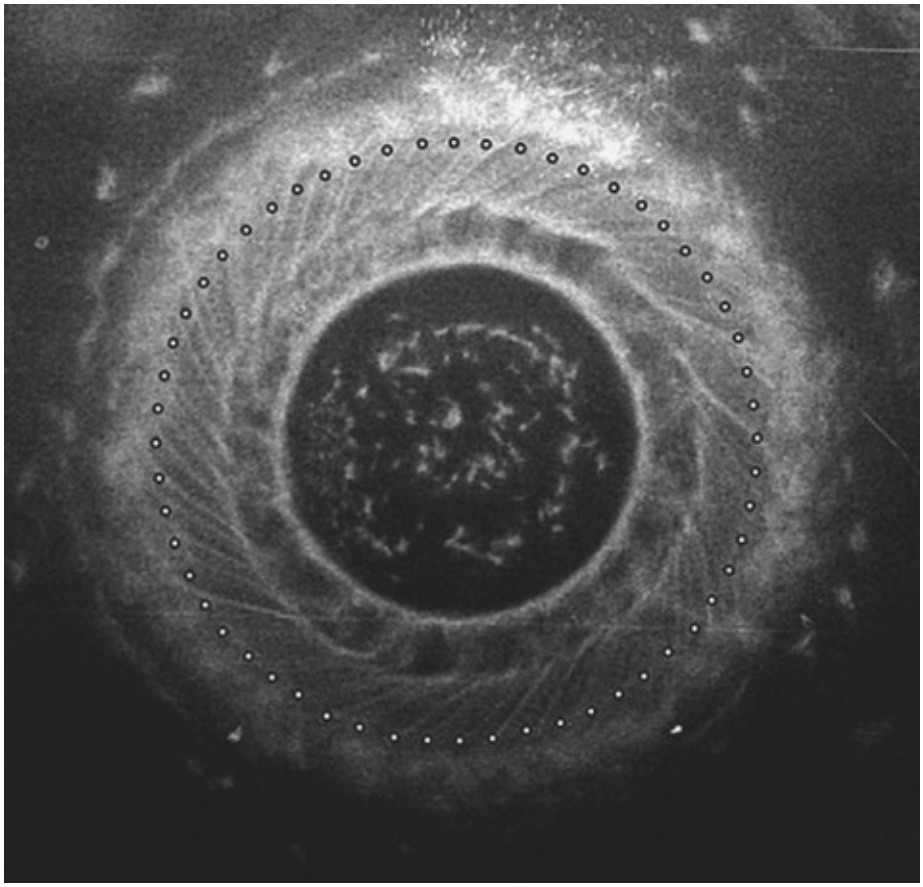


Figure 16. Cross-section of a dense plasma Birkeland Current captured on a photographic ‘witness’ plate in a plasma lab in 2007. The circle of dots is overlaid onto the image to indicate the 56 locations of the apparent spiral-shaped paths of matter. (Image supplied courtesy of Anthony Peratt, reproduced from Donald E. Scott’s seminal paper, ‘Birkeland Currents: A Force-Free Field-Aligned Model’, in *Progress in Physics*, Vol. 11, Issue 2, April 2015, pp. 167–179.) The spiralling currents counter-flow, in other words, one ring flows left and the next flows right, etc., and the whole thing is spiralling forward (towards you, looking at the page) at great speed in a cylindrical ‘skin’ known as a ‘double-layer sheath’.

Birkeland Currents beneath the surface of our own Sun are known to be 40,000 miles wide, as mentioned earlier. The ones linking stars are far larger, and ones linking galaxies in filaments to form ‘the cosmic web’ of the Universe are so gigantic that they are much wider than the diameter of any sun or star. Many have been observed and recorded by astronomers, including the Sloan Great Wall – a filament that is an amazing 1.37 billion light years long.

Birkeland Currents can also be microscopic. Our bodies are full of them. It is because of the nature of such infinitesimally small currents that we are alive, as we will see in the final chapter.

The way in which the ‘ropes twist’ to form Birkeland Currents in a double-helix shape is really rather astounding. Does this remind you of anything? Yes, there is a distinct similarity between the structure of the DNA molecule and a Birkeland Current. Not only is this, in my opinion, no coincidence, but we shall see that since the 1970s there have been cell biologists insisting that charged currents flow along the DNA molecules inside our bodies, and that they are superconducting. Double helixes not only carry currents, they transmit information. All of this is getting us closer and closer to what I believe to be the nature and structure of a plasma body, and to the reasons for believing that intelligence can evolve in plasma.

But first we must return to look in more detail at the way Birkeland Currents function in space. We will see the current standard understanding of electricity and magnetism is still insufficiently developed for us to ‘get our heads around it all’.

As one example of our failure to comprehend the great mysteries that surround us, I come to what we call magnetic lines of force, or magnetic field lines. These are constantly spoken of by scientists around the world, as if they really existed. But they do not exist.

Just in case you think I am being fanciful, here is what John P. Cullerne and Anton Machacek say in their physics textbook, *The Language of Physics: A Foundation for University Study*:

‘… field lines are a fictitious pictorial representation of a field.’[2]

Field lines are used in the way that contour lines we draw on maps are used. The real landscape is not covered in contour lines. When we climb a hill, we do not say: ‘Oh, I just stepped over a contour line.’ Similarly, magnetic field lines are merely aids to visualization, and they are not real.

So where does this leave us? Didn’t I say that Birkeland Currents ‘follow magnetic field lines’? Well yes, I was using a figure of speech.

Now let us examine a bit more closely how a Birkeland Current is formed, and how it works. It all starts with a ‘push’ of currents of electrically charged particles emanating from a source.

The push forward of the current is facilitated by what we call an electric field.

At this point, I should pause to admit that although scientific talk on these matters is confident and well-established by custom, it is often hemmed in by ignorance. For example, we don’t really know what fields are, but we talk about them nevertheless, until we find some other way of discussing them. I tend to believe that electric fields are spiral waves. So we have charged particles called electrons (assuming it is a negatively charged electric current, rather than a positively charged one consisting of protons and ions) spiralling along, pushed by something we call ‘an electric field’, though we don’t know what that is, or what charge is either.

But to return to the questions of how a Birkeland Current is formed, we do know that electric fields are always perpendicular to magnetic fields. These currents flow as if along ‘magnetic field lines’, meaning they follow a direction laid out for them by a large pre-existing magnetic field.

As the currents move on their merry way, each creates a private magnetic field (known as an ‘azimuthal’ field) around itself in a circular fashion, which is thus at right angles to the electric field, but parallel to the larger magnetic field within which these tinier ones appear.

In Figure 17, we see a drawing published by Willard Bennett from his book *Fundamental Principles of Physics*, written jointly with his colleague Herman Heil, showing a section view of a normal copper wire carrying electricity. Remember that this picture is a slice across the wire and its surrounding field, and that the wire is coming straight at you. The black dot in the centre is the wire and all the circles round it are the ‘lines of force’. Bennett describes the convention (‘the usual agreement’, as he calls it) whereby:

> The lines in this figure are drawn nearer each other for positions close to the wire than for positions farther out, which is in accord with the usual agreement to represent field intensity by the number of lines per square centimetre in areas perpendicular to the lines of force.

And the drawing is, he says, to illustrate the fact that ‘the magnetic lines of force are circular about the axis of the wire’. In other words, scientists have agreed a convention whereby the fictitious lines are drawn closer together to represent increased field strength, and further apart to represent declining or weaker field strength. There are no real lines, but there is assumed to be a real field, just as on a contour map, there are real hills represented, but their contour lines are fictitious indicators of height and may be bunched closer together to indicate a steep incline.

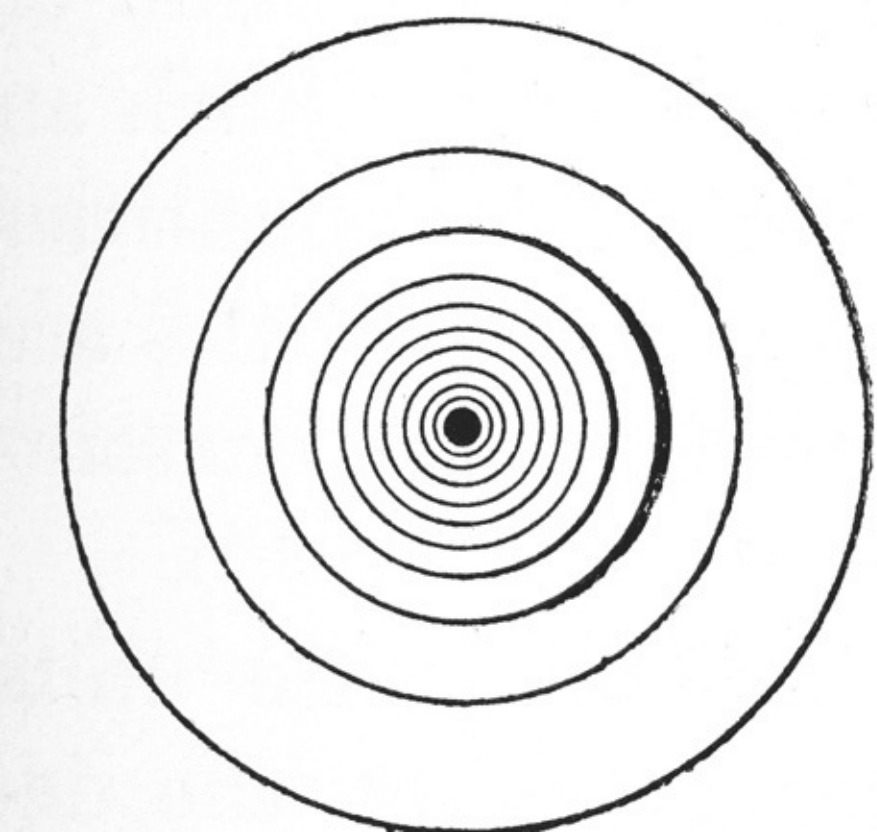


Figure 17. Willard Bennett’s drawing. The fictitious ‘lines of force’ are drawn closer together the nearer they are to the wire (the black dot in the centre) to indicate increasing field strength. This is a section drawing, and the wire is coming straight at you in this picture.

With regard to electric currents, the self-generated mini-magnetic field of each current then constricts that current, as if it were choking it.

The first person to observe that magnetic fields at right angles to electric currents displaced the current and caused it to deviate in its course by a certain

angle was Edwin Hall (1855–1938). He made this discovery in 1879, and it is named the Hall Effect, in his honour.[3]

What happens with Birkeland Currents surely is a kind of extension of this phenomenon of the Hall Effect causing a slight deflection of angle. But obviously we need to do a lot more work on this issue, and part of what needs to be done is to understand better the double-helix phenomenon of the Birkeland Current, as I shall now very briefly explain.

The magnetic currents applied at right angles to Birkeland Currents have the result that two currents running parallel to each other start wrapping themselves around each other in a kind of perpetual lovers' embrace. As we have seen, they twist up into a double helix and flow on like twisted ropes. Their two surrounding magnetic fields join and become stronger as a result. This constricts and compresses the plasma of the double helix further, and at occasional points nodes (special compressed points, like knots) are formed by this inward pressure, called 'Z-pinches'. (In fact, having been discovered and explained in 1933, and published in 1934, by Willard Harrison Bennett (1903–1987), certain types of the plasma pinches known as Z-pinches are now generally called 'Bennett Pinches').

Plasmoids (plasma blobs) form at these points and begin to spin, thus attracting surrounding particles and matter in space to themselves and forming clumps. These are essentially energy whirlpools or vortices. The current flowing through the Birkeland Currents then continues to supply energy, what is called 'becoming a maintenance current', supplying energy to the spinning plasmoid, which goes on expanding. It was suggested originally by Alfvén that by this means, gigantic Birkeland Currents streaming through space form stars, and continue to pump them full of electrons. The 'pinches' can also create atomic matter, X-rays, and vast quantities of neutrons (large particles with no charge, called neutrons because they are electrically neutral), in a portion of the pinch known as the 'sausage instability'.

At the Z-pinch points where matter gets sucked towards the streaming currents, a process called 'Marklund Convection' takes place. This is named after the Swedish plasma scientist Göran T. Marklund. The matter settles into layers, with the lighter elements wrapped around the inner part of the cylindrical current, and heavier elements forming progressive layers outwards. The different

elements are thus separated spatially, and available for the formation of solid bodies in space in separate ‘bundles’, as it were.

A theory of ‘the electric universe’ has grown out of Alfvén’s work; it states that our Sun has electrons streaming into its poles from galactic Birkeland Currents, and protons and positive ions then burst out of the Sun to form the solar wind.

According to this theory, our Sun is powered by streams of electric currents from a filamentary web of gigantic current streams linking all the stars in the galaxy.

On this view, Birkeland Currents supply huge currents of electric power and they are surging round the Universe in filaments. The filaments that fill the visible Universe are so obvious when seen through powerful telescopes, they have led to a widespread acceptance amongst astronomers of the idea that the Universe is a Cosmic Web.

The best practical reference source to turn to for a description of Birkeland Currents in astrophysics is Anthony Peratt’s book *Physics of the Plasma Universe,* which appeared in a much-revised and updated second edition in 2015. Peratt was a pupil of Alfvén’s, and he is the world’s leading proponent of and expert on the ‘electric universe’ theory. As previously mentioned, he is a very high-profile scientist associated with American Government agencies. For several years he was Scientific Advisor to the US Department of Energy, and he has been the Acting Director, National Security, Nuclear Non-Proliferation Directorate. He has worked at Los Alamos on nuclear tests, and is internationally renowned for his plasma research, and Hannes Alfvén was his PhD supervisor.

Here is what Peratt has to say about the electric power filaments that I have just described:

> The high conductivity of cosmic plasma permits electric currents to flow that constrict the plasma to filaments. These current-carrying filaments form transmission lines, which allow electric energy to be transported over large distances. Transmission lines consist of an assemblage of two or more conducting paths. Transmission lines on earth, used for communications and the transport of electric energy, employ conductors that are usually arranged parallel to a common axis [i.e., side by side]. This need not be the

> case in space and is often not the case in filamentary current-conducting plasma in pulsed-power generators.[4]

Figure 18 is an image showing the filamentary structure of the Universe above and the filamentary structure of a neural network below. We will see later in the book that a similar web exists in our bodies, more particularly in what we might call our ‘plasma bodies’.

We will see that not only can we be confident that all dusty complex bodies such as the Kordylewski Clouds are filled like this with a web of filaments, we can also be confident that our bodies are too. The filaments meet and connect at intersection points, which scientists call *nodes*. In interstellar space these are stars. In intergalactic space they are galaxies. But at whatever scale, the pattern of a filamentary web keeps recurring.

Alfvén was, of course, the leading disciple of Kristian Birkeland. He and Peratt have carried forward Birkeland’s ideas about Birkeland Currents. If Peratt’s book is the ultimate ‘bible’ for this subject, Alfvén’s book *Cosmic Plasma* (1981) is also fundamental. Alfvén and Peratt in turn have a disciple named Donald Scott, author of the book *The Electric Sky*. Scott is a retired Professor of Electrical Engineering living in America. My wife Olivia and I have been very pleased to get to know him and his wife Annis, and for me to have the privilege of speaking at the same conference with him on one occasion on the subject of the electric universe.

As for Birkeland, he was ridiculed in his lifetime for his theories about the aurora and was only proved correct in the 1960s when satellite data became available to us. Professor Alfvén was also ridiculed for supporting the theories of Birkeland, which he did from the 1930s onwards. But he too was finally vindicated, and was fortunate enough to live sufficiently long for this to happen in his lifetime, unlike poor Birkeland, who died prematurely. Alfvén Waves are named after him, and if something is named after you, things are certainly looking up.

Time and again in history, science seems only to progress via vicious ridicule, followed by vindication and reluctant, hypocritical acceptance by most of the people who have spent years insulting the innovative thinkers. Kristian Birkeland and those who have followed in promoting his idea of electric currents streaming through space, have defied orthodoxy and ridicule and have put

forward a far more convincing explanation of how the Universe works. I certainly believe them to be correct.

The 99.9 per cent of the Universe that is plasma is not sitting there inert. It is fantastically active and dynamic.

And we shall shortly see that as plasma beings, we are part of that universal process.

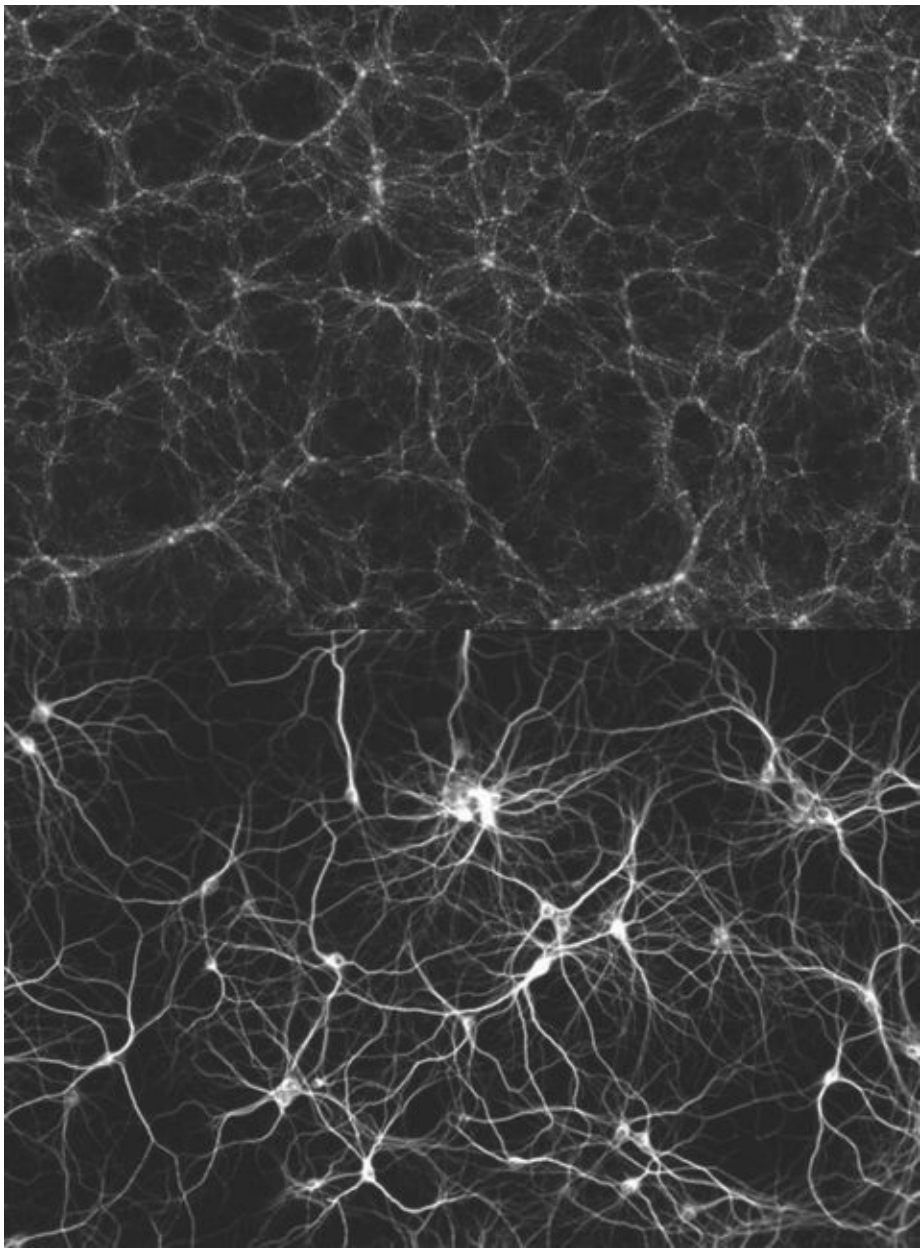


Figure 18. Filaments are fundamental to the Universe, and to all entities. They carry current. And they can carry information in the form of signals, they can

transport energy, and so forth. In the Universe as a whole, they are everywhere. They constitute the major portion of the Universe's structure, which today is known as the Cosmic Web. Here we see two similar adjoining images. The top one shows the Cosmic Web of the Universe. The bottom one shows the neural network of the human brain. Both are constituted of masses of filaments separated by voids and joined at intersection points called nodes. The Cosmic Web is called that because of the web-like nature of the filaments, which many believe to be filamentary channels for the conduction of energy and currents across astronomical distances. Some scientists call them Birkeland Currents (named after the Norwegian scientist Kristian Birkeland), which contain current-carrying double-helixes spiralling forward and surrounded by protective sheaths. Such spiralling currents are sometimes conceived of as 'super-conducting', meaning that they can travel without resistance at speeds approaching the speed of light. The upper image was posted on www.researchgate.net by astronomer Professor Oliver Hahn of the Lagrange Laboratory, Côte d'Azur Observatory, Nice, France, on December, 2014, as Figure 1 on page 2 of his paper 'Collisionless Dynamics and the Cosmic Web', from the *Proceedings of the International Astronomical Union*. (His paper with the image is available for free public download. Hahn does not himself discuss super-conducting currents or use the term Birkeland Currents.) The bottom image is credited to Matt Lee and was posted by eLife Science Digests (www.elifesciences.org/digests/37935) in an article entitled 'Traffic Signals That Wire the Brain', November 19, 2018. As with the Universe and its Cosmic Web, the Brain Web of a human being displays filamentary networks separated by voids and joined at nodes. Is the Universe a giant brain? Is the human brain a mini-Universe? In any case, these phenomena are examples of 'fractality' (a term arising from the study of fractal geometry), which means similar patterns and structures occurring at different scales, from the microscopic to the cosmic. Such reoccurrences of shapes are often referred to as the 'self-similarity' of forms which remain the same across different scales. These concepts arise from the pioneering genius Benoit Mandelbrot (1924–2010), discoverer of fractals. I was so fortunate to meet this heroic scientist on one occasion and attend one of his lectures. There are many videos of him on YouTube, which I enthusiastically recommend to all who wish to have their brains constructively stretched.

9

The Cold Sun

We have all been told for our entire lives that the Sun is a raging furnace blasting out heat and light, which keep us alive here on Earth. The Sun is supposedly so hot that nothing one can imagine could survive for even a fraction of an instant without being melted and consumed and annihilated within its inferno. The Sun is inconceivably hot, inconceivably violent, inconceivably turbulent. It is like a great bully in the sky, roaring with rage and spewing out fire and rays.

But this is not true. And nobody could be more shocked than I was when I discovered this. It had made sense to me, having no specialist knowledge of all the other aspects of the matter, that the Sun must be the roaring inferno that was so widely claimed. And when I was told that it was powered at its core by the equivalent of an internal hydrogen bomb of fantastic and gigantic size, which generated all of its immense energy by the power of thermonuclear fusion and kept us all alive, I saw nothing to question in that. After all, where else could all that energy possibly be coming from? It must be true.

But then the conventional idea of the Sun began to fall apart for me, as I discovered some very strange facts in recent years. The ultimate discovery I made, which convinced me that ‘nearly everybody is wrong about the Sun’, was the revelation that the Sun is cold.

How can that be? Surely the Sun cannot be cold. You can see through telescopes that it is a turbulent mass of fire, spewing out blobs of fire into space, and it looks like a vast fiery creature gone mad.

But no. That is not accurate.

In fact, the ‘surface’ of the Sun, the technical name for which is the photosphere, is only about 5500 degrees Centigrade.[1] (That is 5780 degrees Kelvin, but I shall not use the Kelvin temperature scale in this book, because it is less familiar to readers.) Yes, that is hot for us humans. We would be burnt to a

crisp in an instant if we were there. But it is not truly hot. It is less than four times as hot as the inside of a cement kiln here on Earth, in which limestone is roasted to make cement. And it is only about a third as hot as the electrons in a neon light bulb in an office.

Furthermore, it gets worse. If you go down into a sunspot, which is like a gigantic wobbling open mouth on the surface of the Sun leading down inside to unknown depths, our observational instruments have proved from a distance that the temperature drops to as low as 3900 degrees Centigrade.

What? You mean the Sun gets colder the further you go down into it instead of hotter?! How is this possible if it has got a big hydrogen bomb exploding continually at its centre? Well, the answer is that it does not have a big hydrogen bomb exploding at its centre.

The real heat of the Sun is found far above its surface, in what is called the corona. There the lowest temperature is two million degrees Centigrade, and it is believed that coronal temperatures can actually rise to several million degrees Centigrade. No one is sure of the upper limit, though four million degrees are often mentioned, and sometimes six million. But even the lowest temperature (two million degrees) of the corona is 350 times as hot as the surface of the Sun, despite the fact that it is so very far away.

Its lower limit is 1300 miles above the surface of the Sun. It extends from 1300 miles above the photosphere to the further reaches of the solar system. The Earth is actually within the Sun’s corona, technically speaking. But the main part of the corona from the point of view of solar physics surrounds the Sun in a vast sphere of fire, which reaches several million degrees Centigrade, as already described.

If you were to travel towards the Sun (being miraculously immune to melting), you would pass through the genuine raging inferno of the corona, then you would travel sixty miles from a transition region until you reach a layer 1050 miles thick called the chromosphere, where the temperature would be a much lower 35,000 degrees, and finally after falling a further 250 miles, you would arrive at the photosphere, which I have already mentioned.

The photosphere is not solid, so you could not stand on it. But it looks like a surface from a distance, and so that is why it is called ‘the surface of the Sun’. And then you could make your way down inside the tube of a sunspot, with the temperature continuing to drop considerably, until you passed out of sight and

after that we have no idea of what you might encounter. But the point to remember about this journey is that it keeps getting colder the closer you get to the Sun.

So clearly our conventional ideas about the Sun cannot possibly be correct.

The fact that the Sun is so cold and that the temperature drops as you approach the Sun, from several million degrees to only 5500 degrees, should be conclusive proof that the Sun cannot possibly have an explosion going on inside. Water does not flow uphill. Everyone knows that as you approach a hot stove, you do not get colder, you get warmer. But so deeply wedded are the majority of astrophysicists to their false theory of a thermonuclear explosion going on at the centre of the Sun, a theory originated by Sir Arthur Eddington (1882–1944), that they remain blind to the obvious.

Another point to keep in mind is why are those holes in the surface of the Sun known as sunspots not only colder than the surface, but also dark? Surely if the solar bomb theory were true, any holes in the photosphere would be blazing with light? But dark? So there we have it, the only sure indication of what lies beneath the solar surface is that it is cold and dark. This is far from the 15 million degrees of heat and explosion of light that the solar bomb theorists insist upon as being found at the core of the Sun, where their purported bomb is said to be going off.

Before returning to the question of how the Sun must really be powered, we need to learn a little bit about the ‘solar wind’.

The solar wind

As we learned in Chapter 8, the expulsion of solar material into supposedly ‘empty’ space was discovered in 1936 by the French astronomer Lucien Henri d’Azambuja. Until then, ‘outer space’ had been assumed to be totally empty, consisting of a perfect vacuum, with the exception of the solid orbiting bodies such as planets, moons, asteroids, etc., within the solar system and stars outside it. In other words, no medium was recognized.

However, we now understand that the solar wind consists of plasma together with admixtures of some atoms and a lot of dust, either negatively charged (by electrons) or positively charged (by protons and positive ions). Thus solar wind

comes from the Sun and picks up dust on the way, although it has now been proved that plasma creates dust (as described earlier; see Chapter 3), so that some of the dust in the solar wind is thus plasma-originated.

In other words, the Sun is emitting in all directions a powerful ‘wind’ of plasma, which fills the entire solar system. It flows over the Earth constantly, blowing against and around the globe, being diverted in large part by the surrounding Van Allen Belts, or magnetosphere (see Chapter 4). But how long has this been going on? Has the Sun always been doing this, or is it something new? And could it ever end?

In 1977, Arthur J. Hundhausen, who was later to go on to become probably America’s leading solar wind expert, published a summary paper entitled ‘Plasma Flow from the Sun’.[2] By that time, there had already been fourteen years of satellite data, so that he was able to make reliable statements about the solar wind. He said that the evidence indicated that the solar wind had been blowing continuously for four billion years. That is a lot of wind, a long time span, and a very powerful Sun, with no end in sight!

In May of 1999, a very strange thing happened. For two days, the solar wind stopped completely. That certainly poses some problems for conventional ideas about the Sun. Did somebody turn off the central bomb? How can you turn off a thermonuclear explosion and then start it up again two days later?

The ‘orthodox’ view of the Sun at the moment is, as I say, that the thermonuclear explosion taking place at the core of the Sun powers everything. However, solar scientists admit that if the heat and energy from that explosion are to reach the surface of the Sun, by what they call convection, the process of the energy rising to the surface from the core could take 200,000 years. According to the Establishment theory, therefore, we are currently being warmed by radiation emanating from an explosion that took place 200,000 years ago. The results of today’s core explosion will be felt on Earth in the year 202,017.

There are many bizarre solar anomalies that are ignored and glossed over at the moment. For instance, every 2 minutes and 40 seconds, the Sun shrinks in size and re-expands, or in other words rises and falls, by six miles. That’s a long way to fall and a fast rise! There is no ‘orthodox’ explanation for this strange fact. Is the Sun breathing? If there were continual pressure from a thermonuclear explosion at the core of the Sun, how could that pressure ‘breathe’ every two minutes and 40 seconds? Are we to imagine a fusion process that has lungs?

The solar wind is mostly positive in its charge. Positively charged protons and ions spew out of the Sun continuously except for these short breaks. It seems that if it sheds too many positively charged protons and ions, it stops for a few minutes until it ‘recharges’, and then starts up again. As we saw in Chapter 8, huge streams of electrons pour into the polar regions of the Sun continuously from immensely long galactic Birkeland currents. This continual inflow of negatively charged electrons provides the pressure to expel the oppositely charged positive ions into space, which form the solar wind. This system of solar activity is described in ‘the electric sun’ theory. It provides a way for the Sun to operate for billions of years without the need for any central explosion at all.

Although some atoms are known to be created by the Sun, they are created under the intense temperatures of the corona, far above the main body. In other words, the temperatures needed to create the higher chemical elements are outside of the Sun’s core body and take place in what is effectively its outer skin. This is like trees, the centres of whose trunks are essentially unproductive and simply inert wood, whereas the true life processes of the tree trunk take place in its bark.

Another major problem for the ‘thermonuclear folks’ who refuse to give up their hydrogen bomb in the centre of the Sun is what is known as ‘the neutrino question’. It is admitted by everyone that there should be a very large number of the tiny nuclear particles known as neutrinos pouring out of the Sun as a result of any thermonuclear explosion. But the requisite number of neutrinos has never been detected. This embarrassing lack of neutrinos is often a source of public anguish to many in the ‘astrophysical community’.

In the next chapter we shall look at more scientific discoveries, which show the Earth’s relationship with the Sun to be very different from what we generally assume it to be.

10

Invisible Earth

There is an Earth that is invisible to the human eye, and it surrounds the visible planet Earth. This other Earth is composed of plasma, and it is far larger than the ‘solid core’ on which we live. Which, then, is the real Earth? Or is the real Earth both together? The Invisible Earth was only discovered in 1958 thanks to satellite data by James Van Allen (1914–2006).

When James Van Allen’s portrait appeared on the cover of America’s *Time* magazine on 4 May 1959, with the news banner ‘Space and the Radiation Belt’ angled across the top, he became an instant American hero. He had discovered something called ‘radiation belts’ surrounding the Earth. Few people until then had any inkling that the Earth was protected from the solar wind by these shields, or ‘belts’, surrounding it. But then, prior to 1953, neither had any scientists. As for *Time*, the following year they did indeed name him America’s ‘Man of the Year’ for 1960, thus increasing his fame, in case there was anybody left who had not yet heard of him, which was doubtful.

Inside the magazine, *Time* helpfully provided graphics that both recounted the sequence of discoveries and showed the now famous ‘belts’. This sequence of graphics was headed ‘Space Detective Story’, to help everybody realize that it was only slowly and painfully discovered by intensive research stemming from rocket and satellite launches. The graphic sequence was divided into four boxes. Box One said: ‘1953 – Rockoons [small solid fuel sounding rockets fired in the atmosphere after becoming detached from a balloon, rather than fired from the ground] fired off Newfoundland detect first hint of radiation belt’. The picture showed a small red arrow pointing into space from Newfoundland in Canada. Box Two said: ‘1958 – Explorers I and III find lower portion of inner belt’. The picture shows the inner belt in cross-section above the Earth, and informs us that it is 2000 miles thick. Box Three says: ‘1958 – Project Argus demonstrates charged particles follow magnetic lines of force’.

Project Argus involved exploding atomic bombs above the Earth, and the picture without the slightest embarrassment at this shows an exploding red star above the Earth labelled ‘Atomic Explosions’ and red lines showing the charged particles from those explosions circulating round the Earth, with the orbit of another satellite also indicated, which says, ‘Explorer IV measures results’. And finally, Box Four says: ‘Dec. 1958 – Pioneer III reaches 63,000 mi., establishes second radiation belt’ and the picture shows this, labels it ‘Outer Radiation Belt’, indicates that it is 10,000 miles above the first belt, and there is a further arrow surrounded by dots that is called ‘leakage of particles’.

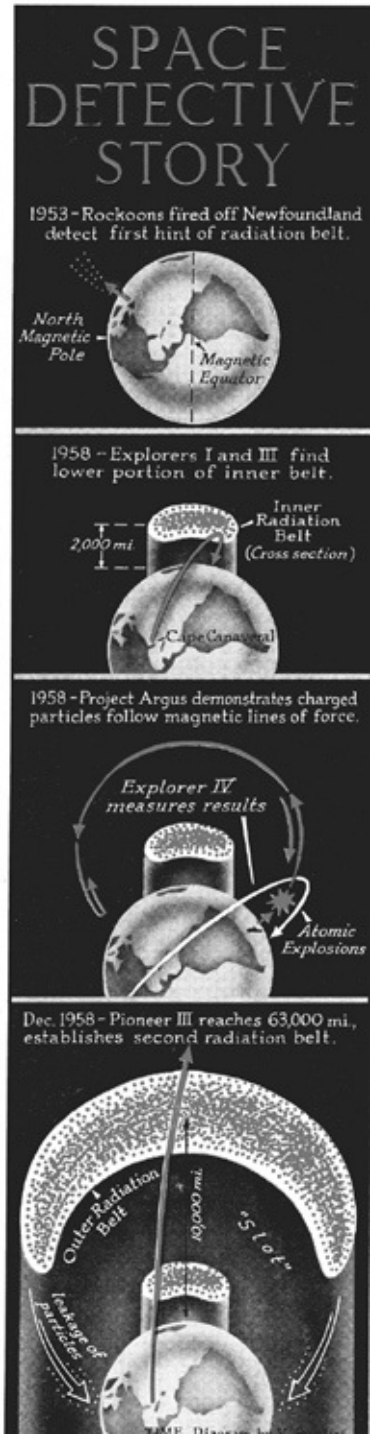


Figure 19. *Time* magazine's explanatory chart by V. Puglisi, of the discovery of the Van Allen Belts. The bottom picture shows how much bigger the Second ('Outer') Belt is than the First. A third higher Belt was discovered later. Note the shameless boasting about the 'Atomic Explosion' in the picture above the bottom one, complete with a helpful red explosion. How incredibly naïve, or should I

say stupid, the military authorities were, and how idiotic the editors of *Time* must have been, to print this without any indication that they had turned their brains on and realized that maybe this was possibly not such a good idea.

Thus did the public get their necessary basic science lesson and see what it was that Van Allen had discovered. There was a lengthy article to explain it all much further, and to describe the man himself. The magazine informed everyone:

> In the race into space, the Russians can claim bigger satellites and more powerful rockets. If the U.S. can retort that it has a big lead in scientific achievement, the man most responsible is James Van Allen, whose instruments, designed and largely constructed in his basement laboratory, brought back from space discoveries the Russians never made.
>
> But Van Allen never expected to find himself, at forty-four, a key figure in the Cold War's competition for prestige. He is and always had been, by inclination and intent, a 'pure' scientist. His real interest is in cosmic rays. He started being curious about cosmic rays back in the pre-war days when they were considered as wildly abstruse and impractical as a study of the mating habits of sea horses, or the inner structure of a grasshopper's brain. But today he can tip back his head and look at the sky. Beyond its outermost blue are the world-encompassing belts of fierce radiation that bear his name. No human name has ever been given to a more majestic feature of the planet Earth.

Readers were also reassured that Van Allen was 'about as American as a man can be'. He came from Iowa and his mother was raised on an Iowa farm, doubtless making apple pie from an early age. As for his Dutch surname, everyone was reassured that those Dutchmen on his father's side 'came to the US soon after the Revolution' and hence had been thoroughly imbued for two and a half centuries with the necessary American credentials and patriotism.

All of this publicity was carefully crafted as part of the Cold War PR battle between America and the Soviet Union. But it had a value as regards popular education in science, because you could only with difficulty find anyone in America after the spring of 1959 who had not heard that there were some kind of strange radiation belts surrounding the Earth, and that they were called Van Allen Belts because the American hero Van Allen had discovered them, from his basement, no less, and those irritating Russians had their noses out of joint as a result. 'They' may have had their Sputnik and Gagarin, but 'we' had Van Allen.

At least all this publicity taught the public something about what surrounds the Earth beyond the breathable atmosphere. Perhaps if there had been no Cold War and Van Allen had not been publicized so widely, the public would have remained ignorant of the Van Allen Belts for many decades to come. Sometimes public education in science comes in strange ways!

In 1956, while Van Allen was still a lowly and unknown scientist ostensibly working quietly at the University of Iowa, he published a book entitled *Scientific Uses of Earth Satellites*. In fact, Van Allen was probably already working for the Electronics Program Office of the US Office of Naval Research, albeit usually physically present in Iowa. The Office of Naval Research is essentially one of the many American intelligence agencies, one that specializes in scientific research, and we will later come across it as the employer of Freeman Cope. The Army and the Air Force have their own equivalents, but the Naval one tends to have the highest reputation for high quality scientific work. All three of them could either operate independently or operate as ‘covers’ for the CIA.

It is very common for talented scientists spread across the universities of America to have their salaries paid ultimately by government intelligence agencies, sometimes not even the intelligence agencies whom they think are paying them, but instead by one hiding behind another, and the universities like this because they get high profile professors for free. The downside is that the Government ‘owns’ those men and women, who have to sign onerous contracts that give the agencies power to withhold publication of much of their most important work, and even to slap secrecy restrictions on what the scientists can say about it to friends and colleagues.

Since 1947, the US Government has had the power to declare any scientific work taking place in America ‘secret’ and restrict its publication on grounds of national security, and these restrictions do not have to be explained or justified. Everyone in the security world knows that there is a great deal of unnecessary ‘overclassifying’ going on, with material declared secret without any rational justification. But there is very little oversight for this process.

In other words, a very substantial proportion of America’s ostensibly disparate scientific community really works secretly for the Government, or as conspiracy theorists like to say, ‘for the CIA’, using ‘the CIA’ to stand for the plethora of intelligence agencies including the Office of Naval Research (now apparently absorbed into DARPA or Defense Advanced Research Projects Agency), which

are all lumped together for the sake of ordinary conversation as ‘the CIA’. It is publicly admitted that there are at least seventeen different intelligence agencies in America. Many are genuinely separate agencies, which exchange information with each other from time to time, and are theoretically coordinated today by a central body, the competence or incompetence of which is of course secret, even from the politicians, so who knows whether it all works seamlessly or not, and who will ever know.

In the Appendix 3, Bibliography for Van Allen (here), it may be seen that under the dates of 1979 and 1982 are listed articles by Van Allen that are stamped ‘released for publication’ by the US Department of Defense. In other words, just about everything Van Allen wrote could only be made public with the specific written permission of the Government. So we will never know how many of his studies remain secret, and there are bound to be many of them. In evaluating the work of Van Allen, we must always keep this in mind, that we know only part of the story and will never know the whole of it.

Some aspects of Van Allen’s work are barely documented in archives open to the public at all. For instance, the fact that he was intensely active in trying to find out how to make better semiconductors is only revealed by the fact that his contribution to a 1961 conference on the ultra-purification of semiconductor materials was included in the Proceedings of the conference published by Macmillan as a scientific text in 1962. The reason why ‘ultra-purification’ is so important for semiconductors is that the purer the chips are (at that stage they would have been made of either silicon or germanium), the better the electrons flow in them, and the more efficient they are.

I have been in a chip factory and seen that the fanatical obsessions with purity and cleanliness are a commercial necessity. Everything takes place in ‘clean rooms’ into which one cannot enter, though you can see into them through windows from a corridor. The slightest speck of dust is enough to frighten everyone in the building. But people do not tend to know that Van Allen was involved in all of this. Instead, Van Allen will forever only be associated with scientific space exploration.

Since 1953, seven years before the article in *Time*, rocket launches had been detecting some anomalous radiation phenomena in the high atmosphere. But it was only in 1958 that satellites were launched, which instead of shooting up into the atmosphere and then quickly falling down again, as rockets did, could

continuously monitor the high regions for radiation. The very first such satellite, which was later publicly known as Explorer I, had initially been called simply Satellite 1958α, identified by the year of launch and the Greek letter *alpha*, which being the first letter in the Greek alphabet signified that it was the first satellite launched that year. This satellite detected unmistakable signs that there was a belt of radiation surrounding the Earth. The second satellite, later known as Explorer II, did not search for such information. The third satellite, 1958γ, tagged with the Greek letter *gamma*, which is the third Greek letter, came to be known as Explorer III and it confirmed what Explorer I had found.

In his book of 1956 and in a five-page article of 1957, Van Allen had published accounts of what the earlier rockets had detected, which he still referred to as ‘auroral radiation’. By that he meant that he thought he had detected the source of the radiation that streams down and forms the Aurora Borealis, and perhaps also the polar ring current made mostly of protons and positively charged ions that circulates in the Earth’s magnetosphere far above the atmosphere.

After the Explorer satellite findings, still referring to them as Satellites 1958 Alpha and Gamma, Van Allen and his colleagues on his team (George Ludwig, Ernie Ray, and Carl McIlwain) published a series of three articles in 1958 reporting on the amazing discoveries of a radiation belt around the Earth. These findings entirely superseded the accounts published only the year before from rocket findings. After that, Van Allen switched to the *Journal of Geophysical Research* as the medium for announcing his further findings, and published numerous articles in that periodical of the American Geophysical Union in Washington. At the same time, he became a member of the Board of Editors of that journal, and an Associate Editor. Due to his official ties with the journal, it was clear that he owed that publication the loyalty of allowing it to be the chosen vehicle for reporting his findings.

The next thing that happened in 1958 was Project Argus (but to consult it on Wikipedia you must type in instead ‘Operation Argus’, since ‘Project Argus’ is a name today better known as one applied to a police operation). This involved sending three atomic bombs up into the high atmosphere and exploding them, as already mentioned. The first bomb was of 10 megatons and was detonated on 1 August 1958. This bizarre project is worthy of extended discussion, which unfortunately in this book would be too great a digression. The bombs sent

charged particles hurtling along magnetic field lines and the results were monitored by the satellite Explorer IV.

This helped scientists understand the radiation belt better. Whether it was good for the Earth and its inhabitants seems not to have been considered! The motto of the people launching the rockets and satellites seems to have been a heedless ‘when you gotta know, you gotta know’, and the hell with what the consequences might be of blowing up all those atomic bombs above people’s heads. The damage done to the atmosphere by this crazy and irresponsible project (one of the bombs was truly gigantic and incredibly dangerous), forms part of the sad history of mankind’s progressive destruction of the ionosphere by military organizations, which I believe is the true cause of climate change, much more important than any carbon dioxide emissions.

Van Allen’s first article to appear in his newly affiliated journal was published in March of 1959 and was entitled ‘Radiation Observations with Satellite 1958ε’, the Greek letter *epsilon* signifying that year’s fifth satellite. It was written jointly with his colleagues Carl Edwin McIlwain and George Ludwig. (McIlwain was a young researcher who had made one of the key observations.) Here are some of the remarks from that article that are of great historical importance and of deep interest:

> The earlier discovery of the great radiation belt around the earth with Satellites 1958α and 1958γ has been confirmed and greatly extended with an apparatus of much greater dynamic range and discrimination. It appears likely that many important geophysical phenomena are intimately related to the reservoir of charged particles found to be trapped in the outer reaches of the earth’s magnetic field … The existence of a high intensity of corpuscular radiation [radiation composed of particles] in the vicinity of the earth was discovered by apparatus carried by Satellite 1958α, launched at 03:48 on February 1, 1958 …
>
> The data from 1958α and 1958γ showed that: (a) The intensity of radiation up to some 700 km was in good accord with that to be expected for cosmic rays only … (b) Above some 1000 km (this transition altitude being longitude and latitude dependent) the intensity of radiation increased very rapidly with increasing altitude, in a way totally inconsistent with cosmic ray [rays coming from space] expectations … It was proposed in our May 1, 1958, report … that the radiation was corpuscular in nature, was presumably trapped in … lunes [arcs of three-dimensional space with

> thickness and shaped like crescents], about the earth, and was likely related to that responsible for aurorae.
>
> On the basis of these tentative beliefs it was thought likely that the observed trapped radiation had originally come from the Sun in the form of ionized gas, which may or may not have been subject to acceleration in the outer reaches of the Earth's magnetic field … The existence of such radiation had been presaged by our earlier rocket observations … We are not at this date prepared to report a range spectrum of the radiation, nor are we able to offer a definitive appraisal of the important matter of whether the more penetrating component consists of protons, of electrons, or of X rays …
>
> On the basis of the evidence presented above, we regard it as established that the great radiation belt around the earth consists of charged particles, temporarily trapped in the earth's magnetic field … The radiation belt may well be the seat of a distributed 'ring' current encircling the earth, and the perturbations of the belt due to arrival of solar plasma may be directly responsible for solar storms. No detailed study of this possibility has yet been made.

What Van Allen had discovered was confirmation of the hypothesis put forward by Kristian Birkeland. Furthermore, without apparently fully realizing the significance of what he was saying, Van Allen said that maybe there was a 'ring current' around the Earth. This article therefore can be considered as the first appearance in print of physical confirmation of Birkeland Currents in space. But Van Allen and his colleagues were still struggling with the concept of plasma in space. They persisted in referring to what came from the Sun as a 'gas', albeit an ionized gas, which they hesitantly called a 'solar plasma'. But at this stage, no one yet understood the true nature of what we today refer to in common parlance as 'the solar wind', the massive streaming of plasma from the Sun outwards into the entire solar system, and bathing the Earth.

In December 1958, the satellite Pioneer III discovered the second radiation belt, high above the first and much larger. It was during this same year of 1958 that Eugene Newman Parker proposed the existence of what we now call 'the solar wind'.

During 1958, Van Allen approached the scientist Tommy Gold for advice on how to understand and interpret the satellite findings. In his article just quoted, Van Allen says: 'We are grateful to Professor T. Gold for an opportunity to

discuss a number of matters of general physical interpretation …' As I mentioned earlier, Tommy Gold (1920–2004) and I were good friends towards the end of his life. It was in 1959 that Tommy coined the term 'magnetosphere' to describe the plasma regions above the Earth, including the newly discovered Van Allen belts. I believe it was Tommy who edged Van Allen and his colleagues away from the idea that what was coming from the Sun was simply ionized gas, and tried to get them to think of it as plasma, which as we now know is correct. He could see that the plasma consisted not primarily of atoms of gas, but instead of charged particles. Tommy thus did a lot to advance our understanding at this stage.[1]

In 2013, a temporary third Van Allen Belt was discovered by NASA, but it was subsequently destroyed by a shock wave from the Sun. Or so the story goes, though it may simply be a cover story to explain its destruction by human interference. The second and outer Van Allen Belt is now known to consist largely of electrons, whereas the inner and smaller one consists of a mixture of protons and electrons. It was only in 2014 that it was discovered that the inner edge of the outer Van Allen Belt is very sharp and highly defined, and resembles a protective barrier. Scientists are still trying to understand that discovery.

This finding is, however, precisely what one would expect, because plasma regions whether large or small are routinely surrounded by closely fitting plasma sheaths, which are rather thin, and their edges do tend to be very sharp and highly defined, as we now know is the outer Van Allen Belt. In other words, what continues to be discovered about the Van Allen Belts provides increasing evidence that they are standard plasma belts of the classic type. Our planet is thus the solid core of a vast plasma entity that surrounds it. We need to accept that the Van Allen Belts and the atmosphere are the Earth just as much as the solid core.

Our planet is more than solely a round ball in space. If we remember the fairy tale of the princess and the pea, we might compare the planet on whose surface we live to the pea under the mattress. All we have to do is bend the mattress into a sphere, suspend the pea in the middle, and presto, we have the Whole Earth. The fact that the mattress is invisible to our retinas, and we can see only the pea, is neither here nor there.

11

Radiant Matter, Plasma and Plasmoids

For the last few chapters we have been considering the existence and flows of plasma in space and how these came to be recognized and understood. Now we turn from the cosmically large scale to the absolutely minuscule, and to the story of how plasma came to be discovered and explored within the laboratory.

Winston Harper Bostick is one of the great heroes of this history. He followed in the footsteps of Langmuir and Spitzer. He was a contemporary of Alfvén, and their work intertwined.

Bostick's great individual contribution was his discovery of plasmoids. Plasma is all around us, as we have seen, making up over 99 per cent of the Universe. Aplasma is a distinct entity that has emerged from the great plasma soup, and a plasmoid is a type of plasma, which as we are about to see is often spherical or blob shaped, or sometimes shaped like a doughnut – and it also has strange properties.

It is worthwhile recounting what happened in some detail, because what was discovered and the manner in which it was discovered reveal so much of importance. In the mid-1950s, the 39-year-old Bostick was working as a scientist in the brand-new Radiation Laboratory of the University of California at Livermore. It is today called the Lawrence Livermore National Laboratory.

The lab had been created in 1952 by Robert Oppenheimer's best friend E.O. (Ernest Orlando) Lawrence (1901–1958), who had won the Nobel Prize for Physics in 1939, and Edward Teller (1908–2003), who is often called 'the father of the hydrogen bomb'. It was created to supplement the US Government's nuclear warfare research at Los Alamos. The Livermore Lab continues to be entirely controlled by the US defence establishment and proudly announces on its website today that for more than half a century it 'has applied cutting-edge science and technology to enhance national security'.

Bostick was asked to investigate the firing of plasma into magnetic fields, in order to see how the magnetic fields might become deformed, and to study the interactions between plasma and magnetism. In particular, he was to look for ‘the manner in which magnetic-field lines can be dragged and twisted’ (as he said in an article of 1938). This had many defence implications, especially relating to the hydrogen bomb, as well as being relevant to the potential control of nuclear fusion for purposes of producing energy, as nuclear fusion can theoretically be confined by magnetic fields. (Any solid material such as steel used in an attempt to confine super-hot plasma would simply melt.)

Bostick had assumed that he would be firing bursts of plasma at a magnetic field and that they would essentially be ‘blobs of plasma’, and that it was the magnetic fields and not the blobs that would be of interest. He was not at all prepared for what actually happened. If he had discovered something of lesser importance, it would probably have been swallowed up in the gigantic secrecy machine that eats most scientific research done for defence purposes in America. However, what Bostick found was of such earth-shaking importance that he had to be cleared to publish accounts of part of what he had discovered – because it was so game-changing in physics that worldwide debate was clearly going to be necessary to try to figure out what it all meant.

Funded by the US Atomic Energy Commission, Bostick had invented what is called a ‘plasma gun’, which he refers to more conservatively as ‘a button source’ (because the tip of the ‘gun’ was like a button), and he began using it to fire plasma into a magnetic field in his lab. And this was when the surprise discovery was made.

Eleven months later, Bostick’s lengthy report, accompanied by many photographs, was published in *Physical Review*, under the title ‘Experimental Study of Ionized Matter Projected across a Magnetic Field’.[1] In this article he announced:

> … the plasma is emitted not as an amorphous blob, but in the form of a torus [the geometrical term for a doughnut shape] … We shall take the liberty of calling this toroidal structure a plasmoid, a word which means plasma-magnetic entity.

In a footnote at this point, Bostick was careful to give the credit to the Princeton physicist David Pines for coming up with the term ‘plasmoid’. Bostick had originally thought of using the term ‘plasmon’, also a term coined earlier by Pines. But Pines pointed out to Bostick that ‘plasmon’ would really be inappropriate for technical reasons, and so Bostick happily adopted Pines’s suggestion of the word ‘plasmoid’ instead.

I contacted David Pines and asked him the details of the naming of plasmoids, and this is what he said in an email to me in December 2015:

> You are correct, I did suggest the name to Winston, as plasmon, a term I had earlier coined, was in the process of becoming widely used to describe a quantized plasma oscillation, just as phonon describes a quantized sound wave. And now we have plasmonics and nano-plasmonics as a major sub-field of nano-electronics.

In case anyone is wondering what ‘a quantized wave’ means, it refers to part of a wave forming something resembling a particle, in other words the ripple (technically called an ‘oscillation’) becomes a thing. The best description of this, together with the analysis of the equations applying to it, and the formation of what he called ‘singular regions’ by a wave, was done by Louis de Broglie in the 1950s, and I have given a lengthy exposition of this in my technical paper ‘Is Particle Mass a Function of Degrees of Freedom?’ in 2016, a paper that may be downloaded from my entry on www.researchgate.net.[2]

So it was that the word plasmoid was coined, which was to be one of the key words of the physics of plasma to come. This 1956 paper by Bostick is thus of immense historical significance. And I am happy to add further clarity here about David Pines’s crucial contribution, for the historical record.

In Figure 20, I reproduce the first published drawing of a plasmoid, which appeared in Bostick’s article of 1956. The three-stage drawing shows the plasma emerging from the plasma gun at left in the form of a ring, and then breaking free and becoming a closed ring, or torus. By this point the plasmoid was about 5 cm in diameter. Numerous photos were also published with the paper, showing many other strange and unexpected phenomena.

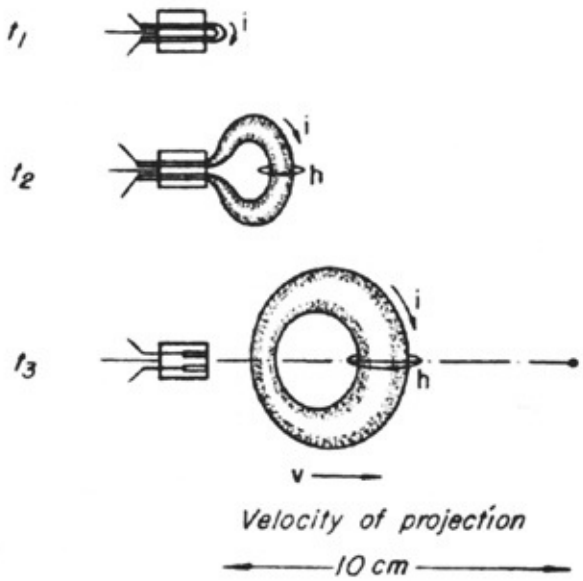


FIG. 2. Mechanism of projection of a plasmoid. No externally excited magnetic field is employed.

Figure 20. How to make an electric doughnut: the ‘plasma gun’ is at left, and from it emerges in three stages (shown as t1, t2, and t3, meaning ‘time one, time two, and time three’) a plasmoid in the shape of a doughnut, known in geometry as a torus. This is Bostick’s own diagram from his famous 1956 paper, and depicts the first plasmoid ever created artificially in a laboratory.

Bostick’s discoveries were truly revolutionary. As he says in the paper:

> In spite of the fact that there has recently been considerable theoretical interest in the interactions of plasmas and magnetic fields, there had been no theoretical predictions concerning the existence of plasmoids …

In other words, no one had ever imagined that such things as plasmoids existed or could exist.

The discovery that bursts of plasma were not merely shapeless blobs but were tori (the plural of torus, i.e., doughnut-shapes) was bizarre enough. But things got much, much stranger than that. In his article and others that followed, Bostick described these features. In this first plasmoid paper, he discussed the interactions of plasmoids with each other:

> Rather interesting and unexpected effects are produced when two plasmoids are projected at one another across a magnetic field … For example, the photograph … shows an interaction that looks (at first sight) like an elastic

> collision of two billiard balls … More striking effects can be obtained when two plasmoids are fired at each other when the pressure in the vacuum chamber is raised … These effects become even more spectacular when four sources, instead of two, are employed …

When four plasmoids were fired at each other, they spun into dramatic spiral shapes, of which Bostick published photographs. They seemed to him to be behaving as living entities. ‘In other words,’ he wrote, ‘we appear to be dealing with bodies which have strong powers of self-organization and preservation.’ He also described the plasmoids as being made of a ‘self-organizing putty’.

Bostick became so excited by this that he also reverted to an earlier concern with galaxy formation, and wrote: ‘It is possible to apply the knowledge gained concerning the nature of plasmoids to a hypothesized process of galaxy formation …’

What Bostick is getting at here is that the behaviour of charged plasma and plasmoids may be similar at all scales of size, from these tiny plasmoids in his laboratory to the scale of entire galaxies in space.

Figure 21. Bostick’s photo, taken as a two-microsecond ‘snapshot’, showing what happened when he fired two plasmoids at each other. To his astonishment, they combined to form a ‘barred spiral’ shape resembling the well-known barred-spiral galaxies in space. As he wrote: ‘Occasionally two plasmoids crashing head on break into fragments, but even these fragments seem to behave

as entities. In other words, we appear to be dealing with bodies which have strong powers of self-organization and preservation.'

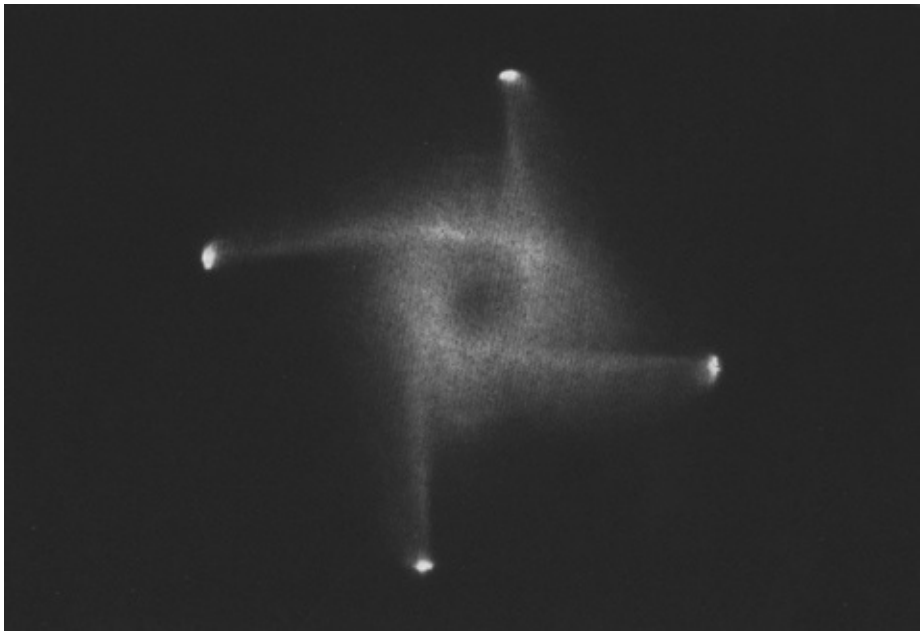


Figure 22. Bostick's time-exposure photo of what happened when he fired four plasmoids at each other, by aiming all of them at a common central point. He did this in a thin gas within a magnetic field, which is at right angles to this page. As soon as the plasmoids were fired, they ionized the gas so that electric current started flowing. The effect was this astonishing phenomenon, of a twisting and whirling ring with spiral arms.

As he says: 'The formation looks strikingly like a photograph of a spiral galaxy … We can look upon the combination of plasma and a magnetic field as a kind of self-shaping putty. Perhaps study of the forms assumed by this putty may help us understand configurations such as the stars and galaxies. It may also throw light, at the other end of the scale, on the construction of fundamental particles such as the electron, the proton, mesons and neutrinos. They, too, may be made of self-organizing putty: a putty composed of the electromagnetic field and its own gravitational forces, which, working together, create the bodies we know as particles.'

He then gave cosmological details about that, which we need not go into, except to point out that he was clearly developing the idea that the tiny plasmoids in his lab were in his opinion models of what took place in interstellar space, with

plasmoids essentially spanning reaches of space that would eventually contain many millions of stars.

However, this was mostly bad news for Bostick's bosses. They wanted bombs and power plants, not galaxies. Bostick was perhaps beginning to look too much like an idealist to make the generals comfortable. They had been hoping for something quite different, an easy way to handle plasma in a magnetic environment. They did not want plasma to start misbehaving and running amok in Bostick's lab like that and forming things that were bouncing off each other and appearing to be solid. But of course they had to find out more, so Bostick continued his investigations. And 'worse' was to come.

The pace of work and of publication now sped up. By 1 January 1957, a further article appeared in *Physical Review*.[3] This time Bostick was joined by two other authors, E.G. Harris and R.B. Theus, both military scientists brought in from the Naval Research Laboratory in Washington. It seems that Bostick was to work from now on with men who had military requirements and interests foremost in their minds and would perhaps keep an eye on him. Harris was a specialist in hot plasma physics. Theus was born in 1921 in Tennessee, joined the Army in 1943 as a private, and by 1956 was a nuclear scientist specializing in radiation and particle beams, who would later study the effects of radiation exposure on organisms.

The new paper was called 'Experimental Investigations of the Motion of Plasma Projected from a Button Source across Magnetic Fields'. It reported new studies showing that the speeds of plasmoids could be increased by aligning the magnetic field in a particular way.

However, there were even more unusual findings:

> The great variety of curious and unexpected phenomena observed seem to indicate that the plasma does not move as an amorphous 'blob' but must possess some sort of structure that is stable for the length of time involved … We shall refer to this structure as a plasmoid. The purpose of the series of experiments reported here is to gain some insight into the structure of these plasmoids, the way in which they are formed, and the mechanism by which they move across magnetic fields.

One of the new experiments was to shoot a plasmoid at a 0.65 cm wide hole in a copper plate to see if it would go through, which it did. This was done several times and occurred in both the presence and the absence of a magnetic field. But when a magnetic field was applied, after going through the hole, the plasma stretched out at right angles to its course. They then placed a wire screen with a 2 mm mesh in front, and the plasmoid went through that even though it was far larger than 2 mm.

So then they thought, as plasmoids bounce off one another, perhaps we can bounce one off a copper plate with no hole. What happened next was really disturbing. The plasmoid passed through the copper plate as if it were not there, a phenomenon we have already noted in relation to lightning balls – and 'fermions' on the quantum scale – and which is also similar to the behaviour of angels and other spiritual beings as reported in religious traditions. Furthermore, the plasmoid did not merely go through the metal sheet head on, it even went through the entire length of the sheet when the sheet was placed flat in its path in a failed attempt to bisect the plasmoid.

Now the military people really had something to spook them. They could produce plasmoids that could pass through considerable thicknesses of metal. What could this possibly mean for potential future weapons? For the vulnerabilities of the walls of tanks? For the sides of aircraft? For the White House itself, which did not even have copper walls?

Little interest is taken these days in Bostick's work, because only a minority of scientists show an active interest in recording the history of discoveries in their fields. The ones who do take the trouble often do a wonderful job, however. If only there were more of them! But as far as Bostick's work is concerned, I have not come across any attempt to chart his efforts since the American Physical Society issued a reprint of some of his key articles in 1963, in the form of a pamphlet.[4]

I have managed to collect original copies of everything that was made public by Bostick at that time. I have found over many decades of studying the frontiers of science that one learns the most about a new subject by very carefully scrutinizing the earliest publications, where unguarded remarks are often made and speculative hints are dropped by the enthusiastic discoverers and their colleagues. This is especially the case with work done for military authorities. But the censors and secrecy guardians at first tend not to understand the full

significance of new discoveries, so they do not always know which aspects of the new things they should be censoring; it takes them a year or two to figure it out.

So often the only time one can get some deeper insight into the new discoveries is from the initial reports. Then the steel curtain is drawn down upon the subject and no one dares talk or publish at all without written approval and very strict controls. I have known many fascinating scientific subjects to vanish entirely from public view because of paranoid censorship. Military and ‘security’ people tend to have no concern at all for the public’s understanding of science; they are only interested in weapons and what they call ‘public safety’. They make decisions, often holding science back by decades by suppressing knowledge of crucial developments.

Although the next article by Bostick to appear in print was his article ‘Plasmoids’ in the *Scientific American* for October 1957,[5] the next development in terms of the chronology of discovery was a paper of his which, although not published until 1958, had been delivered to an international conference in August of 1956 in Stockholm.[6] This was a live talk, the text of which was then published, with many photographs plus the text of the conference discussion that followed the delivery of the paper, in the Proceedings of that conference. Since it often takes a year or two to get such mammoth volumes containing contributions from scientists all over the world edited and printed, that was why it did not appear until 1958. This is the one paper by Bostick usually mentioned in footnotes by contemporary scientists, who have not bothered to look up his other publications. The Stockholm conference was organized and chaired by that giant figure in plasma science, Hannes Alfvén, whom we already know from Chapter 8.

Even though it was really a 1956 paper, I shall call it Bostick’s 1958 paper, after its year of publication, because that is what everybody calls it. When he delivered it, Bostick was still at the Livermore Lab, but by the time of publication in 1958, he had moved to a new institution. A footnote was added describing him as ‘Now at Stevens Institute of Technology, Hoboken, N.J., U.S.A.’ The Stevens Institute is hardly a household name, but it is an extremely important centre of scientific and technological research on the East Coast of America, not far from New York City.

Bostick became Professor of Physics and Head of the Physics Department. Perhaps he was glad to get away from people preoccupied with military matters and be free to do some normal science, without being asked all the time what kind of weapon it would be good for. And who knows, perhaps he was glad to escape certain colleagues as well. He did remain a consultant to Livermore and in 1973 even spent a summer there on a special project with Oved Zucker. But his best colleagues appear to have been the ones at Stevens, his closest being Vito Nardi, with whom he worked for decades. Nardi's name will come up again later.

In his 1958 paper, Bostick extended his insights into plasmoids by saying something truly remarkable: 'It is entirely possible that ions and electrons ejected from the Sun come to Earth in the form of a plasmoid.'

This is an astonishing suggestion, which was later adopted by Hannes Alfvén, who also believed that huge plasmoids came in the solar wind all the way to the Earth from the Sun. Indeed, in his book *Cosmic Plasma* (1981) Alfvén even spoke of plasmoids being fired from the Sun as if from a plasma gun, thus carrying the analogy with Bostick's work even further.

What is important for our argument here is that giant plasmoids from the Sun, given the complex behaviour that led Bostick to think of them as living entities, could easily be so intricate and complex in their structure that, in line with the discovery of the Kordylewski Clouds, they could even be intelligent or consciousentities. The implications of that would truly be limitless. Just imagine, for instance, that every plasmoid belched forth by the Sun and reaching the Earth or one of the Kordylewski Clouds could be in effect a program (in the sense of a computer program) and in that sense a communication of intelligence.

In that scenario, the Sun could be controlling the Earth's atmospheric phenomena directly when it wishes. Such plasmoids could also in principle contain information that receptive people could perceive indirectly as 'inspiration'. The Sun could 'talk to' the Kordylewski Clouds, the planets, our higher atmosphere, and anyone else who is listening. SETI people should really look for coded information concealed in plasma bursts coming from the Sun. But before we can explain that, we need to know some more about the fundamentals of plasmoids, and their habit of emitting signals.

Bostick reported that he had detected from his laboratory plasmoids 'signals which are believed to be associated with the magnetic fields trapped by the

plasmoid'. He says 'the structure of these signals is too complex for analysis'. If that is the case for tiny plasmoids in a lab, how complex might we expect them to be in a gigantic solar plasmoid striking the Earth's magnetosphere and interacting with it? Bostick elaborates further on the solar plasmoids:

> It is quite possible that ionized material ejected from the surface of the Sun proceeds and escapes across the magnetic field of the Sun in the same manner that laboratory-produced plasmoids cross a magnetic field.

Bostick then goes on to talk about how he is playing with multiple plasmoids in his lab:

> … several of these plasmoids can be made to spiral in consort to produce a ring of plasma … not only is the torus produced automatically, but also … it is stationary …

Experiments showed that plasmoids could turn into standing waves, so like ball plasmas behaving like the quantum phenomena already alluded to known as solitons.

There are many books and papers describing solitons, but to go into them in any detail would take us too far afield. The important point to note here is that we have yet another example for the development of one of the weird phenomena observed in the quantum realm occurring in the 'human' or macro realm. They can also exist within the human body, a subject discussed in numerous publications by Alexander Sergeevich Davydov (1912–1993), who was Director of the Institute for Theoretical Physics of the Ukrainian Academy of Sciences. Two of his key books are *Solitons in Molecular Systems* (1985) and *Solitons in Bioenergetics* (1986).

Bostick's descriptions of his plasmoids became increasingly eerie:

> One of the simplest … results which must be understood is the 'barred spiral', which is produced by firing two sources at one time across a magnetic field … the two plasmoids seem to seek each other out unerringly.

Not only do we now have hunting plasmoids, we even have mating ones:

> … the leading edges of the plasmoids seem to seek each other out and latch

> on to one another … After the union of the two plasmoids has been accomplished … the angular momentum will wind them up into a spiral … The resultant plasma and magnetic configuration then seems to be stable … It is rather astonishing that such a bizarre configuration of plasma and magnetic field should appear to be stable. No theoretician known to the author has a priori dreamed of such a configuration, to say nothing of contemplating its stability.

Bostick published photos and drawings of these weird shapes, which clearly delighted him. He was also able to produce plasmoids with forked tails and pairs of whirl-rings composed of helical twists, which moved away from each other in space, along magnetic field lines. He says that magnetic fields were trapped in these rings, but he was unable to ‘explore’ them further.

Finally Bostick enthusiastically reminded people of the possible cosmological implications of what he was discovering:

> By firing simultaneously two or more plasmoids across a magnetic field, it has been possible to produce co-operative phenomena which not only simulate the production of spiral galaxies and astronomical barred spirals, but which permit us to study these processes in the laboratory.

In the discussion that followed and which was printed in the Proceedings, praise was heaped upon Bostick by various distinguished participants. Patrick Blackett (1897–1974), who was created Lord Blackett in 1969 and won the Nobel Prize for Physics in 1948 for his work on cosmic rays, said that Bostick’s work had opened ‘an extraordinary exciting new field’. Vincenzo Consolato Antonio Ferraro (1907–1974), a specialist in magneto-fluid mechanics, said: ‘This is an interesting and important paper.’ And indeed it was.

Meanwhile the consternation of the military people might well be imagined. Bostick’s plasmoids were behaving like mischievous imps. Everything they did was unpredictable. How could anyone ever control such wild things? They were almost as bad as people. And the essential thing for all those who are obsessed exclusively with defence requirements is always control.

Going public

The publication in late 1957 by Bostick of his article entitled ‘Plasmoids’ in *Scientific American*, the widely read magazine that acted as a bridge between scientists and the general population, brought these matters to the attention of the wider public for the first time. One might say that this was both the beginning and the end of public awareness of plasmoids, as the subject then vanished, and no meaningful or sustained public discourse about plasmoids ever really occurred afterwards. There was a flurry of brief press articles in newspapers all over America reporting that a scientist named Winston Bostick had discovered strange things called plasmoids, but after Bostick ceased to be news, this stopped. And no one ‘out there’ seemed to ‘get it’.

Plasmoids in the public sphere became merely a curiosity of the time, superficially reported, partially discussed in one major article by the man himself, and then, frankly, just forgotten. People’s ‘five-minute attention span’ of which we hear so much today apparently already existed in the late 1950s.

It is worthwhile seeing exactly what Bostick did and did not say in his one genuinely ‘public’ article. *Scientific American* has always taken pride in having brilliant artists on their staff, who do absolutely superb illustrations of almost any scientific subject. For Bostick’s article, the magazine artists took his rather basic illustrations and turned them into spectacular displays. This did much to bring the subject vividly alive.

Bostick’s *Scientific American* article commenced with this subtitle:

> These little pieces of plasma (a gas of electrons and ions) are created in the laboratory with an electrical gun. They have an unexpected capacity for maintaining their identity

And on the very first page, there was a photo taken by Bostick of two glowing balls rushing away from each other and leaving luminous streaks behind, with a caption saying:

> Two plasmoids are fired at each other in a vacuum chamber … It can be seen that they repel and veer away from each other, so that each of the strange gaseous shapes retains its separate identity.

So the public got the idea right away that Bostick was making weird little balls of ‘gas’, which turned into entities of some kind. But what was this ‘gas’?

Bostick used his new word in his first paragraph: ‘The gas is called a plasma.’

In this article Bostick paid tribute to Irving Langmuir, who had begun serious plasma research. It was Langmuir who had coined the term ‘plasma’ in 1928. Bostick wrote: ‘The late Irving Langmuir of the General Electric Company began to study plasmas as long ago as 1921.’ Bostick was fascinated by the work of his predecessor Langmuir, and took time to record Langmuir’s ingenious experiments by which he was able to measure the temperature of the electrons in a neon light tube:

> Langmuir measured the electrons’ temperature and found that it amounted to about 20,000 degrees Fahrenheit – about twice as hot as the sun’s surface.

This temperature of 20,000 degrees Fahrenheit is 11,933 degrees Centigrade. And yet that same neon light tube can be held in the hand and feels cool to the touch even when the electrons in the centre of the tube are twice as hot as the Sun’s surface. This information is a crucial fact, which we will need to keep in mind when we consider plasmoid entities. Anyone who thinks plasmoid entities cannot contain within a very small space huge variations in temperature, pressure, charge, and complexity, need only remember the lowly neon light tube. That is proof enough that the sort of complexity in plasma that we will be discussing as we go along is not only possible but probable.

Later on we will encounter such things as double-layer sheaths and spiralling filaments inside plasma cylinders. And we will see how very hot and very cold plasma can exist happily side by side (protected by their surrounding sheaths, which isolate those regions from direct contact with one another absolutely) in closely adjoining regions within cosmic dust clouds such as the Kordylewski Clouds. Complex architecture within a plasmoid or plasma cloud may be built up in this way with ease, contrary as that may be to our conventional thinking and experience.

Bostick returned again to the subject of galaxy formation:

> Photographs of plasmoids in three dimensions show that as a plasmoid moves across the magnetic field it is twisted into the shape of a left-handed screw … The tempting speculation is that the matter of our galaxies may

> have been formed under the influence of vast galactic magnetic fields of one predominant orientation, which gave our matter a left-handed bias.

He then describes another curiosity. In this instance, instead of ‘mating’, two plasmoids sometimes run away from each other. So, just as with humans, not everybody is attracted to everybody else, and there is such a thing as plasmoid rejection:

> Under certain conditions our plasmoids form a pair of rings, which do not stay in the center of the chamber but move away from each other in opposite directions … our plasma rings are not whirls in a fluid but are separate, independent ‘bodies’. As such they represent a form of ordered organization by nature of which we have not been fully aware until now. Here is a case of electrons and ions collaborating with a magnetic field to form bodies which, though inanimate, assume orderly, characteristic shapes and possess a firm integrity.

This should remind us of the plastic microspheres in oil that were described in Chapter 3, which mimicked the behaviour of swarming bacteria and appeared to be ‘alive’ when subjected to electric field pulses.

The lessons to be drawn from Bostick’s work have still not been fully realized. As early as the mid-1950s, it was perfectly obvious that ‘separate, independent bodies’ with ‘ordered organization’ and ‘firm integrity’ had been created in a lab from plasma. And yet, no one dared to imagine what has become clear only in the last few years, namely that these plasmoids can become even more complex than our physical bodies.

12

Plasma Comes Alive

In this chapter, I am going to bring together arguments to show that dusty plasma in space can – and probably has – evolved life and intelligence.

The phenomenon of a burning candle illustrates the significance of dust. We have all seen burning candles, but how many of us realize that the flame of the candle is a small plasma? And why is the candle flame yellowish? That is because of the tiny particles of unburnt carbon dust (soot) embedded within the plasma, which arise out of the wax or tallow as the candle is burnt. When they reach a temperature of incandescence, they burn with a yellow colour, and that colours the flame in the way that is familiar to all of us.

The temperatures of the tiny carbon particulates as they burn in a candle flame can exceed 1000 degrees Centigrade,[1] and yet you can pass your finger through the flame without harm. This is another reminder of the highly complex natures of some plasmas, and that, as we mentioned at the end of the last chapter, extremely high temperatures can occur within them in pockets or isolated sections or bounded cells, while the surrounding plasma remains cool. If we do not realize and emphasize the extraordinary complexities that make these bizarre internal disparities of plasmas possible, we cannot understand the evidence that will continue to be brought forward as to how there can be – as some scientists are now claiming (and also myself in what I have said about the Kordylewski Clouds) – living, intelligent plasmas.

As plasma research progresses and becomes more and more urgent, while also becoming more and more bizarre, there are increasing numbers of experiments being carried out on what are called ‘cryogenic plasmas’, plasmas at extremely low temperatures such as we never encounter in normal life, which can only occur on Earth in scientific laboratories, or in tubes of liquid nitrogen or other substances made in laboratories (here and here).

Scientists are creating plasmas and injecting them into substances at extreme low temperatures, such as liquid helium, to see what happens. Liquid helium is so cold that its temperature is approximately minus 269 degrees Centigrade or minus 452.2 degrees Fahrenheit. At those low temperatures, a different temperature scale is used, known as the Kelvin Scale, named after a Scottish scientist named Lord Kelvin (1824–1907). Using that scale, liquid helium has a temperature below 4.2 degrees Kelvin, also written 4.2 degrees K. The Kelvin Scale is a purely scientific temperature scale, which sets 0 at what is known as 'absolute zero', which we never encounter in daily life.[2]

Surprising differences occur in 'high temperature liquid helium plasmas', which are near to 4.2 degrees K, and 'low temperature' ones, which are much closer to absolute zero. Different phenomena appear at the different temperature ranges, and no one really understands all of that yet by any means. The reason I refer to these cryogenic plasmas at this point is because in 2005, a team of Japanese scientists funded by the US Government's Asian Office of Aerospace Research and Development (AOARD) made an astonishing discovery.

They found 'unexpected high temperature of charged carriers' in the plasma,[3] meaning that surprising temperature variations can occur within plasmas, even when these occur within host plasmas that are very near to absolute zero. This is far more extraordinary than being able to hold a neon light tube when it contains electrons that are twice as hot as the surface of the Sun; this is like finding a patch of heaven that is deeply embedded in hell.

Let us recall that it was only in 1941 when Lyman Spitzer suggested for the first time that the huge clouds of interstellar dust that astronomers had observed for a long time through their telescopes might not be inert and useless stuff, but might be capable of becoming active and be charged dust. He said that negative electrical charges could be transferred to the dust by electrons in what he still called 'ionized gas', by which he meant what today we call plasma. Spitzer was making a tremendous conceptual breakthrough, and today electrically charged dust is a subject of such importance that it is talked about every day by scientists and technologists all over the world.

That is not because they are all trying to figure out the Universe. There are more practical reasons. The dust that occurs within plasma is of crucial importance in the electronic microchip manufacturing business (where too much dust in the plasma interferes with the deposition of circuits onto microchips) and

also – as we have seen – in connection with attempts to control nuclear fusion for power generation. It is no exaggeration to say that trillions of dollars are at stake on matters concerning dust, how to understand it, how to deal with it, and even how to use it.

The following year, in 1942, Hannes Alfvén, some of whose breakthroughs we examined in Chapter 8, discovered the ‘band structure’ of the solar system and was able to demonstrate that electromagnetic forces associated with a dusty plasma cloud (from which the solar system was formed) must have been dominant over the more usually mentioned gravitational forces in the formation of the solar system by contraction and solidification from – you guessed it! – dust. And that dust would have been electrified dust. Electromagnetic forces are so much stronger than gravitational ones that they exceed the latter by a factor of 10 followed by 39 zeroes.

By 1954, Alfvén had elaborated his ideas further and insisted that the planets and comets of our solar system (and by implication those of all other solar systems) were all formed as a result of the coagulation of dust particles in the solar nebula (the ‘dust cloud’ surrounding the early Sun) as a result of being electrically charged by plasma. (The dust was more important for the solid planets, of course, since the giant planets largely consist of plasma that is not solid.)

Many plasma scientists now suggest that stars form initially from dust. What happens is that the charged dust in a large plasma cloud in space coagulates to form a dust ball, which constitutes what is called a proto-stellar core, around which more of the cloud slowly collapses until a star is formed.[4] This would seem to be a variation on the Biblical injunction, to the effect that: ‘Remember, oh Sun, that charged dust and plasma thou art …’ Wouldn’t it be amusing if the centre of our Sun was really a cold compressed dust ball?

As mentioned earlier (Chapter 3), in August of 1981, the satellite Voyager 2 took photos of the rings of the planet Saturn, and the rings were seen to contain mysterious radial shape-shifting ‘spokes’. The scientists Jay Hill and D. Asoka Mendis in 1982 suggested that these ‘spokes’ consisted of charged dust, which was charged in a plasma. This was the first major invoking of charged dust to explain a solar system anomaly that had been discovered on another planet, and greatly raised the profile of dust within the scientific community. The suggestion

was later amplified by Christoph Goertz and Gregor Eugen Morfill in 1983, who suggested that the charging was caused by plasma bursts on Saturn.

In 1986, Norman R. Bergrun published a book suggesting another theory about the rings of Saturn, involving an extraordinary theory connected with ET. Some information about that may be found in the footnote. It is very far from being a purely scientific theory.[5]

We saw earlier that in 1986, Hiroyuki Ikezi predicted that plasma crystals, known as 'Coulomb Crystals', could be formed by dust particles in a plasma. The existence of such crystals was announced at a conference in 1993 by Hubertus M. Thomas and Gregor Eugen Morfill, and in 1994 simultaneously published by three separate teams, consisting of Thomas and Morfill, Jiun-Haw Chu and Lin I, and Yasuki Hayashi and K. Tachibana. At this point, dust reached a new high!

Much of the dust in outer space actually takes the form of what are called dust grains. They are miniscule, but more solid than the kind of thing we are used to in the form of household dust.

How much dust and dust grains is there in the Universe, in proportion to everything else? According to the physicist Douglas C.B. Whittet, author of *Dust in the Galactic Environment*:

> … submicron-sized solid particles (dust grains) … account for roughly 1% of the mass of the ISM [interstellar medium] … Despite their relatively small contribution to the total mass, the remarkable efficiency with which such particles scatter, absorb and radiate starlight ensures that they have a very significant impact on our view of the Universe. For example, the attenuation [weakening because of distance] between us and the centre of the Galaxy is such that, in the visual waveband, only one photon in every 10,000,000,000,000 reaches our telescopes. The energy absorbed by the grains is re-emitted in the infrared, accounting for some 20% of the total bolometric [bolometers measure luminosity] luminosity of the Galaxy.[6]

(Luminosity is a measure of the absolute brightness of something such as a star, as opposed to its apparent brightness, which may be diminished by distance and our atmospheric interference.)

Since we know that more than 99 per cent of the Universe consists of plasma, what little solid matter there is seems to exist primarily in the form of solid dust particles and grains, most or all of which floats in the vast plasma clouds. That reduces even further the amount of ‘solid matter’ of the sort that we see around us every day here on Earth, and it makes planets and moons even scarcer than we had thought, in terms of proportion of what exists, compared to everything else. That does not mean that there are very few planets and moons, quite the contrary, for we now know that there are untold billions of them. But what it means is that no matter how many there are, they still form a negligible proportion of what exists.

I do not believe anyone has calculated how much solid matter is left, after you subtract the plasma-bound dust. But as we face these facts, our familiar world is shrinking in significance all around us in the most drastic fashion. And, as I have already pointed out, if we have a science that is entirely based upon living in an atypical world, our science is going to be atypical. So we must reform it at once!

Are some plasmas alive?

We have been following the observation and testing of the influence of electromagnetic fields in the work of Langmuir, Alfvén, Kapitsa, Bostick and others. Plasmas are bounded entities that persist through time, a characteristic of any living organism at the most basic level.

Plasmas may feed on fresh plasma, and be nourished, for example, by solar winds. They may even compete for such food. Plasmoids seem to bond with one another and interact in other ways

We have seen particles in plasmas swarming like microbial beings (Chapter 3) and forming other patterns such as hexagonal structures, spirals, concentric circles and double-helix patterns (Chapters 2, 3, 11). Nerve-like filaments grow in plasmas, including those that form double helixes and may carry information as well as energy. Plasmas seethe with movement in and around their own internal structures created by electromagnetic fields. Complex plasma entities have countless plasmoid regions within them, all protected within their sheaths and separated by ‘voids’, like organs in animal bodies.

Some contain hot plasmas, some cold plasmas, some dusty plasmas, some non-dusty voids. Some containing impurities that may hinder or accentuate the

flows of charged currents in the manner of electronic semiconductors and transistors. In other words, large plasma clouds are bound to have the equivalent of semiconductors scattered throughout themselves, in order to modulate the current flows.

We have seen in the work of Peter Kapitsa that the crystalline structure of complex dusty plasmas makes them potentially far more complex than human bodies. There are soft, broadly crystal-like structures that grow into beautiful and intricate entities with the ability to transmit information over vast distances. Particles within a plasma can interact in concert with other particles.

Furthermore, and as we shall see shortly, the mysterious ability to move through objects without changing form, seen in quantum mechanics in the phenomenon associated with solitons and sometimes called ‘tunnelling’ takes place between ‘organs’ in a plasma. We will return to this later, when we will explain ‘tunnelling’.

There is no universally agreed, mathematically precise set of defining qualities of a living entity, but most accounts include growth, cellular form, reproduction, response to stimuli, ability to receive and process energy.

Of course, living beings that are not carbon based like ourselves will not be alive in exactly the same way that we are, but will be ‘alive’ none the less. We met Vadim Nikolaevich Tsytovich in Chapter 3. We mentioned that this leading Russian researcher into plasma and collaborator and co-author with Nobel prize winner V.L. Ginzberg in the 1970s, wrote in 2007 that the principles used to define life are:

> autonomy
> evolution
> autopoiesis [a system capable of reproducing and maintaining itself]

He concluded that:

> complex organized plasma structures exhibit all the necessary properties to qualify them as candidates for inorganic living matter that may exist in space provided certain conditions allow them to evolve naturally.[7]

Are there intelligent plasmas?

What are the defining qualities of an intelligent, living entity? For a plasma to count as intelligent, and with an intelligence that involves features a bit like our own – for example memory, the ability to perceive, communicate, model, choose, predict and manipulate reality. For that you may need a much greater level of complexity. You probably need a series of interdependent systems with both internal and external functions, plus an overarching system that coordinates the smaller systems.

In Chapter 5 we saw that plasmas in the form of ball lightning appear to act intelligently – or at least to operate by an intelligence. We saw how they appear to navigate, following aircraft or submarines – they know which way they are heading – turning at right or other angles, being still and then suddenly moving away at vast speeds, and even rolling down the aisle of an aircraft as if on an inspection visit.

Kapitsa's discovery of the crystalline structures in some complex dusty plasmas, discussed in Chapter 5, and the realization growing from that and based on the analogy with crystals in metals, suggested to me that it may be possible to calculate the density of electrons within a plasma. I realized immediately that this density could be crucial when calculating the likelihood that intelligence might evolve in a plasma.

This was much on my mind when I approached my friend, the mathematician and astronomer Professor Chandra Wickramasinghe, who like me was a friend and huge admirer of Fred Hoyle's and had been mentored by him; Fred supervised Chandra's PhD and they co-authored numerous works. Chandra and I agreed to cowrite an academic paper on the Kordylewski Clouds (KDC), considering their potential to evolve intelligence. What follows is an edited extract with the maths removed. The full paper can be found as Appendix 1:

> The Kordylewski Cloud at the point in space between the Earth and the Moon known as L5 (the 'L' stands for Lagrange) has a density over a hundred times higher than the density of ambient interplanetary dust. The maths shows that the mean distance between neighbouring particles within the cloud is thus very short indeed, yielding the possibility of inter-particle 'communication' if electromagnetic signals can be exchanged.
>
> This could be made possible because the dust would be charged to a potential of a few volts because of the photoelectric effect caused by absorption of solar ultraviolet photons; and collisions with ambient gas

> would lead to rotation (spinning) at radio frequencies. Spinning charged grains, particularly those in the form of elongated needles typified by bacilli, would be efficient absorbers and emitters of electromagnetic radiation. [This production of radiation because of spinning is explained more simply in a moment.] Most interestingly the total number *N* of such charged dust particles in a KDC (distance of < 1cm apart) would be truly vast.

With electromagnetic-wave emission/absorption across cloud dimensions as well as electrical connections (charge/current exchanges) between adjacent charged particles only centimetres apart, a Kordylewski Cloud might well be able to function as a gigantic computer/brain capable of storing and processing digital information. The maths also shows that the cloud may have a super-astronomical sum total for its potential computing power, exceeding the computing power available in all human brains, and indeed all other intelligent life on Earth as well, by very many orders of magnitude.

Finally, we refer to a few of the remarkable features that are known to characterize dusty complex plasmas and which could also play a role. The nucleation and growth of dust within such plasmas have been documented in several laboratory studies. In our case, however, the dust nucleation process will be side-stepped, and condensation within Kordylewski Clouds is likely to occur upon pre-existing interplanetary, potentially biological, dust particles. Thus, we could envisage a population of bacterial particles coated with semiconducting siliceous mantles that may well enhance inter-particle electronic connectivity. Such speculations may sound far-fetched, but they lie within a broad framework of possible outcomes based on known behaviour of complex dusty plasmas.

We might thus be tempted to view Dust Balls as highly structured ‘intelligent’ systems capable of storing and processing ‘information’ and realize that they may have many more surprising and unexpected features. Indeed, such huge stable entities that have presumably endured for astronomical timescales and have steadily grown in complexity over billions of years may display spontaneously evolved phenomena resembling those of the most highly complex living entities.

This situation is not dissimilar to the brain-like like complexity of the ‘cosmic web’ discussed by Ginsburg et al.(2019), although it is potentially even more impressive in its computational potential: the Dust Balls would contain an

intricate combination of charged dusty plasma in gaseous, liquid, and crystal states, with regions of positive charge and regions of negative charge separated from each other by sheaths and double layers, and containing superconducting filaments, so that it would be difficult for us to speak of a Kordylewski Cloud as a whole being singly charged or having a total net charge (or zero net charge), since there would be so many multiple regions of varying charges that a total net charge for each cloud would only be relevant when speaking of the cloud externally, such as in relation to the solar wind which is known to be predominantly positively charged.

Readers may still be wondering how such a seemingly tenuous structure as a Kordylewski Cloud can possibly hang together (‘cohere’) and become so incredibly complex?

Space is full not only of dust, but also of elongated grains (not unlike rice in shape, or we may think of them as rods or cylinders), which can be as large as one micron across. A micron is also called a micrometre. It is one millionth of a metre. (The next smallest measure is a nanometre, which is one thousandth of a micron, in other words, one billionth of a metre.) So don’t think you can ever actually see a ‘space grain’ with your eyes, as a micron-sized one is the largest, and most are even smaller.

It is dust spheres and elongated dust grains of this size that constitute the ‘bodies’ of the Kordylewski Clouds, and they are much too small to be detected by satellites that might ever pass near or through the clouds. But the clouds are so gigantic that there are trillions upon trillions of trillions of these constituents within them; they can be very diffuse by our standards, in other words, very far apart from the point of view of our own bodies, so diffuse as to seem almost not to exist at all. After all, at our human scale, we think of the atoms constituting our bodies as being very near to each other. Of course, the idea that our bodies are solid is an illusion: Sir Arthur Eddington asserted a century ago that all atoms consist of 99 per cent empty space; nowadays we might modify that to say 99 per cent an amorphous mist of tiny, tiny particles called quarks and gluons.

The point is that if you shrank to the size of a ‘space grain’, you would find that you could easily traverse an entire human body and see nothing substantial because everything of which it was constituted was too far apart to appear to consist of anything. In other words, we would all essentially be undetectable. So everything is a matter of scale. If you were the size of a Kordylewski Cloud, you

would very readily see them. You have to be big enough to ‘see’ them properly, or to have technology that can reveal them, as ours has done, but with difficulty.

Some of the dust grains are elongated rather than spherical, which generates the forces that are needed. That is because the space grains are each rapidly rotating, or as we can also say, are spinning. (This is no connection with the entirely separate subject of ‘quantum spin’.) These rotations generate low-frequency waves in the plasma, some of which have colourful names: ‘the electron whistler’, ‘the dust whistler’ and ‘dust cyclotron waves’, Alfvén waves, and ‘electromagnetic ion-cyclotron waves’. Many of the dust grains are essentially levitated by electromagnetic forces.

The space grains are set spinning by electrical fields. But they do more than rotate. They also ‘quiver’ and ‘bounce’, to use the very words actually used by the plasma scientists who published these findings in 2002. The idea of invisible spinning, bouncing and quivering rice grains floating around in outer space and ‘whistling’ may seem like some science fiction fantasy, or somebody’s idea of a practical joke. But it is all true. As the scientists say: ‘The dust grains execute bouncing motions … Furthermore, each grain also performs transverse quivering across the sheath electric field …’

The energy of the dust rotation can flow into the surrounding plasma and generate plasma waves. The grains are magnetic dipoles, meaning that they have positive and negative poles. They are charged either negatively, by thousands of electrons clinging to each of them, or positively by protons and ions clinging to them. And those charges are directly coupled to the electric field in which the dust grains reside. It is obvious therefore that these spinning grains are generating collectively a great deal of energy that pours into the surrounding plasma. As a result, microwaves are emitted and it has been proved that ‘Coulomb Crystals’ (crystalline structures that can sustain themselves and remain differentiated from the plasma sea) can form, thus creating the elements of macro-sized structures, compartments, and ‘pods’ within the plasma cloud.

So we see that it is the spinning grains that generate the energy to form structured clouds, as if they were a vast army of microscopic power generators, which ‘create’ the organization of the whole cloud. The number of spinning grains inside each Kordylewski Cloud could be as many as 10 followed by 26 zeroes. As we point out (see Appendix 1), the electrical connections and current exchanges between adjacent charged grains, even if they are as much as a

centimetre apart in a Kordylewski Cloud, would create a structure that might well be able to function as a gigantic computer/brain capable of storing and processing digital information.

Having described the spinning micro-generators inside the clouds, I will now clarify a strange fact about dusty complex plasmas that makes all of this possible. I am going to quote a few words from the plasma scientists Dietmar Block and André Melzer in a paper they published in 2010, but first I need to explain that scientists have a term for describing elements of a system, such as particles, which have powerful interaction energies holding them together. They call this ‘strong coupling’. (Think of a happily married couple who stick together for decades.) Block and Melzer mention how ‘strong coupling’ works in ‘normal’ solid matter, which consists of atoms with very small inter-particle distances. Then they say:

> In dusty plasma the situation is different. If micrometre-sized particles are immersed in a plasma environment they immediately attain high negative charges due to the higher mobility of the electrons … Therefore, even at particle distances of the order of several hundred micrometres the mutual interaction energy of two particles exceeds by far their thermal energy and the system is strongly coupled … At the same time this strongly coupled system has a fairly low particle density … and a favourable ratio of interparticle distance to particle radius … This combination results in a very high optical transparency [i.e., it is almost invisible], which allows us to observe individual particles even at the centre of clouds containing more than 10^6 [the mathematical way of writing ‘onemillion’] particles.[8]

Just think what this means if translated into human terms. If we speak of human beings instead of particles, it means that if there were one million people standing together in a vast crowd covering a huge area of land, they would have to be so far apart from each other that even at a distance we could with a telescope distinguish and detect every separate individual. This brings the common phrase ‘you are one in a million’ into sharp focus!

This is what a dusty complex plasma is like. Every single particle is ‘one in a million’ and can be individually detected in principle, and yet this vast and seemingly tenuous grouping constitutes a powerful structure, unified, coherent and immensely complex, bound together with overwhelming invisible strength

and powerful forces. For us feeble humans, who are not used to thinking of such things, we are like the public at the time of Copernicus (1473–1543), who simply could not imagine an Earth going round a Sun. This is how fantastically different thinking about dusty complex plasmas is from anything with which we are familiar in our lives.

An analogy here on Earth would be if we were to claim that the ocean is a giant brain. Well, it is not. That is because it is here on Earth, is made of atoms, and is physical matter. This is how different plasma really is. With dusty complex plasmas, a tenuous and essentially invisible cloud in space can hold together and become a brain even bigger than an ocean, a brain so gigantic that it is many times larger than our entire planet. We have to get used to thinking like this, and to realize that these clouds in space are so different from anything we know in our lives, or anything we could have imagined, that all of our conventional notions are completely useless.

Another crucial thing to realize about plasma structures is that they maintain their integrity by means of something called the double layer, also sometimes called a bilayer, which has helpful electromagnetic properties.

Two different plasma regions of entirely different kinds can be rigorously separated from one another by these double layers. The double layers are like a double skin, being a sheet of positive charge on one side and a sheet of negative charge on the other side. For those familiar with microbiology, they are similar to the double layers that occur within our own physical bodies as walls of cells, called membranes, with a hydrophilic (water-loving) surface facing one way and a hydrophobic (water-hating) surface back to back with it and facing the other way.

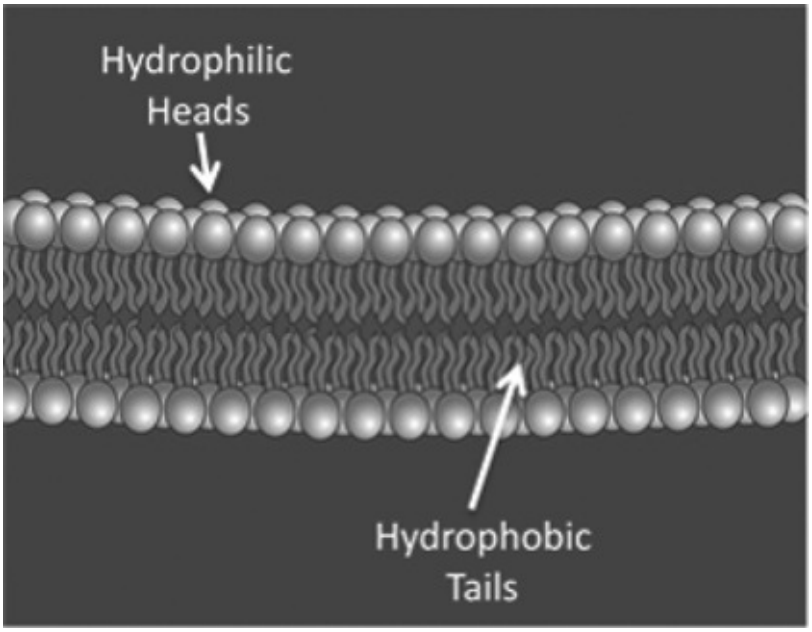


Figure 23. A typical double-layer cell membrane within a human body. Such membranes are analogous to the double layers that exist in plasma, and which surround the plasmoids and all the current-carrying filaments inside plasmas. Unless organic cells are protected by these walls called membranes, they cannot exist. The outward-facing parts of the membranes are hydrophilic, meaning 'water-loving' heads, and hence friendly to the watery environments of the cell and body. The inward-facing parts are hydrophobic, meaning 'water-hating' and they just hate being exposed to water. This excellent image comes from a course in Anatomy & Physiology, Bio 264, Cell Membranes section, at Brigham Young University, USA, and may be viewed at https://content.byui.ed. This is a simplified image of the basic structure of a cell membrane, although in reality there are often various 'plug-ins' sticking through and pathways for biocurrents such as flows of protons and ions across the membrane. In this book it has not been possible to take the space to discuss all those phenomena, for the discovery of which Peter Mitchell was the brilliant pioneer. (By showing how currents flowed through membranes, he totally changed the previous view of metabolism as being a static chemical process, known as 'the Bag of Enzymes' theory. He replaced that theory with the true description of what really happens, which is often called Vectorial Metabolism, meaning that metabolic processes are like vectors and have a direction in space, which is far from the random processes of chemicals sitting idly in a 'bag of enzymes' like loungers on adjoining deck chairs who might occasionally have a chat or a joke.)

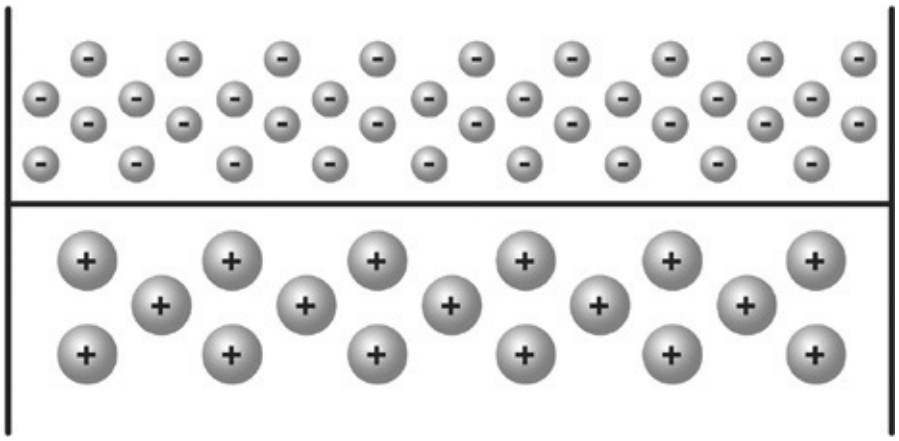


Figure 24. An electric double-layer. At the top of the diagram, the rows of small circles enclosing minus signs represent electrons, which are negatively charged. (The minus signs mean ‘negative’.) At the bottom of the diagram, the rows of larger circles enclosing plus signs represent protons, which are positively charged. (The plus signs mean ‘positive’.) Combined in this way in a double-layer, the electrons and the protons form a protective sheath which enables a blob of plasma to be protected from whatever is going on outside, and therefore to remain intact ‘come Hell or high water’. Such a blob can cohere and retain its integrity no matter what surrounds it, blasts rays at it, or tries to destroy it, up to a limit which is usually very high indeed. Without protective sheaths, such plasmoids and other plasma blobs, filaments, and entities would be rapidly destroyed and could have only a momentary existence. It is clear that the same basic underlying principle is at work in the double-layers of organic cells and the double-layers of plasma blobs (or ‘plasma cells’ as we might well call them). In other words, the principle of the double-layer surrounding wall seems to be a universal structural element found in both organic and inorganic natural phenomena, as a means of enabling entities to maintain their identities within hostile or stressful environments. (Image drawn for the author by Eric Wright.)

So to refine what we said earlier about the roles of sheaths, crystals and voids in plasmas, it is partly because of these double layers that vastly differing regions can exist within a plasma body, practically side by side. For instance, you can have an extremely hot interior of one plasmoid and an extremely cold interior of another plasmoid. As already discussed, they can be practically next to one another, but can coexist because of these double layers, which help isolate them entirely from one another. It is such double layers that surround the Birkeland Currents in space, which were discussed earlier, and which transport electricity

across interstellar and even intergalactic distances. Within those filamentary structures, the current spirals can be superconductive, which means that the current can pass without loss over vast distances, and there is no resistance to cause it to diminish at all.

It is often said anecdotally that the human brain contains more neurons than there are observable stars in the night sky. But the human brain fits inside a small skull. A stable dusty complex plasma ball of immense size, which has possibly endured for aeons and experienced continual growth and expansion over countless millennia, is in principle capable of developing something resembling a much more complex nervous system than a human brain with its average lifetime of around a hundred years. A complex dusty Kordylewski Cloud that has existed for many millions of years might even have become self-aware, with all that this implies. It is conceivable that Fred Hoyle's fictional *The Black Cloud* has a reality in the context of Kordylewski Clouds – which, of course, he could not have recognized in 1957.

I would recommend Hoyle's science fiction novel to everybody, as it is a thrilling and scientifically based tale of cosmic menace and the race against time to save our species.[9] In the book, a dark patch is noticed in space by astronomers looking through a telescope. It wasn't there before. How did it appear? What is it?

Over a period of time, the dark patch gets bigger and bigger. The conclusion is inescapable: it is headed our way! It gets more and more threatening as it gets closer. Eventually the astronomers notice that it is a gigantic cloud that emits no light, hence is a 'black cloud'. No one knows what it could possibly be. It must be stressed that this extraordinary anticipation of the existence of the gigantic dark and invisible clouds in space resembling the Kordylewski Clouds was published at a time when space was regarded as a vacuum, four years before Kordylewski reported his extraordinary discovery.

As the cloud gets closer and closer, the fate of the Earth and all its inhabitants is threatened, since the Sun's light will be blotted out. It is discovered that the black cloud is a huge intelligent entity with a gigantic brain (we might even think of it as a non-glowing plasmoid). Intelligent contact is established with the cloud, and Hoyle satirizes the political as well as scientific hysteria on Earth.

The public are kept uninformed for as long as possible, of course, since that is always official policy. And just when the Earth is about to be destroyed and

everyone is prepared to die, something unexpected happens. The black cloud with its super-sensitivity to distant signals in space picks up a signal from very far away indeed in another part of the galaxy. It is another black cloud! So the black cloud, which is about to engulf the Earth (not intentionally, but because it is big and clunky), suddenly changes course and rushes off to find a new friend, and the Earth is saved.

Fred's novel brings up the obvious subject of communication with the Kordylewski Clouds. If the clouds are as intelligent as I am suggesting, then they already know all about us while we know almost nothing about them.

In conclusion, from Chandra's and my paper we can see that the particles in dusty plasmas such as the Kordylewksi Clouds can be close enough to exchange electric signals.

In Chapter 14 we will look at other great scientists who have developed ideas that can help us understand more clearly how intelligence in complex dusty plasmas might work, including Paul Dirac and David Bohm (1917–1992).

And we will look too at the role that quantum properties in plasma might have had, not only in the development of superintelligence in the Kordylewski Clouds and the development of quantum computers, but in human beings too.

13

The Mysterious Case of the Dirty Gas

Our bodies are so covered with bacteria that there are ten million bacteria to be found on every square centimetre of our skin. Fortunately, most of them are friendly. And we thought maybe they stopped there, our skin being presumed to be the boundary of our bodies. But then we found out that things are not as simple as that.

In late September 2015, a flurry of news reports appeared in the media about an article that had been published in a scientific journal by Dr James F. Meadow, an American microbiologist then doing post-doc work at the University of Oregon, where his PhD was in Ecology and Environmental Sciences.[1] He has now become the Lead Data Scientist at the law firm Dillon-Harrison's biotechnology service, Phylagen, in San Francisco's Bay Area.

In his article, Meadow reported the results of experiments he carried out with a group of people concerning the bacteria that he knew covered all human bodies. What he discovered was that the bacteria formed unique 'clouds' surrounding the bodies. His scientific report on his findings was published in the online journal *PeerJ*, on 22 September 2015, by him and six colleagues.[2]

The amazing findings revealed that people can be uniquely identified from their 'bacterial clouds', which are equivalent to fingerprints or iris scans. Everybody is surrounded by a cloud consisting of millions of bacteria. The exact sizes of these clouds have not yet been measured, but the clouds appear to extend for several feet beyond the body in all directions. When we walk around, therefore, we are really clouds of bacteria with a hard core called a physical body. As for the body itself, the cells within it and supposedly 'constituting' it are outnumbered by the microbiological entities (bacteria, fungi, and viruses) living on it and in it by ten to one.

What this means is that only 10 per cent of the cellular components of ourselves are really what we think of as us, and 90 per cent is a cloud of microscopic parasites that follows us around. However, most of that 90 per cent used to be us, and was ejected. So if you follow the logic through, what this means is that 10 per cent of us is currently us, 90 per cent was us in the past, and thus we are in a sense made up of 90 per cent past and only 10 per cent present. Never in the course of human history has proof been so forthcoming that people really do come with baggage!

According to Meadow and his team, humans emit ten million particles per hour, which means that we emit 240 million particles per day, into the air around us. Upon learning this, it did not take me long to figure out that the sedentary lives most of us live today, compared to the lives of our ancestors who spent so much time outdoors having their bacterial clouds being buffeted and continually blown away by the winds and breezes, obviously means that the concentrations of our personal bacterial residues are much greater than those of our ancestors. If our houses are well-insulated and have no breezes or airflows, as older houses with open chimneys always had, then we are living daily in incredibly dense concentrations of bacteria, fungi, spores and viruses.

In Meadow's studies of microbial clouds, he specified that the particles in those clouds included also 'resuspended dust' and 'emission from clothing', so in order to eliminate clothing dust from his experiments as a variable, he had all his subjects wear the same clothes. The billions of microbes we emit may be harmless to ourselves, but not necessarily harmless to people visiting us. For they have their own clouds, which are not necessarily compatible with our clouds, and they may be vulnerable to the highly intensified microbial concentrations in our excessively insulated home environments.

The interactions of different people's bacterial clouds have not even begun to be studied, and neither is there yet a science of bacterial habitats for bacterial clouds, although microbiology is constantly producing studies of bacterial colonies on and within humans and on our cell phones, our computer keyboards, our doorknobs, and our TV remote controls.

Getting nervous? You ought to be. The COVID-19 pandemic should have brought home to people by now the importance of what, during the epidemic, came to be called 'social distancing'. In fact, being six feet (two metres) apart from each other in order to avoid contamination of one another is a confirmation

that forbidding our surrounding microbial clouds to touch can prevent us getting infectious viruses. The irony is that none of the medical authorities who recommended this social distancing appeared to be aware of the existence of our microbial clouds. They ‘instinctively’ knew that we must be six feet apart, and justified this by speaking of airborne droplets, or just because it ‘seemed sensible’.

It is time they learned the full facts, which provide a sounder justification for their instinctive policies. The good news is that they pursued a sound policy in this regard anyway. Masks, however, make little difference to our microbial clouds and are pretty useless except in intensive care wards, because the viruses are a thousand times smaller than the smallest holes in the masks worn by the public during the pandemic. (Intensive care masks work, the ones made available to the public don’t.)

Rather than speaking of ‘bacterial clouds’ we should more properly speak of ‘microbial clouds’, which include all species of entities emitted by our bodies at every moment of the day and night, and include fungi and viruses. And there is a close connection between these microbial clouds and dust, for a great deal of household dust comes from tiny bits of shed human skin, all of which carry bacteria on them, and those bacteria are carried off the body and then leave the skin flakes and float up into our microbial clouds and join in the merriment of ‘being microbes together’.

Microbial clouds and dusty plasma are analogous in many ways as both are made of invisible and microscopic particles. And later in this chapter and the next I will be examining the work done on what are called our ‘bioplasma bodies’, which are invisible and which surround us, just as the microbial clouds do. The concept of bioplasma bodies suggests that we are jointly constructed of physical bodies and bioplasma bodies, which operate in synch.

The further suggestion is that when we ‘die’, because our physical body has worn out or been damaged beyond repair, our bioplasma body may detach from our physical body and abandon it to ‘death’. We might be said to continue to exist as bioplasmic beings made of non-atomic matter – of plasma. On this way of looking at it, the ‘soul’ is thus material, but in a different and more rarefied sense than was the physical body. This leads to the concept of bioplasma beings existing without ‘physical bodies’, and I suggest that this is what is often referred to as ‘the Other World’.

Traditionally it has been called ‘the spiritual world’, upon the assumption that it must be wholly immaterial. It was assumed that body and spirit were entirely separate, one being ‘material’ and one being entirely non-material. I touched on this earlier, and it is what I regard as the prime fallacy of our Western civilization (as previously explained, it is not a fallacy that was ever traditionally adopted by the Chinese.)

But we must return to our discussion of the microbial clouds. What I want to raise as a question now is this: are the microbes in the clouds themselves charged? As we will see as we proceed, there are many researchers who insist that we have invisible counterpart bodies made of plasma (bioplasma) that surround us and extend several feet from us, so how does this relate to the fact that it has suddenly been discovered that there are invisible microbial clouds surrounding us?

Could and should we call our microbial clouds our extended bodies? And could our bioplasma bodies be continually interacting with our microbial extended bodies (clouds)? Or could they even be the same, with the microbes taking the place of the charged dust grains that one finds throughout space, for example, in dusty plasmas? And since all of those hundreds of millions of microbes that surround each and every one of us are alive, can they possibly all be coordinated by a plasma body that charges and energizes and forms them?

Even if the microbes themselves are not charged, there is sufficient dust accompanying the microbes within the clouds to make it reasonable to say that we are all perhaps surrounded by charged microbial clouds, if only on the basis of the accompanying charged dust that is within them. As for the effect of charge upon bacteria and viruses, I know of no experimental investigation of this that has ever been undertaken.

In a paper that is in preparation at the time of writing, I call for such experiments to be done. Things to be investigated include this question: if a virus is positively charged, does it act in one way, and if negatively charged, in another? We do not even have the answers to questions as fundamental as that. We have been through an entire pandemic without knowing whether we could have intervened against the COVID-19 virus by the use of electric charge or magnetic fields. That is a shocking dereliction by the worldwide medical profession.

My own opinion is that COVID-19 viruses travelled on the winds in charged ‘viral clouds’ protected by sheaths, which explains why outbreaks were able to take place on cargo ships at sea, which had had no contact with anyone for six weeks. What makes such a viral cloud suddenly ‘dump’ may be connected with encountering powerful thunderstorms. The Earth itself is negatively charged, as all lightning experts will tell you. Ordinary rain varies in its charge. High rain is positively charged while low rain is negatively charged. Most people do not know any of this. Virologists should really be given crash courses in geophysics.

I would suggest that most or possibly all ‘bacterial or virus colonies’ are unified entities in some way, but that when it comes to microbial clouds, that must be true to a higher degree. If we all have invisible microbial clouds and also have invisible ‘bioplasma bodies’, and both surround our dense physical bodies and both are approximately the same size, then how could they not interact with one another? Is it possible that the microbes that stream off us at the rate of ten million per hour become charged by the ‘bioplasma body’, become subsumed within it, take on its shape, and lend substance to it? I do not see why not. Indeed, it may well be the microbes and dust continually sucked into our bioplasma bodies that enable our bioplasma bodies to function in relation to our physical bodies.

When scientists can figure out how to do so, the sizes, shapes, and configurations of our microbial clouds will surely merit close study. In addition, we will need to examine the electrical charges, whether positive or negative or both, of the microbes and the accompanying dust within our personal clouds, and, most important of all, try to determine whether the clouds have cellular internal structures. For if they do, that means that there are insulated pockets within the clouds that can contain microbes and dusts of highly varying characteristics.

For instance, there could be cloud-cells full of positively charged microbes, cloud-cells full of negatively charged microbes, cloud-cells in which toxins and pathogens are isolated, and charged double-layer boundary layers resembling membranes separating the cloud-cells from one another. In the event of ill health, such boundary layers might break down, and pathogens that would normally have been safely contained get released. If we could determine such things happening, we would have early warnings of disease.

We should also urgently undertake investigations of the effects of aerosol sprays on our microbial clouds. They would in my opinion be certain to alter the ultra-weak charged currents in our clouds. But before we can even examine that, we need to know what kind of charge aerosol particles carry. Are they positive or negative? ‘Charge’ can be defined as ‘a quantity of electricity or proticity’. ‘Charged particles’ are called particles because they are small. But they are called ‘charged’ because they have either a positive charge, like a proton or ion, or a negative charge, like an electron.

Positively charged dust particles and grains tend to be larger and slower moving than electrons. A positively charged dust grain can easily have 10,000 or more electrons adhering to its surface, like sperm chasing a single egg and irresistibly attracted to it. And yet no one appears ever to have thought about the charges that exist on aerosol particles, particle sprays of perfume or cologne, dust particles from talcum powder, tissue dust when we wipe our noses, and antiseptic sprays that fill most restaurant serving areas as the staff wipe the tables using a technique of ‘reconnaissance by fire’, i.e., first spray your way in, and then close with the enemy and wipe. (If the adjoining customers choke, ignore them.)

Ignoring all these sorts of things is a danger to public health.

I recommend the creation of a new scientific discipline, which could be called electro-microbiology. Scientists working in that field should attempt to study the charging of microbes and accompanying dusts. For instance, if you take a microbe and give it a positive charge, what is the difference between that and taking the same microbe and giving it a negative charge? How do groups, or colonies, of microbes behave when they are: (a) positively charged, (b) negatively charged, and (c) both? How do microbes of the same charge relate to each other? Of the opposite charge? And how do these interactions differ from uncharged interactions?

Putting aside the bacterial clouds, what about the human body itself? It is a little-known fact that one-fiftieth of our body weight is made up of bacteria that are inside or on the surface (skin) of the body, and these are all in addition to the ones in the clouds that are outside the body.

The number of bacteria living inside us is so great that our bodies contain 10,000 times more bacterial cells than actual human cells. And as for the surfaces of our bodies, as we have already learned, there are so many bacteria on

our skin that approximately ten million bacteria live on every square centimetre of our skin. They mostly live in the outer layer of the skin, the stratum corneum, which is made up of dead skin cells. So the surfaces of our bodies largely consist of dead human cells filled with enormous colonies of live bacterial cells. The total bacterial biomass on the Earth is a thousand times greater than the total world human biomass. Earth is thus the planet of the bacteria, not the planet of animals and humans.

Furthermore, the bacteria multiply their numbers so fast that if we completely cleansed a patch of our skin of bacteria it would take less than twelve hours for them to grow back again to the same numbers.[3] And now we also know that in addition to that we are surrounded by clouds of further bacteria and microbes, as I have just described. So what does that make us? Our bodies are largely bacterial support, incubation and transport vessels. Fortunately, the majority of ‘our’ bacteria are beneficial to us, for otherwise we would have died out as a species long ago.

It is possible that most microbiologists of today do not know enough about plasma to realize that it acts as an excellent conductor of charged currents when there are imbalances of charge in the plasma, or when the plasma has a cellular structure, such as we find in the Earth’s atmosphere or in dusty plasmas such as the Kordylewski Clouds. (As we have seen, cellular structure implies the existence of boundary layers, known as ‘double-layers’, surrounding the cells, and these layers themselves carry currents, often very powerful ones.)

If the microbial clouds around us are charged by plasma or become part of a plasma cloud, or even generate a plasma cloud through their own charges, then they can potentially carry electric currents, whether electricity (negatively charged currents) or proticity (positively charged currents). And of course, once you have electric currents, you get magnetic fields. We may thus be surrounded by highly complex ultra-weak currents and fields, the existence of which no one has ever suspected until now, at least not ones involving microbes and dust.

What is more, we cannot rule out the possibility that the toxic characters of some microbes will be cancelled out, or enhanced, by charge. And if there are electric currents and magnetic fields surrounding us within our charged microbial clouds, these too can have beneficial or harmful effects on us. I am inclined to suspect, however, that the average effects must be helpful, because otherwise how would we have survived throughout the ages?

The electric currents and magnetic fields that would thus occur within our microbial clouds would be what is known as ‘ultra-weak’. This means they would be extremely hard to detect. ‘Ultra-weak’ sounds as if such currents and fields would be of negligible effect. However, there is a massive amount of scientific evidence concerning the crucial importance of ‘ultra-weak’ fields and currents in relation to the human body. Much of the work done in that field is furiously opposed by various corporate interests, especially those of the big power companies, because the studies largely are related to what is known as ‘electro-pollution’, a subject which ‘Big Money’ wants to hush up, because it threatens their financial interests.

It is not only that living beneath power lines is dangerous, which is something everyone can readily understand, but also the intense radiation produced by 5G poses great risks to people. However, that is not for discussion at the moment. I mention it here only to point out how overwhelming the evidence is that the human body is ‘ultra-sensitive’ to the ‘ultra-weak’, especially to what we will describe later as ‘bio-photons’, and indeed to any and all forms of electromagnetism.

We must not forget that the body itself is electro-magnetic.

The relevance of electricity and magnetism to the human body was revealed very dramatically in 1963, when Gerhard M. Baule and Richard McFee made the first scientific detection of a naturally occurring ‘biomagnetic field’ in the human body, and they proved the existence of a magnetic field associated with the action of the human heart.[4] The electrical and magnetic aspects of the human heart are now universally accepted, but it was very painful and difficult for scientific and medical experts to accept this discovery at the time, because it went against the ‘body as a machine’ theory, by which everything was supposed to be chemical and mechanical. (Modern machines use electricity, but ‘the body as a machine’ theory did not allow for that, and was essentially based on models of clocks and nineteenth-century factory machines.)

Pre-existing fixations, theories rigidly adhered to, ossified notions, and fixed opinions are the great enemies of progress in science; but scientists are human beings, with all the limitations that that implies.

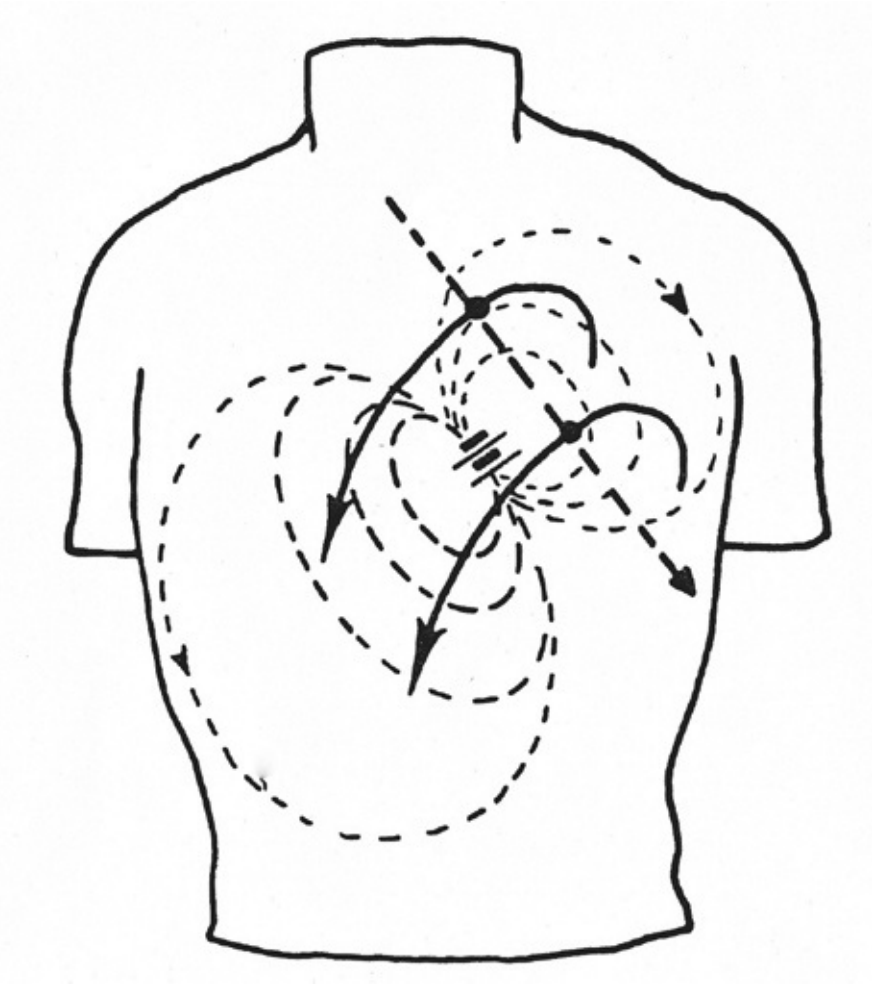


Figure 25. A diagram showing the electrical and magnetic activity of the human heart. The solid lines depict ‘lines of force’ with directional arrows, demonstrating that the heart’s magnetic field travels from left to right across the human chest. The dotted lines show the electrical current produced. The artist has drawn a schematic small electric battery at the location of the heart to suggest the electromagnetic nature of the heart. From Gerhard M. Baule and Richard McFee, 1963 (see Footnote 4 to this chapter)).

Over the decade that followed Baule and McFee’s findings, further understanding was gained, and in 1970, David B. Geselowitz (1930–2020) published a preliminary paper,[5] and then in 1973 wrote a very lengthy technical account of the subject of the magnetic heart and biomagnetism,[6] in which he said:

The past decade has seen a dramatic improvement in the ability to measure biomagnetic fields. They are extremely small, about one million times weaker than the Earth's magnetic field in the case of fields of cardiac origin and even smaller in the case of fields originating in the brain. Hence, the detection of these fields has been a major experimental challenge. Nevertheless, it has been possible to develop instrumentation so that such fields can be measured almost routinely.

Figure 26. The magnetic field around the human head. The magnetic field goes from the left hemisphere of the brain around the head and back in through the right hemisphere. The 'lines of force' have been drawn to depict this, with the arrows showing the direction of the field. From Gerhard M. Baule and Richard McFee, 1963 (see Footnote 4 to this chapter).

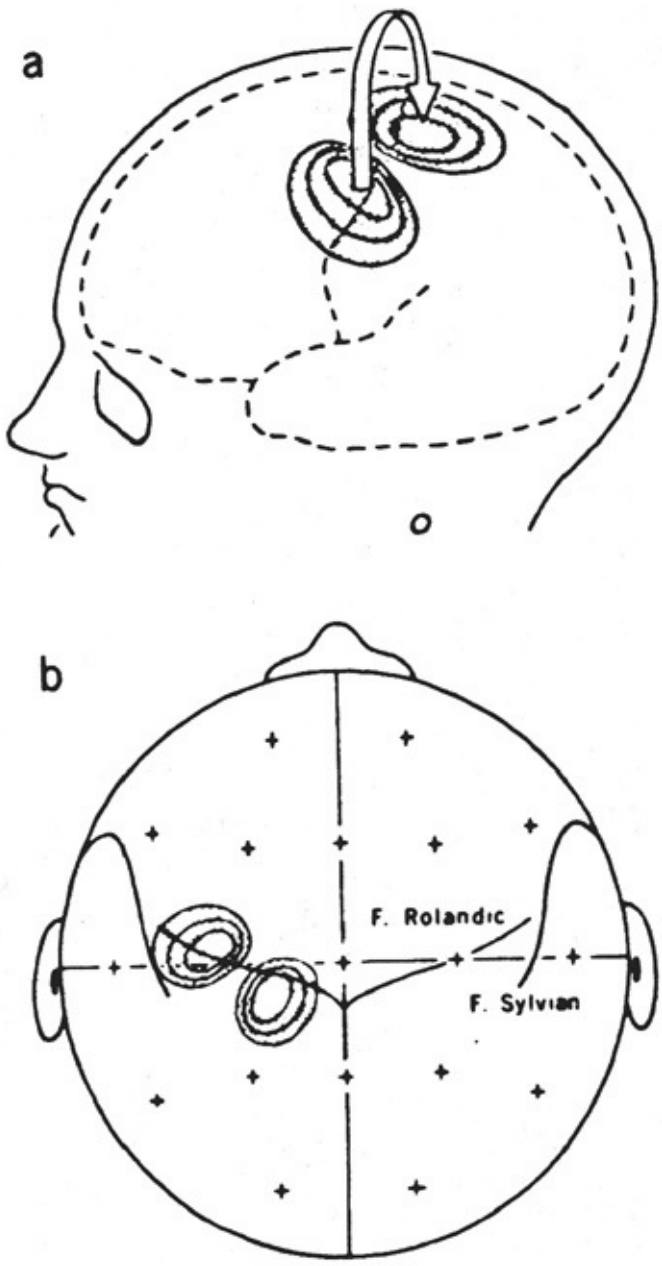


Figure 27. A separate magnetic field in the brain to that shown in Figure 26, and discovered subsequently. This field is sharply localized in a tiny region of the brain's left hemisphere – 'a': side view (with the arrow showing the field direction goes from left to right, as was the case with the field shown in Figure 26, and 'b': top view. This field is an 'evoked' field, created by shooting electric current into a person's finger! From Gerhard M. Baule and Richard McFee, 1963 (see Footnote 4 to this chapter).

These biomagnetic fields are crucial to our ‘bioplasma bodies’, as they continuously interact with our physical bodies through the actions of electricity and magnetism. We will return to the revolutionary idea of bioplasma bodies in the chapters that follow.

Electro-magnetic clouds around us

After I had written the above, Marco Bischof, an eminent Swiss writer working in Germany on the frontiers of science, sent me copies of all of the articles he had by Freeman W. Cope concerning the existence of superconductivity (which as we have seen, occurs when electricity flows without any resistance) within organisms, including our own bodies. It was originally thought that superconductivity could only happen at a temperature not far above absolute zero. Then it was discovered to be possible at higher and higher temperatures, and then it became common to suggest that it could happen at room temperature.

I had come across Cope’s early articles in the mid-1970s and wanted to write about them at that time, but my literary agent and all potential publishers were scornful, insisting it was nonsense and that no one would be interested. Even to publish an article about it in a newspaper (and I was doing plenty of science stories for the media in the late 1970s) was impossible. There was a complete wall of steel erected in people’s minds against the subject.

I will be returning to this later. I only mention it now in order to explain that I asked my friend Marco if he had any articles by Cope, the best-known researcher into the subject, which I did not already have. He sent me some, and along with those he sent five more by Cope on an astounding branch of study of which I had no previous knowledge. Furthermore, they came to my attention shortly after I had finished writing about electrified dust and microbes forming a cloud around the human body. Talk about perfect timing! It is those articles by Cope which I will discuss now.

Freeman Widener Cope was unquestionably one of the great pioneers of biochemical research. In 1982 he died rather young, aged only fifty-one or fifty-two, so that his work was tragically cut short. As far as I can determine, he spent his entire professional career working for the US Office of Naval Research, which as we have seen does all the secret work ‘for the Navy’ (really shared with the entire American security establishment) and is scientifically by far the most

important of the four main American defence security agencies. Cope was Head of the Biochemistry Laboratory of the Naval Air Development Center in Johnsville, near Warminster, Pennsylvania. All of Cope's work was funded by designated grants from the Office of Naval Research, officially acknowledged at the end of each of his articles.

Prior to his work on superconductivity, Cope had been engaged in wholly different routine work in the Biochemistry Division of the Aerospace Medical Research Department of the Bureau of Medicine and Surgery of the US Naval Air Development Center of the US Department of the Navy. He wrote a number of reports, and his Report No. 5, dated 2 July 1970, was declassified at some time subsequent to 1979, so that we can see what he was doing. The title of the report was 'Activation Energies of Acceleration and Hypoxia Stress'.[7]

Hypoxia is a deficiency of oxygen. He was studying the stresses imposed on pilots by rapid acceleration and oxygen deficiency. He concludes that 'moderate brain damage' may result and points out that 'tolerance to acceleration stress is not limited simply by the ability of the nervous tissue to endure hypoxia, but must be dependent upon additional mechanisms.' This shows that he was doing highly important 'normal' work concerning the health of naval pilots.

But then everything changed. Cope was taken away from his normal research and instead he remained until his death the Naval agency's special researcher into everything weird.

The Office of Naval Research does not exist simply to figure out how to stop ships from sinking and facilitate communications between submarines. It has a huge remit, which covers almost any scientific subject you can imagine, many of those subjects being very 'far out' indeed, beyond the known fringes of science. The Naval agency even joins with or competes with the Air Force agency to research the atmosphere! They are, of course, unaccountable to Congress for their budget, being 'secret'. All their scientists work under the most stringent security rules, have to sign many secrecy agreements, and can only publish what the agency permits them to publish.

And yet, out of this secretive milieu, not only did an amazing discovery come, but the people vetting publications actually permitted it to appear in print. I suspect they realized their mistake too late, because it was not necessarily obvious at the time how much they were 'letting slip', and what the implications would be. I suspect they also must eventually have become nervous of Freeman

Cope, who appears to have been an idealistic scientist, and the last thing a security agency wants is an idealist of any kind.

It is not easy to summarize briefly what Freeman Cope was proposing in his five revolutionary articles, because they cover complex matters to do with theories of electricity and magnetism, quantum theory, and some unfamiliar concepts of physics not normally discussed. But before I get to that, I must analyse how embarrassing the revelations of Cope really are regarding the Naval agency's files. This cannot have occurred to the censors at the time, for nothing explicit is said that could have breached Cope's secrecy agreements. It is only when all five articles have been read carefully, if one knows something of the background, that it becomes clear what was really going on, and why Cope became involved in this research in the first place.

For what had clearly happened was that the Naval agency had asked Cope to examine the seized secret papers of Wilhelm Reich and give his opinion as to whether there was anything to Reich's weird ideas. In other words, he was tasked with an evaluation of one of the stranger collections of scientific files in the agency's possession.

What seized files? Wilhelm Reich (1897–1957) was an Austrian psychoanalyst and one of the most brilliant students and protégés of Sigmund Freud (1856–1939). In 1922, he became the director of Freud's outpatient clinic. He began to develop ideas that went beyond Freud's, to do with the energy released in human orgasms. He began to speak openly of sexual matters and to promote more open sexuality in society. This caused a great deal of alarm in Vienna. He was also passionately anti-fascist, and he fled Austria for America in 1939. He lived there for the rest of his life.

But in America Reich caused even more alarm because he was speaking openly of orgasms, and as everyone knows Americans in the 1930s, 1940s and 1950s didn't have any. Reich's main interest in them was their release of a special kind of energy. He called this 'orgone' energy, and he regarded its release in orgasms as being only one of its many manifestations.

It was, in his opinion, a genuine universal life energy. Reich carried out many elaborate researches, attempting to find out what this strange undefined energy really was. He came to believe that most of it appeared to come streaming in from the Sun, so he viewed it as part of what came to be known as the solar

wind, but he believed it was not light, or electrons or protons or ions. It was something else, he did not know what.

Reich's theory of 'orgone energy' was that it was the essential life energy of all living beings, and that the sexual orgasm was a specific form of a general biological phenomenon (occurring in all creatures in different forms and for varying purposes, but found in specialized form in humans sexually) to do with 'an involuntary contraction and expansion of the total plasma system' resulting in an 'energy discharge', in which a bit of the orgone energy was released. He believed that orgone energy could occur in the form of tiny particles, which he called bions. Reich had concluded:

> that every living organism is a membranous structure that contains an amount of orgone in its body fluids; it is an 'orgonotic' system. Thus, the term orgone comes from 'organism' and 'orgasm', and means an energy found within all organisms and basic to the orgasm reflex.[8]

Because he was a protégé of Sigmund Freud, Reich emphasized the sexual part of this theory, causing a certain amount of hysteria amongst many people who did not like open discussion of sex at all. Reich had published his book *Die Funktion des Orgasmus* (*The Function of the Orgasm*) in Vienna as early as 1927, carrying forward Freud's theories of the sexual energy called libido. Reich was not a physicist, and parts of his research were rather amateurish. Despite this, he made some significant and important discoveries.

He also designed 'orgone accumulators' to capture and store the orgone energy. At the time, there was no explanation for how they worked, and most people naturally assumed they were a fantasy and that Reich must be a madman or a charlatan, or both.

But there were some people who knew that Reich had stumbled onto something. It is necessary to give some of the political background to this, as one of the side effects of what happened was to suppress for many decades any public discussions of plasma, especially of cosmic plasma and any plasma or electronic functionalities within living systems. In Chapter 14 we will see related actions by the same people to suppress the work of the Nobel laureate Albert Szent-Györgyi, who like Reich had sought refuge in America. All these actions were part of the same systematic pattern of persecution intended to prevent

public awareness of certain sensitive issues that many immigrant scientists imported into America after the Second World War for defence and security work.

It was in 1947, the year of the formation of the CIA, that a campaign to attack and discredit Reich commenced. That was at the same time that Nazi scientists were being brought to America at the instigation of Allen Dulles, who in the 1930s had been employed by the Gestapo's front organization in America, the American subsidiary of I.G. Farben (famous as the manufacturer of the poison gas that killed the Jews in the death camps). He had also refused to act to save the lives of Jews being killed by the Nazis, of which he was informed at least as early as 1942.

In 1944, Dulles simulated horror at pretending to hear about the holocaust for the first time, whereas he had known all about it for at least two years, and had not only refused to do anything to stop it, but prevented others from acting. The shocking details of Dulles's lies and duplicity in relation to this issue of the genocide of the Jews are documented by David Talbot of the *New York Times* in his book *The Devil's Chessboard: Allen Dulles, the CIA, and the Rise of America's Secret Government*, published in 2015.[9]

Dulles was a close friend of Hitler's banker, Hjalmar Schacht, President of the Reichsbank, who had created a thriving economy in Germany, which enabled Hitler to go to war. Dulles was also a close friend of the American traitor Tom McKittrick, a former New York banker, who in his role as head of the Bank of International Settlements (BIS) at Basel in Switzerland (very near to Bern, where Dulles was based after November 1942) treasonously laundered stolen gold for the Nazis and obtained foreign currencies for them to enable them to buy essential war materials, such as the tungsten from Portugal and the oil from the Ploesti oil fields of Romania. McKittrick even went so far as to receive many tons of gold from the Nazis that he knew to have come from the teeth of Jews murdered in the death camps.[10]

Later, Dulles was to defy direct orders from President Truman about bringing SS men to America in defiance of American law. One can probably attribute to Dulles the origin of the CIA's traditional arrogance, its certainty that it knows best, and its contempt for mere presidents. In other words, we may probably regard Allen Dulles as the founder of what has come to be called by the name of the Secret State. Certainly the partiality of Dulles for the Nazis is well

established, and authoritarianism seems to have been institutionalized within the CIA, an organization in which love for democracy seems to be in short supply.

As Talbot says of Dulles, viewed from the perspective of 1942: ‘He was running his own foreign policy,’ and from the perspective of today: ‘Dead for nearly half a century, Dulles’s shadow still darkens the land.’[11]

After the war, Project Paperclip, and other similar projects with different names, got properly organized, and the American security establishment was being powerfully manipulated by the imported Germans, some of whom went straight into important positions. Many of them went to work for the US Army, Navy and Air Force security agencies. (The Air Force was formed for the first time in 1947, having previously been a branch of the Army.)

It was easy to attack Wilhelm Reich, who was a highly eccentric loner. Reich was arrested, his orgone accumulators were hacked to pieces with axes by FBI men in front of his eyes, their remains burned, and there were two book burnings of many tons of his published works. This was ironical, because Reich’s books had been publicly burned on the orders of Himmler’s SS in Austria years before, and now here were the American imported SS men doing it to him again, with the aid of their FBI colleagues. Yes, this really happened in the United States, ‘the land of the free and the home of the brave’.

The SS men also violently hated Wilhelm Reich for his anti-Nazi 1933 publication *The Mass Psychology of Fascism*, in which Reich was merciless in attacking Hitler and the Nazis. And he hits home with pungent personal observations about Hitler, such as this one: ‘He assures us that only once in his life did he cry: when his mother died.’[12] Such critical observations about the Führer would have enraged the Nazis, for Hitler was meant to be the ultimate superman, capable of feeling and sharing all the emotions of his people (*volk*).

To make things worse for himself, in 1946 Reich’s Orgone Institute Press published an English translation of that provocative book, which until then had been available only in German, though most copies had been destroyed by Himmler. It was effectively a public slap in the face to Allen Dulles and his friends, and to their entire policy of bringing large numbers of SS officers to America and putting them into positions of power and influence at the heart of the American security establishment.

In fact, in June of 1946, Dulles went further and helped to arrange for the Eastern Europe and Russia wing of the Nazi security apparatus to be transferred lock, stock and barrel under its leader Lieutenant General Reinhard Gehlen (1902–1979) into a spy organization called ‘the Gehlen Org’ funded by the United States and ostensibly under American control, which was absorbed into the CIA following the CIA’s formation in 1947.

With all this going on, Wilhelm Reich was considered a very dangerous enemy, lest the American public come to know that the Nazis now secretly composed the entire Eastern wing of America’s foreign spy service, not to mention all those many Nazis who were being brought to America to work on American soil in the most secret projects such as mind control, and of course in the development of rockets and missiles.

But burning Reich’s books was not all. Reich was committed to prison and mysteriously died there not long before he was due to apply for parole and be released. There are suspicions that he was murdered to shut him up. But the most important thing of all which happened was that his most important secret research papers were seized by the FBI and ‘disappeared’. And that brings us back to Freeman Cope’s five articles.

After studying the articles carefully, reading between the lines of what Cope says, and knowing something of how the weird scientific branches of the security agencies operate, it became obvious to me (and it must have been obvious at the time to others) that the FBI had given all of Reich’s seized papers to the Office of Naval Research in the 1950s for evaluation and safe-keeping. And that is what brought Freeman Cope to his own discoveries, partly based, as he freely admits, upon Reich’s researches. After all, how else would he have known so much about the scientific aspects of Reich’s researches, not all of which had ever been made public by Reich?

The Naval agency must have selected Cope, who worked for them, to do some work on Reich’s papers because he himself had recently discovered strange forms of energy within the body, by suggesting that superconductivity took place along the double-helix of the DNA molecule and used organic ‘Josephson junctions’ (named after their discoverer Brian Josephson, who received the Nobel Prize for Physics for their discovery). These junctions use the weird quantum tunnelling effect, mentioned earlier, in order to control and modify the

flow of currents, sometimes in surprising ways; we will return to this subject to discuss them in Chapter 14.

Cope's superiors must have thought him well equipped for having another look at Reich's strange files and papers. I might add that all my attempts to contact former colleagues of Cope to learn more about him have met with total silence, which tells me that these colleagues are bound by secrecy agreements and are terrified to say anything at all.[13]

That is the background. Now for the discoveries.

Cope came to the conclusion that each of us is surrounded by yet another invisible cloud. He describes it as 'a gas of electromagnetic (EH) dipoles.' (A dipole is so called because it has two electromagnetic poles, a north pole and a south pole. A dipole may be a molecule or some other object that has both poles.) He believes this cloud can be detected on rare occasions by sensitive persons, who tend to call it an 'aura'. Cope stresses that he wished to investigate this by sweeping away mystical theories and tackling the matter purely scientifically.

Cope had no knowledge of the microbial clouds that I have described above, and which would not be discovered until thirty-four years after his death. Nor was he knowledgeable about microscopic dust, whether charged or uncharged, and nor was he apparently knowledgeable about plasma either, except in the sense that he may have known about Reich's researches into something that seemed a lot like plasma. That means, of course, that he was also not familiar with the prevalence of dust in plasma, and all the phenomena associated with that. What he discovered was therefore something entirely extra, though the two phenomena may well be intimately related.

He says: '… it is proposed that in the universe around us exist a large number of particles each of which is both an electric and a magnetic dipole.'[14]

Apart from Wilhelm Reich's unexplained findings, Cope's initial stimulus appears to have come from the work over several decades by Alexandre Rothen of the Rockefeller University. Rothen had also been researching a strange phenomenon since 1942; he had been working with proteins, and he had discovered that molecules could in certain circumstances interact with molecules on the other side of a layer of fat, which should have been completely impenetrable to them. Proteins tend to be spherical, and he started spreading

them on the surface of water and discovered that they more or less collapsed and went flat. Normally, by being flattened, they could not have been expected to be capable of interacting with antibodies from the bloodstream.

He laid a layer of beef fat (stearite) across them and proved that it was impermeable to any kind of direct diffusion of molecules across it. But he then noticed that the flattened proteins were interacting with antibodies laid on top of the fat anyway, with which they could have no conceivable form of direct contact. It must be stressed that according to conventional thinking, any form of interaction between these molecules other than direct contact was deemed to be impossible. This was when Rothen discovered mysterious 'action at a distance', previously only observed in the realm of quantum mechanics, operating inside organisms in the everyday realm and having a material effect.

Otherwise known as quantum entanglement, this action at a distance, which Einstein (1879–1955) famously called 'spooky', is the puzzling way that pairs of particles can seem to interact even if they are separated in space – indeed even if they are light years apart.

As result of this astonishing finding, Rothen began an immensely long series of careful experiments, and he was still working to try to solve this mystery in the 1970s. Cope not only drew upon articles published by Rothen between 1971 and 1976, he was also in touch directly with Rothen and received a copy from him of an article that had not yet been published, entitled 'Influence of metallic shields on presumably cosmic radiation …' Rothen had discovered that there was something else peculiar going on, and it concerned insufficiently understood electric and magnetic phenomena, and some strange form of cosmic radiation, which was also capable of having material effects over large distances.

One needs to recall that Wilhelm Reich had also been concerned with some strange form of cosmic radiation. Cope wondered whether what Reich had looked at and what Rothen was looking at might be the same thing. In going back through even older studies, Cope became intrigued by the meticulously documented and lengthy experiments carried out in the mid-nineteenth century by Baron Karl von Reichenbach, whose extremely large book *Researches on Magnetism, Electricity, Heat, Light* … had been translated into English and published as long ago as 1850.[15] Reichenbach's work was at one time fairly well known, but it had been regarded as antique and of little relevance for nearly a

century when Cope rediscovered it. He believed it contained much valuable information.

Reichenbach reported that many individuals whom he tested insisted that they could see faint auras around the poles of magnets as well as around people's heads. But Reichenbach was led to formulate a concept of what he called 'odic force', to refer to some unknown energy that was involved. Reichenbach's 'odic force' seemed to Cope to be similar to Reich's 'orgone energy'. Reichenbach did not however discuss the forbidden subject of sex, as sex did not yet exist in 1850, it seems.[16]

Cope also discovered that Rothen was moving on from his discovery of weird quantum effects in proteins to building electronic devices that would duplicate them. He comments on Rothen's experiments, and the type of particles forming the body-clouds suggested by his findings:

> Rothen's magnetic electrode experiments seem to require that it [the type of particle suggested by Rothen] be a magnetic particle, which suggests the possibility that it is a magnetic (H) monopole [a particle having a single pole, not two, as with dipoles]. However, H-monopoles have never (with one controversial exception) been observed experimentally despite careful searches …[17]

Discouraged at the unlikelihood of single-poled 'magnetic monopoles' really existing, Cope fell back on the dipoles that I mentioned a moment ago (any magnetic object will normally have a 'north' and a 'south' pole, which is to say 'di' or two poles) and suggested them instead.

Well, since Cope's day, magnetic monopoles have come back, and as we are about to see, they are fantastically important and wide-ranging in their implications, and so worth taking the time to understand.

The famous Nobel Prize-winning physicist Paul Dirac had predicted the existence of magnetic monopoles in 1931 and published the quantum physics equations that 'showed' it.[18] His arguments are very convincing. In 1948, he published an expanded version of this theory, which has been largely ignored, though it has the potential to revolutionize much of contemporary physics.[19] In

this paper he introduces the idea of a ‘quantum string’. (See my extracts from this brilliant paper and my comments on its radical ideas in the footnote.)

On 30 January 2014, Des McMorrow and Steve Bramwell of the London Centre for Nanotechnology announced their proof of the existence of these monopoles. On 4 September 2015, scientists of the Universitat Autonoma de Barcelona in Spain announced that they had actually produced magnetic monopoles.

Then Georges Lochak, President of the Fondation Louis de Broglie in Paris, and the German physicist Harald Stumpf, a former student of Werner Heisenberg, published a remarkable book in 2015 that revives magnetic monopoles, and contains a veritable tsunami of horribly complex mathematics, a whole book full in fact, to back it up.[20] Indeed, I proofread Georges Lochak’s contribution for him to improve the English, as English is only his third language, his first being Russian and his second being French.

Steve Bramwell has stated: ‘We have observed monopole currents analogous to electricity.’ He also agrees that it should eventually be possible to harness monopole currents for technology, though that is a long way off.

The evidence for the existence of magnetic monopoles keeps piling up, and many physicists are now talking increasingly about magnetic monopole plasmas. This is very important for us, because it means that there may be portions of the Kordylewski Clouds that are plasmas which are not made of charged particles, but instead of magnetic monopoles. In July of 2019, a paper appeared in *Nature* reporting experiments that appear to have confirmed the existence of magnetic monopole plasmas.[21] It referred to numerous other investigators, papers, findings and theories about this subject.

This paper reported the results of investigations with a superconducting device known as a SQUID, to investigate whether the ‘noise’ that magnetic monopoles would make according to theory really exists. They found it and said: ‘Intriguingly … magnetic monopole flux noise amplified by SQUID is audible to humans.’

They say of their findings that they are ‘consistent with other studies that imply that Dy_2Ti_2 and $HO_2Ti_2O_7$ [Dysprosium dioxide, titanium dioxide: Dy is the rare-earth chemical element Dysprosium that is never found in nature, but when produced in the lab is known for its high magnetic strength; Ti_2 is titanium

dioxide; HO_2 is hydrogen superoxide; and O_7 is an anion of oxygen and in combination means heptoxide] contain a plasma of emergent magnetic monopoles.' And they cite nine references to other papers from *Nature*, the *Physical Review*, and so on.

A 2016 paper they cite discussed both positive and negative magnetic monopoles, which would be the magnetic equivalents of electrons and protons. In other words, there may be a whole other science of plasma taking shape, which verifies the 1979 predictions of Freeman Cope, though he is forgotten.

Let us pause briefly to consider why this is so significant. Scientists expect their theories to be symmetrical and for the most part symmetries are a good sign that your theory may be on the right lines. The established theory of electromagnetism, called the Maxwell-Heaviside Equations (named after the two scientists who formulated them), has a symmetry when it comes to fields – there are both magnetic fields and electric fields. But there is no symmetry when it comes to currents. There are electric currents, but apparently no magnetic currents.

In order to complete the symmetry and for there to be magnetic currents, there would need to be magnetic particles which, like electrons, the particles of electricity, have a charge operating in a single direction. But all magnetized particles known about operate in equal and opposite directions, which is to say they have two poles, one negative and one positive. Therefore, in standard physics there is no such thing as a magnetic monopole.

The quest to discover them has been called the Holy Grail of physics, because not only would this give symmetry to the theory of electromagnetism – with gravity the most important formative factor in the Universe – it would open up a vast new dimension of theoretical physics when it comes to exploring the fields that give our Universe the form it has.

As for the practical implications and how to harness the power of magnetic monopoles; well, that was what Cope was interested in discovering in his top secret work.

In what I will now quote from Cope, we must remember that according to standard scientific symbol protocol, H stands for magnetic and E stands for electric. Also, we must mentally re-insert the monopoles back into Cope's argument, and consider them as well as the dipoles he discusses. Also, Cope uses

the polite phrase ‘our unknown something’ to refer to the strange phenomenon, and he has coined a wonderful phrase, ‘magnet auras’ to describe the clouds around magnets visible to some people.

Cope says:

> … the observation that our unknown something seems to collect near surfaces of magnets (magnet auras) suggests that we may indeed have H-dipoles [remembering that ‘H’ means magnetic, he means magnetic dipole particles, but we can now add also H-monopoles], which are pulled into regions of high magnetic field gradient; e.g., regions near magnet surfaces.

In other words, since it is known that Cope’s ‘unknown something’ accumulates near magnet surfaces, he reasons that the ‘unknown something’ must be composed of magnetic particles. He assumes that they would have two poles, north and south. But since his death, magnetic monopoles having been confirmed, we may add that they might just as well have only one pole and hence be monopoles, as he had initially hoped.

He continues, expanding his comments from magnetic (H) particles to electric (E) ones:

> Our unknown something seems also to collect near the surface of the human body (human auras). No magnetic field gradients exist there. (‘Gradient’ in this paragraph refers to a flow of energy either magnetic or electrical.) However, if our H-dipole is also an electric (E) dipole, it would collect also at regions of high electric gradients. The human body forms an electric discontinuity with the electric field around the Earth, thus causing large electric gradients near the body surface. Therefore E-dipoles should collect there.

In other words, since human bodies have electric fields around them, forming ‘bubbles’ within the normal electric field on the Earth’s surface (see a drawing of a human standing in such an electric field bubble in Chapter 17, Figure 32, here), Cope’s particles would collect there.

Cope goes on to explain how these new insights mean that Wilhelm Reich’s supposedly crazy ‘orgone accumulators’ might really have worked. After

explaining how a sandwich of dissimilar materials arranged in a certain way – perhaps not unlike the layers in Rothen's original experiments – might be able to trap such particles, he makes this explicit statement:

> Because of this effect, a box made of two layers of dissimilar materials might accumulate and concentrate EH-dipoles from a surrounding gas of EH-dipoles, analogous to the experimental observations of Reich …[22]

He adds:

> Reich seemed to observe accumulation of some sort of solar radiation [remember I said earlier that Reich believed his orgone energy was being streamed from the Sun to the Earth] with physiological activity within bilayer boxes (sheet iron covered by cellulose) … we may expect bilayer structures to act as diodes or rectifiers (both are devices that conduct a current in one direction) for EH-dipoles. A box constructed from such bilayer sheets might therefore operate as an EH-dipole accumulator, which would explain some of the phenomena observed by Reich.[23]

This is an astonishing revelation. Reich was sent to prison for making orgone accumulator boxes of exactly this kind, which he insisted were trapping some unknown solar energy that he named 'orgone'. Here we have Cope, twenty-three years after Reich's death, and obviously entrusted by the American security establishment with evaluating Reich's research papers, concluding that Reich's orgone accumulators probably worked after all, and paving the way for these to be understood in terms of magnetic monopoles that have since been shown to exist. Cope is talking about reconstructing the very same boxes that were chopped to pieces with axes in front of Reich's eyes by FBI men outside his house, and their constituent parts thrown onto a fire with his books.

It is beginning to look as if Wilhelm Reich may have been a twentieth-century Giordano Bruno. What kind of mad frenzy possessed the FBI men to behave like this? As I've already mentioned, Reich's books had previously been burned by Himmler's SS and then they were burned again by fanatical opponents of his scientific findings within the American Government.

At this point in his account, Cope begins to refer to the work of another brilliant scientist who seriously challenged orthodoxy, Herbert Charles Corben.

In his ‘day job’, Corben was one of the world’s leading experts on spinning particles, who wrote the definitive book on the subject for that time in 1968, which is so heavily mathematical that you need swamp boots to wade through it.[24] But when left free for his thoughts to roam, Corben was an astonishingly bold thinker, as we see in a rather visionary article that was published in 1978, from which Cope draws.[25] Cope and Corben were also in personal touch and exchanged information privately, as Cope makes clear.

Anyone who thinks that monopoles and ‘orgone’ energies are ‘way out’ phenomena will perhaps be surprised to hear that the subject of tachyons is even more so. And Corben seriously investigated tachyons, along with a small number of like-minded scientists. What are tachyons? They are particles that travel faster than the speed of light – and they are predicted by relativity theory. ‘What?’ you may exclaim. ‘But surely it is relativity theory that says that nothing can go faster than the speed of light?’ Well, not really … But if we get into the speed of light, then this book will become twice as long, and we cannot allow that to happen.

A tachyon, like the magnetic monopole, is a particle that exists in theory, but is in practice a very rare bird, which most scientists would probably say does not exist in the real world. Before we get too sceptical, we should remember the way physics evolves. It often happens, and happened in the case of the Higgs boson, for example, that a particle is shown to exist in theory many years before it is actually verified by experiment.

So I will have to ask you to swallow hard and try to take my word for it, that tachyons may turn out, as magnetic monopoles have now done, to exist after all, despite a chorus of doubters shouting ‘crazy!’ The moral to this story is: When someone shouts ‘crazy’ at you, put your fingers in your ears and carry on.

Drawing upon discussions with Corben, Cope was able to expand his theory of clouds of dipoles surrounding the human body and suggest that clouds of EH-monopoles might actually be tachyons. This would mean that even the laziest person on earth, the teenager who sleeps all day for instance, may at all times be surrounded by a cloud of particles going faster than the speed of light. So when an exasperated mother shouts at her teenage son, ‘Get out of bed, it’s the middle of the afternoon!’, he might justifiably call back to her, ‘I’m completely exhausted because my body-cloud has been going faster than light all night long.’

Without going into all the technical details, fascinating as they are, I shall give some of the conclusions that Cope comes to on the basis of all of this. He and Corben worked out together that diffraction patterns [interference patterns of waves that can tell you the frequencies of the waves] of tachyons could create 'certain resonance interactions or standing wave patterns of interactions between the tachyons and crystals'.[26] (Remember what I said earlier about solitons and standing waves? To explain resonance interactions, which can create standing waves, would require too lengthy an account. But when wishing to understand resonance, think of music, and harmonious chords as opposed to those that are not. The most harmonious chords are called fifths by musicians, and are examples of harmonious resonance.)

Cope is saying here that if tachyons do exist, their rhythmic interactions would naturally make them resonate with crystalline structures in intimate and interesting ways. This is a wonderful vision and a joy to conceptualize. Critics may say it is highly speculative, but Cope found a way to describe the relationship between crystals and mysterious energies in scientific terms. He found a scientific language for it.

Cope goes further. He comes up with mechanisms in the form of 'superconductive regions' to explain how these particles might be the trapped within the body. (Again, superconductivity is when electricity travels without resistance.) He also suggests that on the planetary scale, these phenomena could create a standing energy grid, a vast grid system of resonant standing waves of 'earth energy'.

He adds as a footnote that this could explain dowsing, if we all have these particles inside us rendering some people hypersensitive to invisible energy fields. In relation to dowsing, returning to the subject of magnetic monopoles, Cope says:

> My hypothesis is that the long sought magnetic monopoles are all around us, and are in the form of delocalized tachyon (faster-than-light particles) clouds, which form periodic wave functions detectable by sensitive quantum mechanical processes in man … the general pattern of reported experimental observations seems to suggest that delocalized clouds (wave-functions) of tachyon magnetoelectric monopole polymers (substances made up of large molecules) surround all solid and liquid objects, and that these … are detectable by sensitive persons trained in dowsing techniques.

> The detection is presumably by quantum mechanical interactions with living cells … Dirac monopoles exist as large, delocalized, polymeric clouds (or wave-functions) with spatial periodicities …[27]

I realize that this is very technical language and probably confusing. But what he is saying is that there are these clouds surrounding each and every one of us, and indeed not just us but ‘all liquid and solid objects’. Thus, we are all surrounded not only by charged dust and microbes, but by even smaller electromagnetic particles, which are whizzing round us constantly faster than the speed of light and causing effects that we have not yet even begun to explore or explain.

And in this connection, I should add that bees and flowers also have an electromagnetic dimension. For scientists at the University of Bristol have proved that bees when flying around are positively charged, and sense the flowers that are negatively charged, using specially sensitive small hairs on their faces.[28] The pollen that they gather also becomes charged, and then the charged dust is scattered in the air by the bees rustling around inside the flowers. We may thus look upon bees and flowers as engaged in a continuous orgy of charged intercourse with one another, generating and displaying their auras and creating plenty of charged dust in miniature clouds as they do so.

It really is true to say we live in an electromagnetic world, and are only beginning to understand how it works. All of us are electric people, full of multiple currents of both negative charge, called electricity, and positive charge, called proticity. Since charged currents always generate magnetic fields, we are also all full of multiple magnetic fields. When we say that people sometimes have ‘magnetic personalities’, we may be closer to the truth than we thought.

14

Electric People

I have known many distinguished scientists over several decades and had opportunities to sit around discussing these issues with many of them, often for hours, and sometimes for days. The first scientific Nobel laureate I met, aged eighteen, was Paul Dirac (1902–1984), who won the Nobel Prize for Physics as long ago as 1933. I went to tea with him in his rooms at Cambridge and spent four hours with him. He was a great admirer of tea time and made quite a fuss of it, pouring tea and serving dainty little sandwiches, small tarts and cakes.

Dirac was very solitary and silent and rarely talked to people. I seem always to have had a way of getting such people to chat; in Dirac's case, I instinctively knew that I must sit in my chair at a 60-degree angle from him so that he could talk 'without being observed'. He had in fact put the chair there and I knew that its angle was the key to having a conversation with him, as he could not talk to people comfortably if they were looking directly at him face on.

Dirac shyly confessed to me that he was far more interested in biology than he was in physics, but he said he did not dare to tell anybody that in Cambridge. Dirac did not accept physics as it was at that time. He complained that no one would listen to him about quaternions (a number system that he believed essential for understanding quantum mechanics, but which his contemporaries insisted had no practical applications), and he thought physics was in many ways on the wrong track. This had a big impact on me, for there I was in conversation with a living legend of science, and he criticized the very foundations of the science of his time and even preferred a different scientific discipline from his own because it was more lively.

That was an early encouragement to my own scepticism about anything and everything that 'everybody believes'. I have an inclination to think that 'everybody' is always wrong. We discovered that we had both entered university at the age of sixteen, and we talked about that and how it teaches one to be a bit

isolated from one's contemporaries, because they are not really contemporaries chronologically at all, but already well on the way towards becoming ossified and rigid. I have written a long account of that interesting meeting, which perhaps I shall publish one day.

Dirac was one of the few scientists who have had the courage to speak of these uncertainties openly – like my hero Percy W. Bridgman did in his books. Bridgman had won his Nobel Prize in 1946, he had been a famous Harvard professor for decades, and he did not give a damn if querulous and timid colleagues decided to turn on him, savage him, and call him crazy because he was pointing out that not only one emperor, but many wore no clothes. Bridgman was that most honest of persons: someone who is not afraid to admit that he does not know things. He admitted that he did not know what 'a field' actually was, but he went further and said that no one did.

My old friend David Bohm is well known for formulating his alternative interpretation of quantum mechanics, which involves something that he called 'the quantum potential'. When I asked him what the quantum potential actually was, he said he did not know, and that no one really knew what any of the potentials in science were. He had come up with the ideas mathematically and hoped one day to find out what it was, but meanwhile it was just there in the equations and he could describe what it did, but not explain what it was.

It is heartening to know that there are some famous physicists who have courage. But if you have courage in life you will suffer, because the herd will attack you. Most of my scientist friends or good acquaintances, many of them very famous indeed, have been at heart renegades. What does it mean to be a renegade? It means that you use your own brain rather than the herd's brain.

I befriended David Bohm in 1982 when he was Professor of Theoretical Physics at Birkbeck College London. The reason I mention David at this point is because I want to quote from my own article. These are words of his that come from the voluminous sound tapes which I made with him over the course of many meetings:

> What is an electric field? We don't know. If we knew, we would know why field and charge are connected in the particular way in which they are … when I was a child people would say 'Electricity is very mysterious.' Now we say it's not so mysterious, but still nobody knows what electric force

> really is. We're used to it, that's all, by giving it a name and getting used to handling it … What is a gravitational potential, what is an electrical potential, what is a quantum potential? You see, you would have to explain all the forces and explain why they act on particles. Now, nobody has done that.[1]

The non-scientist may be astounded to hear this confession from one of the most famous physicists of the twentieth century, but many of the most brilliant scientists have expressed these and similar sentiments not only in private, but in many articles and books. One example was my close friend, Peter Mitchell, of proticity and the protic motor (here), who insisted to me many times that 'nobody knows what energy really is'. And the famous physicist Richard Feynman (1918–1988) was honest about our ignorance. He bluntly said, 'I think I can safely say that nobody understands quantum mechanics …'[2]

> And elsewhere he made statements such as these:
>
> Whether the proton decays or not is not known. To prove that it does not decay is very difficult … there are … quantum theories of gravity … (but) … there is no way to test them … The best of these theories is not able to include the particles that we do find, and invents a lot of particles that we don't find … there remains one especially unsatisfactory feature: the observed masses of the particles, m. There is no theory that adequately explains these numbers. We use the numbers in all our theories, but we don't understand them – what they are, or where they come from.[3]

Nobel laureate Ilya Prigogine, whose work was discussed in Chapter 3, said:

> I think we are only at the beginning of science. We are at the beginning of studying the complexity of Nature. The classical universe was a simple, quiet universe. And now we see, we only conceive the extraordinary complexity of nature, like for example the complexity of the gene expression. We still don't understand completely the structure of the gene. Yet I don't think that once we understand the structure of the gene we shall see the meaning of man, because the genetic content of a mouse and a man are very similar. Therefore the non-genetic part of biology is very important. But we know little about it … In addition I would say there is no fundamental science … why do we have so many elementary particles?

> Nobody knows … we still don't know the origin of the Universe. The theory of the Big Bang is the most widely accepted theory, but what is the Big Bang? … We are at the beginning. I always say that we are at the beginning of a new science, not at the end of science.[4]

So now we come to another remarkable man and great scientist, Albert Szent-Györgyi (1893–1986), who became a great influence on many pioneers in this field, and with his contemporaries Alfvén, Bostick, Kapitsa and Cope, one of the great heroes of the history of plasma. He was a Hungarian whose surname means Saint George and is pronounced just like 'Saint Georgie'. He was the second scientific Nobel laureate whom I met, when I was twenty-one. He won the Nobel Prize for Physiology and Medicine in 1937 when he was still Professor of Medical and Organic Chemistry at the University of Szeged in Hungary.

By the time I met him, he was an exile living in America, whither he had fled in 1947 from the Communist regime of his native country, and he was working at the Marine Biology Lab of the Woods Hole Institute on the coast of Massachusetts, where I visited him for an afternoon.

Things had not gone happily for him in Hungary during the Second World War because of the Nazis. He had led a resistance movement against them and saved many Jews from being killed, and was lucky not to have been captured, tortured and killed by the Gestapo himself. The Hungarian Prime Minister sent him to Cairo to negotiate secretly with the Allies, and Hitler personally issued a warrant for his arrest. Szent-Györgyi was a larger-than-life extrovert character, with a ravaged face, a good sense of both humour and sarcasm, and someone who was not shy when it came to letting his genius glitter in conversation.

What is important for our story is that it was Szent-Györgyi who laid the true scientific foundations for the electric view of humans (and of all plants and animals also, for that matter). It is not for nothing that his most famous and provocative books are *Bioenergetics* (1957) and *Bioelectronics* (1968). I met with him in the summer of 1966, before the latter book was published. In 1976, he carried his views further and published *Electronic Biology and Cancer*. He believed that cancer was a condition associated with electrical and electronic malfunctions within the body.

Szent-Györgyi's *Bioenergetics* is such an amazingly provocative, challenging and brilliant book that its full effect has not been felt even today, for it contains

insights that have yet to be pursued. It is a bombshell still going off, even though it appeared three-quarters of a century ago. I don't imagine any physicist read it at the time, because it is so heavily technical about biochemistry that few if any physicists could have understood most of it. It was published before the discipline now called biophysics came into being. In fact, it was Szent-Györgyi who helped to provide the impetus for the founding of the science of biophysics, by injecting discussions of physics into biochemistry to such an extent that biochemists were forced to learn some physics in order to comprehend what he was telling them.

Indeed, Szent-Györgyi in his 1976 book *Electronic Biology and Cancer* based a portion of his arguments upon the work done by the famous French physicist Léon Brillouin (1889–1969), thereby forcing any of his colleagues who wished to understand him to study Brillouin's unique discoveries about electrons and the energy levels named 'Brillouin Zones' after him.[5] Brillouin had been insisting that semiconductors existed inside the body. Also, Szent-Györgyi had referred to Percy Bridgman's seminal book *The Physics of High Pressure* (1949), forcing his colleagues to read Bridgman in order to understand one of Szent-Györgyi's most important ideas.

For more than twenty years, Szent-Györgyi had been relentlessly pushing physics into biology, and it was becoming impossible to ignore this, so that the discipline of biophysics had to be born to cope with it.

He remarked in his 1957 book *Bioenergetics*:

> Experimental evidence for the existence of a semiconductor [semiconductors are necessary for the ordered flow of electricity] nature of biological material is not missing … chloroplasts [the tiny organelles inside plants that carry out the process of photosynthesis] can 'store light', that is, conserve the energy of absorbed photons, which energy they could again shoot out later in the form of light, if heated … That energy can move through protein molecules is an experimental fact … I have no doubts that the coming century will witness a profound revolution, extension of biology, the establishment of a quantum mechanical biochemistry … This book may be but one of the early swallows of this spring.[6]

We will see later that the quantum mechanical qualities of plasma, some of which we have already touched on, are crucial for understanding its role in the evolution of high levels of intelligence.

Bioenergetics was indeed an early swallow, and an influential one. It may have gone unread by many people, but they knew it was there, lurking. It is immediately obvious, if one thinks about it, that Albert Szent-Györgyi was an outstanding genius who was denied proper recognition in the United States; he discovered Vitamin C and won the Nobel Prize, but was he ever offered a professorship in America? No! Was he ever head-hunted by one of the Ivy League universities? No! Did the Institute of Advanced Studies at Princeton ever try to recruit him? No! Was he ever awarded any of the usual distinctions? No!

Instead, he took refuge in an oceanographic institute, which is what Woods Hole is. And he was given a job in a Marine Biological Laboratory. What on earth did Szent-Györgyi have to do with fish? Pretty much nothing. In fact, he was relegated eventually to something called the Institute for Muscle Research. It is true that he had done a lot of research on muscle and was one of the world's experts on the subject. But for him, that was a sideline. What was really going on was that the American scientific establishment was clearly afraid of Szent-Györgyi, wished to exclude him from the mainstream, and tried to prevent him upsetting all of their empty apple carts. And the appearance of *Bioenergetics*, throwing a bomb into the middle of all of conventional biological thinking, did nothing to render him less dangerous to the mediocre minds of the establishment figures.

With his book *Bioelectronics* (1968), Szent-Györgyi became even more of a threat to standard thinking. The first two sentences in his book are:

> The greatest stride in biology, in our century, was its shift to the molecular dimension. The next will be its shift towards the submolecular, electronic dimension.[7]

He went on to speak of plasma existing in every molecule in the body, saying each molecule contains something that 'can be looked upon as an electron gas pervading the whole molecule'.[8] An electron gas is a negatively charged plasma [negatively charged because electrons always have a negative charge, being distinct from the ionized, positively charged plasmas we have, for the most part,

been discussing]. Publishing something like this, insisting that there was a branch of biology that was electronic, that every cell in the body was electronic, and that every molecule contained plasma, was too much for the scientific establishment. Most biologists did not have the faintest idea how electronics worked even in a radio, much less in a molecule.

The more Szent-Györgyi published things that required people to stretch their minds, asking biologists to learn a little bit about physics and a little bit about electronics, the more certain it became that he would never be accepted or recognized in America. He could not go back to Hungary, because he would probably have been arrested, tortured and shot. He was also not in favour with the American security establishment, because he had led an anti-Nazi movement, whereas America in the 1950s and 1960s was being flooded with ex-Nazi scientists being brought over by Allen Dulles of the CIA as part of Operation Paperclip and other such projects.

But worst of all for Szent-Györgyi was the fact that Hitler's personal hypnotist, Ferenc Völgyesi, who had carried out hypnotic experiments on more than 60,000 Jews and Gypsies in the death camps, had become Allen Dulles's little darling, given a new identity as 'Frank', treated as an American, and put in charge of all the American security establishment's mind-control operations. And he was Hungarian.

Völgyesi was clearly going to use his influence with Dulles to prevent a distinguished anti-Nazi Hungarian from gaining any recognition at all in America, lest Szent-Györgyi might spill the beans on Völgyesi being a war criminal and a fanatical Nazi responsible for the abuse, torture, and deaths of thousands of Jews. And the CIA must have gone into full gear to keep Szent-Györgyi as obscure as possible, hidden away in his little port on the Massachusetts coast and buried in harmless muscle research, given no attention, and having no opportunity to acquire an audience who might ever listen to him.

Szent-Györgyi was in any case handicapped by terrible personal grief, because both his wife and his daughter had died of cancer by 1972, when he dedicated his book *The Living State: With Observations on Cancer* to their memory, saying in his Introduction that cancer 'took away most of what was dear to me'. And in his Preface, he thanked those few people who had 'helped to keep me "above water"'.[9]

A brief but fascinating account of a conversation with Szent-Györgyi has been published in Andrew Marino's autobiography. They met in San Francisco in June of 1980 (Szent-Györgyi died in 1986). Szent-Györgyi complained bitterly to Marino that he had never been able to get any federal grants for his research during his years in America, confirming my suspicion that he was blacklisted by the security agencies to make sure he never received any support for anything at all.[10]

Despite all this, Albert Szent-Györgyi laid the groundwork for crucial discoveries and developments in science, by helping to create the discipline of biophysics and introducing so many new and exciting notions that are still being explored today. For instance, he is looked upon as the 'grandfather of biophoton research', a subject I will be discussing in Chapter 15. He describes how 'ultra-weak' photons are emitted by the body; which, when their emission is correctly detected, has enormous implications for the early detection of diseases, especially cancer.

He also laid the groundwork for much of Peter Mitchell's work, turning upside down the discipline of bioenergetics and the explanation of how energy is used within the human body, and explaining how energy is transported across membranes and used in cells. But the main point of all this for us here is that the details of what Szent-Györgyi says in his books relate directly to the nature, structure and workings of intelligent plasma entities.

In *Bioenergetics*, Szent-Györgyi refers to the fact there are several different kinds of ice. This may surprise many people! Surely ice is ice, isn't it? Well, no, not really. Szent-Györgyi found this information briefly referred to in Percy Bridgman's *The Physics of High Pressure* (1949).[11] Bridgman was possibly the world's leading investigator of high-pressure phenomena, and he refers to 'the high-pressure modification of ice'. With the correct pressure techniques, one could change one form of ice into another. He could change Ice I into Ice III, Ice V, and Ice VI, for instance. All these are ices made of pure water, but they are different water ices.

Research into different ices continues today. In 1998, the number of different kinds of ice increased to twelve, as Lobban, Finney and Kuhs published in *Nature* an account of their discovery of Ice XII.[12] But by 2016, the number of ices had grown to eighteen. Although these different ices are described as 'crystalline phases of ice', they vary a great deal. Their oxygen atoms tend to

remain in fixed positions relative to each other, but their hydrogen atoms do not. In addition to the eighteen crystalline ices, there are three non-crystalline ices known as amorphous ices. So that makes twenty-one kinds of ice so far, all of them made solely from water.

There is also ‘hair ice’, which exists as thin threads spreading between trees, and ‘ice flowers’, which are produced by some plants but not others. No one knows why.

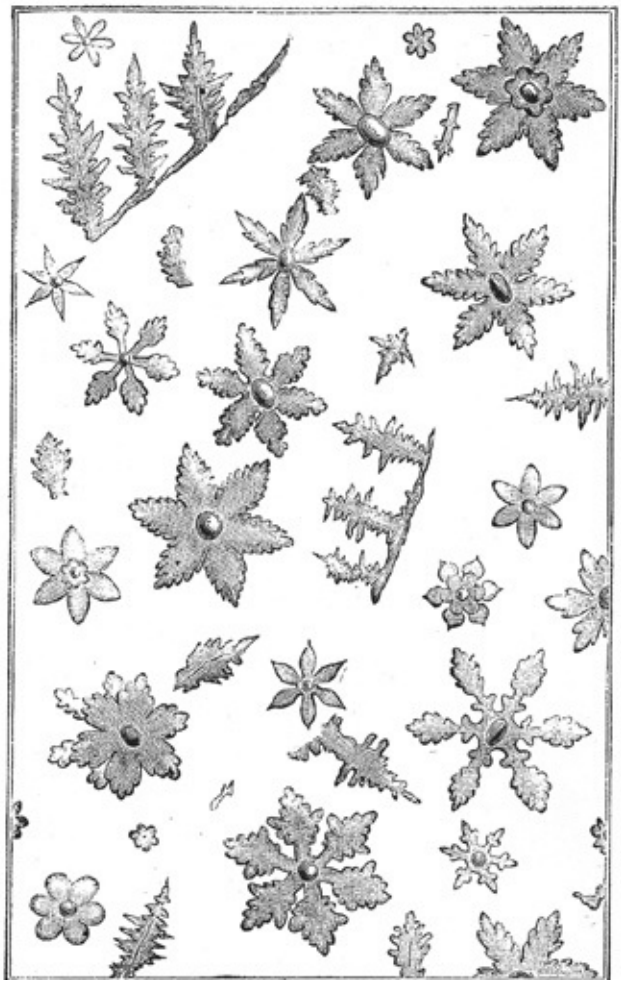


Figure 28, A nineteenth-century engraving of ‘ice flowers’ as seen through a microscope.

Does this mean there are twenty-three kinds of ice? Are there more? What does it mean to have twenty-one kinds of ice? Or twenty-three? Or fewer? Or, frankly,

even only two? Are the different ices also different kinds of matter? Or is ice just ice, regardless of which of the eighteen or twenty-one or twenty-three kinds it is?

Crucially it is not only ice that behaves in various strange ways. In *Bioenergetics*, Szent-Györgyi may have caused the greatest upset to his colleagues of all by discussing the weird nature of water. These days there are many books, many of them New Age titles, discussing different kinds of water at great length; they concern such ideas as 'water having memory', to explain how homeopathy is possible (where the dilution of a drug in water is so extreme that not one molecule remains, and yet the water appears to retain a potency derived from that drug anyway), and many other mind-boggling ideas. But Szent-Györgyi's thoughts on the strangeness of water in 1957 are so extraordinary that I must quote a bit of what he says:

> When considering water structures we enter a fantastic and fascinating world. Bridgman, in his studies on high pressure, could distinguish between half a score [ten] of different ices. But we need not go to ice to find structures in water. [J.D.] Bernal and [R.H.] Fowler … showed water to have a quartz-like 'crystalline' structure which is different from that of common ice … The situation becomes more complex still if we consider water structures built around solid surfaces. The tendency of building structure-ordered layers around surfaces running deep into the fluid phase seems to be a general tendency of liquids …
>
> The surface zones of liquids are tens and hundreds of molecules deep, rather than monomolecular, as commonly assumed … water … around ice (behaves) not as water but as 'liquid ice' … These layers of ice were found to be several microns deep … the building of lattices means 'long range order' in which the single molecules collaborate collectively … No attempts have been made yet to apply our knowledge of water structures to living systems … Living matter seems to be a system of water and organic matter, which forms one single inseparable unit, a system, as the cogwheels do in a watch.
>
> Water is not only the mater, mother, it is also the matrix of life on Earth, and biology may have been unsuccessful in understanding the most basic functions because it focused its attention only on the particulate matter, separating it from its two matrices, water and the electromagnetic field.[13]

What is most interesting of all in this for our purposes is that Szent-Györgyi grasped the importance of ‘structured-ordered layers around surfaces’ within a watery mass (in other words the concept of a mass of water containing protected, or walled, cells within itself, which themselves are made entirely of water). These boundary layers within water are analogous to the boundary layers known as sheaths found within plasmas. All plasmoids are enclosed by sheaths. That is how they maintain their identities.

Szent-Györgyi had a deep intuition of the extraordinarily complex, dynamic structures that inform naturally occurring materials, including ice, water and plasma, but of which science had been ignorant before his discoveries. We have been building complex plasma entities having countless plasmoid regions within them, all protected within their sheaths.

Researchers such as Kapitsa, Bostick and Tsytovich have shown that some of the plasmoids contain hot plasmas, some cold plasmas, some dusty plasmas, some non-dusty voids, some containing specific impurities that hinder or accentuate the flows of charged currents precisely in the manner of electronic semi-conductors and transistors. Furthermore, there is the mysterious phenomenon called ‘tunnelling’ (to be explained in a moment) that takes place between them, and there are also superconducting and superfluid portions and sections. That water and plasma – which Szent-Györgyi showed to be present throughout human bodies – spontaneously generate structures adds a whole new dimension to the argument.

In order to understand the implications of Szent-Györgyi’s work in more depth and to see how it works in practice, we will look again at superconductivity and Josephson Junctions, before delving back into the weird and shadowy world of Freeman Cope.

Superconductivity and Josephson Junctions in the lab, outer space and human beings

It often happens in the history of science that a new scientific theory will give rise to new inventions. This is quite natural, but sometimes it happens the other way round.

The invention by Brian Josephson of Josephson Junctions as a device to control and regulate electric currents in complex machines helped drive the development of machine intelligence and eventually quantum computers. This in turn gave rise to theories that there might be things in nature that have similar functions.

We have already touched on the idea that there might be features in complex dusty plasmas in space which have similar capabilities to computers, and that these may help the evolution of intelligence in space. Now we are going to look at features that resemble Josephson Junctions in plasma in human bodies. We will do this before we actually explain Josephson Junctions.

The story starts in 1911 with the observation of superconductivity in a lab by the Dutch scientist Heike Kamerlingh Onnes. When electricity flows along a wire, it is called electrical conduction. When it flows through something without any resistance at all (an amazing phenomenon that scientists could barely believe when it was first discovered), it is called superconductivity.

Superconductivity is entirely counterintuitive. Everything that has traditionally been known about electricity is that it encounters resistance as it flows along, and as everyone who has ever had anything to do with electronics knows, and every electrician who wires your house, the units of resistance are known as ‘ohms’, named after the German scientist Georg Ohm (1789–1854).

At first, superconductivity was thought to take place only at extremely low temperatures near Absolute Zero, temperatures so low that in everyday life we never encounter them, because they have to be artificially created by scientists and technicians. But then as time went on, it was discovered that superconductivity could take place at higher and higher temperatures, and it was discovered that current could flow in this manner through increasing numbers of materials, many of them artificial.

As Freeman Cope put it:

> Superconduction is the passage of electron current without generation of heat and hence with zero electrical resistance. Such behavior has been observed only in inorganic materials and only at temperatures below approximately 20ºK [on the Kelvin scale; it equals minus 253.15 degrees Celsius], although theory predicts that superconduction might occur in organic materials at room temperatures.[14]

When current is flowing by superconductivity, it encounters no resistance at all; it can go on forever. It is, in fact, an electric version of a perpetual motion machine. If flowing in a coil under suitable circumstances, the current goes round and round by itself with no power source and it can in principle do this for eternity. It needs no recharging. It flows like an endless river. In fact, machines creating superconductivity have been made, which – all other things being equal – will continue to flow beyond the end of the Universe, if the Universe should actually end, that is (which in my opinion it will not).

The next great breakthrough for our purposes came in 1962, when Cambridge physicist Brian Josephson predicted with mathematical precision how a supercurrent would leap over a thin insulating barrier connecting two superconductors by means of the quantum phenomenon called ‘quantum tunnelling’.

This precision is key. Josephson realized that by modulating the insulating barrier between the two superconductors, the flow of current could be modified. If electricity flows too strongly and too well, it is too powerful for electronic devices and can overwhelm them. And if it cannot flow at all (through an insulator), it is obviously of no use whatever. Because of what became known as Josephson Junctions, it became possible to use superconducting electricity that was not too strong, but of semi-strength only, and by varying the semiconductor materials by adding small amounts of this or that substance (what is called ‘doping’), the strength of the electric flow could be varied and fine-tuned.

These junctions are what make our most advanced modern computers possible, and without semiconductors (the ordinary ones, which had been known for a long time before this and that regulate normal electrical flow very precisely) there would be none of our contemporary electronic devices. There would be no portable computers, no cell phones, no tablets, and hence no internet, and so on.

Josephson was awarded the Nobel Prize for Physics in 1973 for his discoveries. He is another one of the Nobel laureates whom I have met and talked with about their work. He is a very shy and modest fellow, whose success in science came to him so young that he was rather intimidated by it all and for a long time seemed to dread all the attention he received. One day I must transcribe the tapes I made of our conversation.

Josephson Junctions are also fundamental to the development of a quantum computer. Indeed, some scientists go so far as to speak of a ‘Josephson Quantum Computer’. Josephson Junctions can now be made at the nano scale, with a thickness of only one tenth of a nanometre. They are able to act as computer switches so sensitive that they control currents one electron at a time, letting an electron through when desired and blocking an electron when necessary. This level of control has already been perfected, and when quantum computers finally come onstream, it will probably be because of the pioneering work and insight of Brian Josephson. For radiation detection purposes, vast arrays of tens of thousands of tiny Josephson Junctions working in synch are capable of obtaining results unobtainable by any other known means.

In a dusty complex plasma that has developed emergent properties of self-organization, where superfluidity is made possible by countless layers of sheaths, cells and crystals, we can expect superconduction and Josephson Junctions to form the basis of the energy flows within the plasmas. A dusty complex plasma such as a Kordylewski Cloud would thus be expected to have more than a trillion trillion trillion Josephson Junctions within it. (Or just keep adding the zeroes, as they would in effect become incalculable in number.)

Intelligent calculations by such conscious plasmas would be so rapid and so massive that a Kordylewski Cloud would easily have the capacity to monitor every living creature on Earth in real time and model future events for all of them. Such a cloud could thus foresee with a high degree of probability what would happen in almost any Earth situation, and have models of every conceivable variable’s effect on events. From the point of view of the limited human brain, a Kordylewski Cloud therefore has the capacity of what to us would be indistinguishable from omniscience.

If this complexity is possible in plasmas in space, what about in the human body? We know from Szent-Györgyi’s work that the human body contains organic semiconductors. For the achievement of the Josephson Effect within our bodies, these can suffice for the necessary ‘barriers’ to create the ‘jump’. The impetus for the ‘jump’ can come from something called ‘the Proximity Effect’. When two superconducting currents are near enough to each other, they can influence each other because of their proximity, and this can result in a Josephson Effect if there is an organic semiconductor available.

To understand the implications of Szent-Györgyi's discovery in more depth, we need to dive back into the weird world of Freeman Cope. I originally discovered his publications in the mid-1970s, as at that time I was constantly in Oxford doing research, though not living or based in Oxford. I would drive down to Oxford from the cottage where I was living in our little Morris 1000, which had an engine like that of a lawnmower, cold wind whistling in through the soft roof, and a heater so feeble that to avoid freezing in the winter one had to wear a heavy overcoat covering one's legs.

The irony is that I was studying organic superconductivity, which generates no heat because it encounters no resistance. So it would have been of no use when driving.

The journal I had discovered was *Physiological Chemistry and Physics*, published by the Pacific Publishing Company in Portland, Oregon, which is where they were at that time (they are now in Melville, New York). This exciting journal was packed full of astonishing articles and they were causing me to look at the physical body in an entirely new light.

As I looked into this more deeply, I discovered that William A. Little of Stanford University seems to have been the first person to start this chain of reasoning going. As early as the summer of 1964, he had published a paper in the prestigious *Physical Review* entitled 'Possibility of Synthesizing an Organic Superonductor'.[15] He concluded that 'superconductivity should occur even at temperatures well above room temperature' using 'certain organic polymers (substances made up of large molecules with repeating subunits) … which could have considerable biological significance.' After surveying numerous technical issues, he said: 'This forces upon us the remarkable conclusion that superconductivity could and should occur in structures such as this even at room temperatures.'

These findings tied in with work Cope had been doing since 1963, and he cites in footnotes relevant publications of 1963, 1964, 1970, and 1971, when he published his first major paper making claims of superconductivity in the body, in the 1971 article I cited a moment ago. In this paper, Cope refers to 'electron tunneling', which is the essence of Josephson Junctions.

Cope says in his paper:

> we may predict … special characteristics that superconductive biological systems should have, for which pertinent experimental data already exist. First, cells which perform single electron superconductive tunneling might also perform two electron (Josephson) superconductive tunneling [relating to] nerve processes … The apparent association of superconduction with growth which is indicated by the evidence of this paper.

The importance of the distinction between single and two electron tunnelling is that the latter are of a higher order when it comes to controlling the flow of currents, and they come into play when Josephson Junctions are used to control superconducting currents. A Josephson Junction, to put it simply, can act as a switch.

The following year, in the same journal, two Hungarian scientists published a paper commenting on Cope's ideas, and concluded:

> The … electron tunneling between the mentioned regions of DNA might be responsible for the experimental facts described by Cope, if we accept his hypothesis about superconductive tunneling in biological systems.[16]

In the spring of 1973, Cope published another paper in the same journal carrying his ideas further.[17] In this paper, Cope said:

> Various species of organisms can detect weak magnetic fields (0.1 to 5 Gauss) [Gauss units are a measurement of the field strength]. Indirect evidence suggests that electron tunneling may occur across junctions between superconductive micro-regions in living systems. Man-made superconductive Josephson junctions have been fabricated with magnetic sensitivity as high as 10–11 Gauss. It is suggested that superconductive Josephson junctions in living systems may provide a physical mechanism with more than enough sensitivity to explain the observed responses of organisms to weak magnetic fields.

Considering what was said about Cope in Chapter 13, it is interesting to note that at the end of this paper Cope states that his work was 'supported in part by Office of Naval Research Contract NR 105-717.' Cope had obviously persuaded his military security agency bosses that what he was doing deserved funding. A month later, the same journal received a paper from J.P. Marton extending

Cope's ideas to considerations of cancer, and this appeared in the next issue of the journal. Entitled 'Conjectures on Superconductivity and Cancer', the paper by Marton said:

> On the assumption that biological cell membranes possess superconductive properties and that dead and cancerous cells do not … the mechanism of control for embryonic, normal, and cancerous tissue growth may be explained.[18]

The next spring, in the same journal, Solomon Goldfein (1914–2003) one of the brightest scientists working for the US Army's Engineer, Research and Developments Labs in Fort Belvoir, Virginia, contributed to the discussion. Perhaps the Army did not wish to be left behind by the Navy! Goldfein's paper was entitled 'Some Evidence for High-Temperature Superconduction in Cholates' and started his paper by saying:

> When [William A.] Little examined [Fritz Wolfgang] London's idea [of 1937] that superconductivity might occur in organic macromolecules … he concluded that it was not only possible but might even occur at room temperature.[19]

By summer, once again in the same journal, Cope published yet another paper in which he said:

> Superconduction is the passage of electron current without generation of heat and hence with zero electrical resistance, accompanied by particular kinds of interactions with magnetic fields. Until recently, such behavior had been observed only in certain metals, and only at temperatures below approximately 20ºK. Theorists have long predicted, however, that superconduction might occur in organic solids, which theoretically might superconduct even at room temperatures and above.

Cope was also reporting evidence that some functions of nerves are controlled by superconduction and he proposed that biological sensitivity to weak magnetic fields is comprehensible only in terms of a biological superconductive Josephson Junction. Once again, Cope acknowledges the Office of Naval Research and Contract no. 105-717.

Also in early 1974, Profesor Antoni K. Antonowicz of Poland published an article entitled ‘Possible Superconductivity at Room Temperature’ in *Nature*.[20] This attracted wider attention and was reported in the *New Scientist* magazine on 28 February 1974, p. 525, beside a report on work by Freeman Cope. Antonowicz was reported as using a sandwich of amorphous (which is to say non-crystalline) carbon between aluminium films to engineer Josephson junctions, and he like Cope discovered that the tunnelling involved was modulated by a magnetic field.

Cope next delivered a paper to a conference in 1978, the abstract only of which was published in the volume of conference Proceedings by the US Department of Energy. He discussed how superconductive Josephson Junctions make it possible for organisms to detect not only weak magnetic fields but also microwaves, and he referred approvingly to the work of Antonowicz.[21] Cope’s full paper appears never to have been released for publication.

At this point, Cope’s involvement in this subject appears to have ended, and in this same year he switched his work to the dipole clouds that have already been discussed.

No one else has ever done a survey of these publications, and I thought it necessary to put it all on record, as it was an important episode in the history of science. Since this flurry of exciting papers appeared, this subject has mysteriously ‘gone quiet’ in America. That is often a sign that the security agencies are working on it, or if not working on it, then actively suppressing it for some paranoid reason of their own. (How dangerous can it be for the public to know about superconductivity taking place within the human body?) But several decades of silence is extremely annoying, especially in light of the crucial importance of this almost-forgotten subject.

What does all of this mean for our discussion in this book? It is fundamental. We are looking at the dynamics of currents of electricity and proticity within our bodies, an interface between the plasma inside us and our physical bodies – and also, as Cope’s work suggests, between our plasma selves and universal electromagnetic fields and perhaps microwaves. In other words, Cope discovered a plasma-based mechanism by which our physical bodies are affected by fields.

As we will see later, quantum biologists have shown that some birds navigate their migrations by means of interaction with the Earth’s electromagnetic fields,

which have now been shown to cause chemical changes in their brains. Could this interface identified by Cope also work in much more subtle and complex ways in the human brain and account for important features of own consciousness and behaviour?

This subject needs to be investigated continuously and relentlessly. Either it has been done in secret, in which case the facts need to be made public, or it has not been done, which would be a major dereliction.

In 1989, an unexpected contribution to this subject appeared from Europe. A group of five authors prominent in biophoton research published a paper supportive of the idea of superconductivity in organisms. They were Emilio Del Giudice, Silvia Doglia, Marziale Milani, Cyril W. Smith, and Giuseppe Vitiello. I have had very friendly and productive relations with Smith and Vitiello for some time by email, but missed the brilliant Emilio Del Giudice, who was no longer alive by the time I established contact. Their joint paper especially dealt with Josephson Junctions in living systems.[22] The five authors were preoccupied by what it means for long-range order to occur by correlated behaviour of the elementary components of an organism.

The five authors say:

> A living system can be considered as a set of many microscopic components whose interplay occurs through a network of mutually coupled and sequentially ordered chemical reactions. The macroscopic [large scale] ordering could be considered as emerging from the collective behaviour of the elementary components … One of the authors [Cyril Smith] and his co-workers have, over many years, found evidence that Josephson-like phenomena are occurring in living systems. The first piece of evidence came in 1975 … there is a small superconductive region with dimensions (which are very small) … A dispersion of such regions … could give rise to an a.c. [alternating current] Josephson effect … a pair of nearby cells acts as a Josephson Junction … (which gives) rise to an intercellular coherence.

In other words, ordered complexity is created in organisms by means of the actions of adjoining cells influencing each other across Josephson Junctions. It was impossible for Freeman Cope to enter this discussion, because he had already been dead for seven years.

However, a year later in 1990, William A. Little jumped back into the fray, twenty-six years after his seminal paper of 1964 considered earlier. As an organizer, he took part in an International Conference on Organic Superconductors, which took place 20–24 May 1990, at South Lake Tahoe, California. This conference was funded by the deceased Freeman Cope's old employers, the Office of Naval Research, under contract N00014-90-J-1384, along with the US Department of Energy.

Bill Little, describing himself as 'Principal Investigator', wrote the necessary classified Final Report for the Navy and submitted it on November 30. This Report has now been declassified. It contains a photo of all the participants and a chart identifying them all by numbers. The papers are not included, but abstracts of them are. Little states that the Proceedings will be published by Plenum Press, and then he says:

> It would be appropriate to mention two items which were brought up by the participants and which might be of interest to funding agencies. The first was a perceived need to develop a better understanding of the process of electro-crystallization … The second, was the remark by Professor J. [James] P. Collman that the field of organic conductors, organic magnets, and organic superconductors … appears to many to have the potential of contributing an enormous amount to the development of new materials of commercial value in the coming years …

When the Proceedings of this conference were published, containing all the papers,[23] none of these remarks or the photo appeared. In a brief preface about the history of the subject for the preceding twenty-five years, Little does not mention a single one of Cope's papers, or indeed any of the other papers we have considered here except his own of 1964. To me, this gives the appearance of a wish to conceal the earlier history of the subject rather than to reveal and discuss it.

In the large volume, Josephson Junctions are mentioned only once,[24] and the conference as a whole appears to have taken place in a parallel universe where all that we have considered so far does not exist. And after this conference, the entire subject drops off a cliff and that is the end of it, as far as the public gaze is concerned. Perhaps 'the development of new materials of commercial value' (and probably military value as well) was the reason for this subject 'going dark'

after 1990. In which case, I am glad to be resurrecting it, since probably no one else would ever have done so.

The mechanics of superconduction within physical bodies will certainly also be found in a similar form in plasma bodies in space. There can be no doubt that superconducting regions and Josephson Junction switches operate within plasma entities, and must occur in their hundreds of millions or billions (or probably trillions) within the Kordylewski Clouds. They will be fundamental to any computing powers of the Kordylewski Clouds. And there must be hundreds of thousands of them within each one of us, in both of our bodies, the physical ones and the plasma ones.

In addition to this, superconductivity is, as we saw in Chapter 8, bound to occur within the Birkeland Currents that stream through the whole of the Universe. There is no reason why such superconductivity within those galactic and inter-galactic filament streams cannot travel at speeds known as ‘relativistic’, meaning near to the speed of light. As we have also seen, we know the streams of electrons within the Birkeland Currents move forward in a double-spiralling fashion in counter-rotating layers. Similar filaments, operating in the same or a similar fashion, must exist within the Kordylewski Clouds, and at a micro level within ourselves. These are areas of research that need urgently to be pursued, as we need to know so much more.

I shall add just one clue as to why this subject may have been suppressed. Everything that I have described above could be exploited in the creation of robots that combine inorganic with organic components. There are people who write about ‘transhumanism’, which deals with this subject. The work of Cope and the others, in fact, has direct relevance to efforts to build robotic ‘super-soldiers’, who can enter a battlefield and kill, kill, kill. Isn’t that wonderful?

15

How Our Bodies Emit Light

All of us emit light, as do all living things. But it is a kind of light that cannot easily be detected. Since particles of light are called photons (a word coined for them in 1916 by the physicist Leonard Thompson Troland), those spontaneously emitted by living tissues have come to be called ‘biophotons’.

Biophoton emission is not the same as ‘bioluminescence’, which is what we see with fireflies, electric fish and a few other creatures. It is also not the same as ‘chemiluminescence’, light emitted by a chemical reaction, which can also sometimes be seen taking place in living things. All those emissions of light can be seen by the eye. But biophotons cannot.

Biophotons are emitted when electrons in the organism get energized or ‘excited’. They are therefore useful for detection and diagnosis, and as indicators of what is happening in the organism.

Biophotons are so faint that they are what is known as ‘ultra-weak’ emissions of light. If something is ultra-weak, then surely, you might say, it is of no importance. But nothing could be further from the truth. We have good reason to believe that biophotons are fundamental to our existence. And when the emission of biophotons by our bodies goes wrong, it means that we have a serious illness.

It is now known, for example, that changes in biophoton emission rates are the earliest possible sign of cancer. So early is their warning that millions of lives could be saved or significantly extended if a mass biophoton detection programme were adopted. With such extremely early warnings, incipient tumours could be removed before they became dangerous, when they were still only a few cells in size. (Such tiny incipient tumours can easily be zapped and destroyed by ablations, using keyhole surgery.) Biophoton detection is not invasive and does not require expensive scanners. It does not bombard the body

with radiation. It is an entirely passive process. It need cost very little. Indeed, it can be done by a simple blood test.

At the present time, only one machine exists in the world for taking these images. Biophoton research is barely funded and is ignored by all the world's governments except the Dutch, which is strange, considering that cancer prevention at an early stage could save such gigantic sums of public and private money in treating cancers. In fact, the world's medical insurance companies should sponsor mass biophoton detection to increase their business profits enormously.

For a large-scale biophoton scan of, say, half of the body, the person needs to sit in complete darkness for at least half an hour in order for residual light effects to dissipate. After that, it takes some considerable time to wait for the ultra-weak emissions to register. Here is an image of the head and torso of someone in total darkness, with spontaneously emitted biophotons as the only light source for the image:

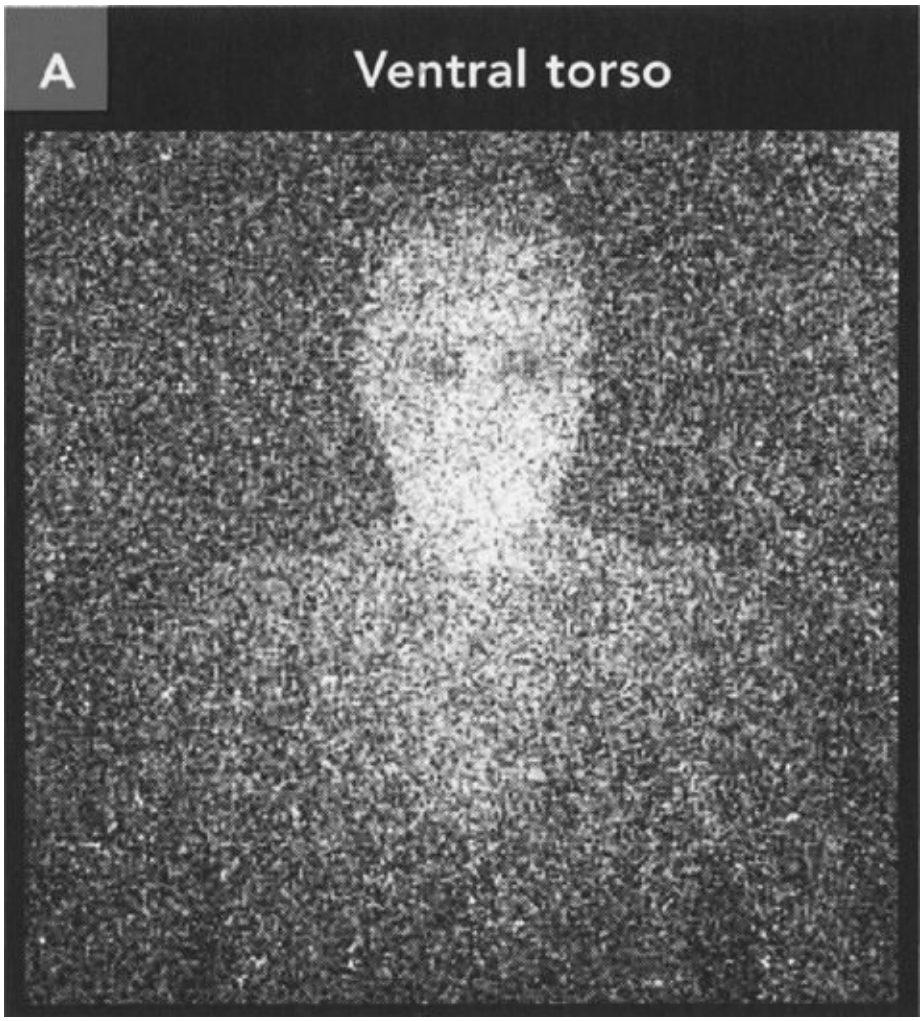


Figure 29. An image of the head and torso of a man sitting in total darkness, the only source of the light forming the image being the spontaneously emitted biophotons coming from his own body. For reasons that are not entirely understood, the eyeballs do not emit many photons, and so appear here as dark holes. Image courtesy of Professor Roeland van Wijk.

There is another way to detect biophotons by means of a portable detector with two long empty gloves hanging from the front. A person inserts his or her arms into the gloves, which reach to the elbow. The hands, being entirely in the dark inside the small machine, then have their spontaneously emitted biophotons counted by the machine's twin photomultiplier detectors. Just from counting the biophotons coming from the hands, it is possible to know whether a cancer condition is developing somewhere in the human body. A 'positive' finding then

suggests that more tests should be carried out to locate it. A ‘negative’ finding suggests that they are probably unnecessary and there is no cancer condition.

The main basis for this is that ‘changes in ultra-weak photon emission occur in the transition from a healthy to a diseased state.’[1] And this is the earliest warning signal.

Biophoton research, despite all its promise, has been shrinking, not expanding. There is little or no funding for it. Public health officials are too dim to see its potential, and it is ‘outside their comfort zone’. Big Pharma is never going to promote it, and most doctors don’t know about it. The heyday of biophoton research was in the 1990s, when many publications on the subject appeared. But at that stage, the detectors mentioned above did not yet exist, so all that was written was based upon laboratory research, and the equipment was not yet in existence for public use.

The big-name researchers in the field at that time have mostly died or retired by now, and have not been replaced. One can go down the list of names prominent then, and one soon discovers that only a few are still alive, and several of those have become inactive because they could not find anyone to fund their work. The combined knowledge of several brilliant scientists from many countries is in danger of being lost to humanity through ignorance and prejudice. And the price of this ignorance and prejudice is that many, many people will die needlessly.[2]

The leading proponent and researcher of biophoton technology for human health today is probably the Dutch scientist, Professor Roeland van Wijk (known as Roel). Although he is now retired, his son Dr Eduard van Wijk leads a group at Leiden University in the Netherlands, to which his father is a leading scientific advisor. They are actively researching biophotons, and are apparently the only group in the whole of Europe doing so. Roel did important work earlier with another such group in Japan, headed by Masaki Kobayashi of Tohoku Technical University at Sendai.

In 2014, van Wijk published a mammoth book on biophotons in biology and medicine, which is extraordinarily clear and explanatory.[3] It can easily be read by any medical doctor or person with some basic education in biology. It is described as an interdisciplinary textbook, and the hope is that some academics somewhere will actually use it as such. In any case, the book exists, and van Wijk has done the public a great service. However, the number of copies

available is now very small, so that the book is not achieving the wide circulation it urgently needs.

Biophotons were first discovered in plants by a brilliant Russian scientist, Professor Alexander Gurwitsch (1874–1954). (Gurvich is the correct Russian spelling, but he is more widely known as Gurwitsch, the spelling used for his German publications.) While studying the growth of onion roots in 1923, Gurwitsch was able to demonstrate the existence of biophotons, though he did not call them by that name.

Gurwitsch's theory was that organisms grew in connection with fields of some kind, which he named 'morphogenetic fields'. He was the first person in history to use the term 'field' in connection with biology, in a paper concerning the growth and development of embryos, which he commenced writing in 1911 and published in 1912. But at that stage of his work, he had no proof, only a theory. It was only in 1923 that he was able to demonstrate physical evidence for his theory. He had already concluded that cell division (known in biological terminology as 'mitosis') in embryos must require not one, but two, factors.

The first was a 'possibility factor', meaning that the circumstances must become such that cell division was rendered possible. The second was a 'realization factor', meaning that the cell division, having become possible, was then somehow triggered. Without this trigger, it simply would not take place. He did not believe that this trigger was chemical. Instead, Gurwitsch decided that the way the organism as a whole triggered cell division for its embryonic cells to divide and grow must take the form of external non-chemical signals of some kind. But what could they be, and how could the signals be detected by the cells?

He decided that each cell membrane must be 'an organ perceiving signals for cell divisions'. Gurwitsch became the first person in the history of biology to use the term 'receptor'. He suspected that the cell membranes must contain 'receptors' of some kind to detect signals of some kind, to cause cell division, which he called 'mitotic signals'.

Gurwitsch then carried out his now famous onion experiment, studying the growing tips of onion roots. (A drawing of the experimental setup is to be found on this book's website.) The roots had to be as even and smooth as possible, and were placed at right angles to each other so that the tip of one root was directed precisely at the zone of the other where cell division would take place. He found that the tip of one onion root, which he called the 'inducer', when directed at the

wall of the other onion root, which he called ‘the detector’, induced more cell divisions on the side of the detector root that faced the inducer root than it did on the shadow side.

This led him to believe that some kind of signals (which he called ‘external impulses’) were being sent, affecting the near side much more than the opposite side. It was as if the near side was in the light and the far side was in the shade. Then he had the extraordinary idea of inserting first a glass plate and later a transparent quartz plate between the two roots. He discovered that the glass plate blocked the signals, so that no cell division (‘mitogenetic activity’) took place in the detector root. But the quartz plate did not block the signals. This unexpected and bizarre finding ruled out chemical or mechanical signals, since the signals were not blocked by quartz.

It quickly became apparent to Gurwitsch that the mystery could be solved only by postulating that the inducer roots were emitting photons in the ultra-violet range, and that those were the signals in play. As most people know, UV radiation from the Sun does not penetrate glass windows, which is why we do not get sunburn indoors even if we are sitting under a glass roof in the blazing sun. But ultra-violet radiation does penetrate quartz.

Gurwitsch called the ultra-violet signals ‘mitogenetic rays’, because they were rays causing cell division, i.e., mitosis. (As I mentioned earlier, the word ‘photon’ for light particles had only been coined in physics seven years earlier, in 1916, and it was not yet in common use, so the idea of calling his rays ‘biophotons’ did not occur to Gurwitsch. It was the German Professor Fritz-Albert Popp who introduced the term ‘biophotons’ in the 1970s to replace the terminology ‘mitogenetic rays’.)

A fascinating account of the history of Gurwitsch’s work and discoveries was published in English in 2007 by his grandson, Professor Lev Beloussov, jointly with his colleague Professor Vladimir Voeikov, entitled ‘From Mitogenetic Rays to Biophotons’.[4] In this account, they explain that Gurwitsch looked for the evidence in order to support a theory he had formed, and how he found it. Lev and I were in touch and commenced a joint effort to preserve all of Gurwitsch’s writings and place them on the internet. He was extremely enthusiastic about this. Suddenly he died of a heart attack. But his efforts are being continued by his student and protégé Ilya Volodyaev, with whom I now cooperate in this. We are making good progress in preserving the material that is in Russia.

There was tremendous enthusiasm for Gurwitsch's discoveries, and Gurwitsch was nominated for the Nobel Prize in the 1920s and on numerous occasions over the years thereafter. Between 1923 and 1939, according to Beloussov, more than seven hundred papers on the subject appeared, as well as books.[5]

Gurwitsch wrote in Russian and in German and very little of his work has ever been translated, but in the 1930s his work became accessible in Europe thanks to the appearance in German of one of his main books, written jointly with his wife and scientific collaborator Lydia Gurwitsch, *Die Mitogenetische Strahlung* (*The Mitogenetic Rays*), published in Berlin in 1932. But by 1939, the Second World War brought about such chaos that communications and academic exchanges were interrupted, especially with Germany. Gurwitsch was awarded the Stalin Prize in 1941, but after the war his work was forgotten thanks partly to the Cold War between the Soviet Union and the West.

Furthermore, from 1942 Stalin's favourite and wholly dominant pseudo-scientist Trofim Lysenko began to persecute Gurwitsch, so that Gurwitsch was not allowed to work in any laboratory and became a political pariah. Gurwitsch's ideas thus dropped out of sight. My friend Joseph Needham, whose colleague I had the honour to be for some years from the mid-1980s, presciently supported Gurwitsch's ideas in 1950,[6] but this unfortunately had no significant effect on the widespread ignoring of the subject subsequent to 1939.

Gurwitsch also discovered that the emission of the ultra-violet photons must be coordinated by the whole organism, which he attributed to its morphogenetic field, in line with his pre-existing theories. He was extraordinarily prescient in this, because the work in physics had not yet been done to explain the mechanics of how such a field might work. It was only after his death that the concept of 'coherence' (in the specialist sense of waves having the same characteristics, such as phase and frequency, within a spatial area, as distinct from its better-known usage to describe 'superposition' in quantum mechanics) emerged in physics, as a result of a paper published by Robert Dicke in America in 1954.

This coherence only became a concept in biology many years later, which then made it possible to put some flesh on the bones of Gurwitsch's field theory. It is not granted to us all to live long enough to see our theories justified, and Gurwitsch did not have this good fortune. But in trying to figure out the mechanics of the process, Gurwitsch was ahead of his time, and became the first person to suggest the existence within organisms of what we now call 'collective

states’ and ‘cooperative phenomena’, but which he called ‘states of mutual alignment and orientation of molecules’.

He suggested that this was associated with a redistribution of energy within the organism in an organized fashion at the macroscopic scale, and that chain reactions of signal propagations took place. It was the spatial organization of the whole organism that was important, and it superseded the importance of individual atoms and molecules, demonstrating to him the existence of biological fields.

All of these ideas now exist in far more sophisticated form, substantiated by a huge amount of experimental work. But ‘mainstream biology’ and ‘mainstream medicine’ show no knowledge or recognition at all of this progress. With one exception that I know of (a large grant by the Dutch Government), there are no grants or funding anywhere in the Western world for biophoton research. Scientists cannot yet live on air, and until they invent a way to do so, they must either starve or abandon their biophoton work. And biophoton work takes laboratory time, and needs assistants, and then the findings need journals willing to publish the results.

So difficult was it to find journals willing to publish biophoton findings even in the heyday of biophoton research that the small but international biophoton research community had to adopt a different strategy to achieve publication and get around the roadblocks of the unwilling journals. They held numerous international biophoton conferences, gathered up the papers of the speakers, and published them in volumes of conference Proceedings, and sometimes anthologies of papers were also published without an underlying conference as a source. The majority of the conferences were held in Germany and Russia, but the papers were published in English.

So underfunded were these endeavours that many of the papers translated into English by their non-English-speaking authors have poor grammar and spelling, and strange phraseology and usages replicating those of the native languages of the authors, because there was no money to pay for most of the volumes to be copyedited or proofread. In quoting from some of these publications, I shall therefore correct their English, and thereby clarify their meaning. I shall do this in the rest of this book, simply for the sake of clarity.

This defect of language is particularly true of one of the most interesting biophoton books of all, *Current Development of Biophysics*, published in 1996

by Hangzhou University Press in China. The book is very rare, but it contains some of the most important insights relating to biophotons ever published.[7]

It had three editors, two of whom I know. The third editor was Professor Fritz-Albert Popp, whom I was never fortunate enough to meet because of his many years of debilitating illness before his death. The others were Marco Bischof and Zhang Changlin (I give his name in the Chinese form, with the surname first). Both of them are absolutely delightful men of warmth, humour, and brilliance of mind. Marco is a great scholar of the history of these subjects, who has been tireless in writing and publishing on the subject such fundamental, incisive, and broad surveys that they shall remain classic accounts for ages to come.

Leading international biophoton researchers who contributed to that volume were Popp (one of whose most important papers appears in it); Poland's leading researcher, Professor Barbara W. Chwirot; Gurwitsch's grandson Lev Beloussov from Russia; Professor Roeland van Wijk; Professor Ke-Hsueh Li of the Chinese Academy of Sciences; and Professor Michael Lipkind of Israel, whose paper was entitled 'Application of the Theory of the Biological Field of A. Gurwitsch to the Problem of Consciousness'.

In the attached footnote, I give a list of important books on biophotons in English, many of which are extremely difficult to find, but all of which are of great importance. I have listed them chronologically by the dates of their publication.[8] A list of some important biophoton books in German that have never been translated into English is also included here.[9] (These bibliographies are to be found on this book's dedicated website.)

There are in addition numerous volumes not specifically devoted to biophotons, such as those concerning coherence in biological systems, which are nevertheless highly relevant and contain important material relating to biophotons. Some of these will be cited in the closing portion of this book, where physical 'coherence' is stressed in a wider context. And of course there is the book by van Wijk of 2014 already referred to, as well as a sequel volume by him, which appeared in 2017.[10]

It is important to tell people where to find information about this 'suppressed subject', as it took me a long time to discover and obtain all of these books, and it is not easy to do so. I therefore hope I have made it easier for others by listing them.

The biophotons themselves are only part of a much larger picture, which took shape largely as a result of studying the biophotons. It was the brilliant Russian scientist Viktor Mikhailovich Inyushin, who pushed the boundary much further in his writings about ‘bioplasma’. This term ‘bioplasma’ was coined in 1944 by the Russian scientist V.S. Grischenko (aka Grishenko). By 1967, Grischenko and Inyushin were working together on bioplasma, and they announced then that they envisaged a plasmatic state within living organisms which, in contrast to inorganic plasma, would be a cold plasma possessing a high degree of order.

This was an interesting idea, for the cold plasmas in space, such as the Kordylewski Clouds for instance, are more likely to be intensively ordered and to show ‘emergence’ and self-organization, and indeed inorganic life. One would not normally think that the human body could contain a cold plasma, which seems counterintuitive, considering how warm the body is.

But Grischenko and Inyushin worked out that this is possible. And what is more extraordinary, as we will see in a moment, they believed that this cold plasma would chiefly be found in the brain. So, to make it clear, bioplasma is the name they gave to that plasma which, they were convinced, joined with the physical body and helped it to operate, or even coordinated and guided its growth and development.

This idea was essentially the same as Aristotle’s pneuma (here). Just to remind the reader, Aristotle believed that aether existed beyond the Earth’s atmosphere and was a ‘fifth element’, and that pneuma was a somewhat inferior form of aether that actually was found inside physical bodies and helped to animate them. Grischenko and Inyushin, doubtless without realizing it, have duplicated Aristotle’s reasoning and consider plasma to exist in space, and bioplasma to exist inside our bodies (hence the ‘bio-’ prefix). And one of the manifestations of the bioplasma is the emission of the biophotons.

This was a concept where for every organism’s plasma body, biophotons would just be one manifestation. Very few Western scientists were ever allowed to meet Inyushin, since he was considered by the former Soviet Union to be their most brilliant and important expert in the field of parapsychology, with its many military applications such as ‘remote viewing’. His existence first became known to the outside world in the 1970s, and in 1977 a tantalizingly brief article by him of only five and a half pages appeared in English translation in the compendium *Future Science*, entitled ‘Bioplasma: The Fifth State of Matter?’[11]

In this, he says:

> A living organism can be described as a ‘biological field’ or ‘biofield’ … we have obtained evidence that a fifth state of matter, bioplasma, exists as a part of each organism’s biofield. Bioplasma consists of ions, free electrons, and free protons. It is highly conductive and provides opportunities for the accumulation and transfer of energy within the organism as well as among different organisms. Bioplasma appears to be concentrated in the brain and the spinal cord. At times, it may extend considerable distances from the organism, raising the possibility of telepathic and psychokinetic phenomena.

It was the latter aspects that so interested the military and security services of the Soviet Union, in connection with what they called ‘psychotronics’, and they were careful to keep Inyushin under wraps, whereas other less important scientists in this field such as Viktor Adamenko were allowed to mix with Western investigators.

Inyushin had known the Kirlians, a husband and wife team who were the inventors of Kirlian photography, as they were his neighbours when he was young. As a boy, he had sometimes assisted them in their work. He thus built up a lifetime’s background in investigating and experimenting with strange phenomena relating to living organisms of all kinds, including humans, especially psychic humans of the type of the American Ingo Swann, but only those who were within the Soviet Bloc, such as the famous Russian psychic Kulagina.

The Soviets had some truly spectacular people of this kind, who were the best recorded cases of psychokinesis, which means the ability to move physical objects around by the power of the mind alone, without touching them. It was Inyushin who provided the scientific theory to explain all of this. And that theory was a highly elaborate one that developed out of ideas of bioplasma.

Very little of Inyushin’s work has ever been translated into English, except for secret translations that have never been released by the American security agencies. I have some privately translated writings of his, the earliest of which dates from 1969 and concerns acupuncture. These translations (in very poor English) were commissioned by my friend Marco Bischof, and he kindly let me have copies. Inyushin’s work also related to biophotons, and as he wrote in his

1977 article: ‘Our experiments with light indicate that bioplasma is especially conductive for photons in the ultraviolet range.’ That is precisely what biophotons are, photons in the ultraviolet range. And he adds: ‘Our group has hypothesized that an organism’s bioplasma is an important factor in … the emission of light from an organism from causes other than high temperatures.’

Inyushin’s concept of a bioplasma body accompanying the physical body (which we might also call a ‘dense matter body’) will come back into the discussion in the next chapter. His bioplasma theory follows Gurwitsch’s suggestion that biomolecules in the organism are predominantly present in the ‘excited state’. I am again using the term ‘excited state’ in a quantum physics sense to mean that a system, or an electron, has absorbed energy and entered a state of having higher energy than normal. In Inyushin’s account the energetics of living systems are based on excitation–deexcitation dynamics. Inyushin describes bioplasma as a ‘cold’ plasma of highly structured collective excitations produced by the polarization of biological semiconductors. In other words, the energies in bioplasma bodies are dynamic grids of excitations – which interact with fields outside the body.

In 1967, at the same time that Grischenko and Inyushin were announcing their bioplasma hypothesis, the Polish biologist Włodzimierz Sedlak (1911–1993) independently came up with his own bioplasma hypothesis as well. He and Inyushin later got together and worked on the idea jointly. This was facilitated because at that time Poland was part of the Soviet Bloc so that their mutual cooperation was considered acceptable by the authorities. Inyushin himself lived in Alma Ata in Soviet Kazakhstan. Inyushin also researched biophotons.

According to the bioplasma studies of Inyushin and Sedlak, the plasma particles constituting the bioplasma in the body set up highly structured waves of excitation, that, as we have just seen, serve as an energy network. The energies stored in the network form an internal ‘biological field’. Remarkable as it may seem, this ‘biological field’ has a complex broadband wave structure of great stability that stores holograms.

In exploring the complexities of plasma in the body and its connections with consciousness and images in the brain Inyushin and Sedlak are here leaning on the work of Professor Karl H. Pribram (1919–2015) who originated the ‘holonomic brain theory’ to explain consciousness, using the idea of holographic memory.[12]

Most people today are familiar with holograms, and are aware that the making of holograms (holography) has something to do with light rays, though they may be vague about how it all works. A hologram made by this method is a 'picture' not of an actual image, but instead of a light-wave interference pattern. When the pattern is activated then the image appears in a three-dimensional mode. The internet is full of explanations of how this is done. However, what few people realize is that holograms can be made without the use of light rays.

Karl Pribram explained this at length as long ago as 1971 in his technical book *Languages of the Brain*.[13] He believed that holographic processes operated within the human brain, and were used in the storing and activation of memories in particular. Pribram said:

> Optical systems are not the only ones that can be subjected to the holographic process … Holograms are thus not dependent on the physical presence of 'waves' … This independence of holography from physical wave production is an important consideration in approaching the problem of a neural holographic process.

Clearly, it would take too long to summarize here Pribram's theory of the brain-as-a-hologram, about which many books have been written, not least by Pribram himself. But it is important to realize that enormous intelligences in the Kordylewski Clouds would probably have fantastically advanced holographic capabilities, which would be used not only to store their massive amounts of information, but also to generate images in any form, whether as wave-forms, pure data, or optical images that could be seen by the eye (if there are any eyes in the clouds). Technically, none of this poses any problem. The clouds would readily be able to extract 3-D images of the kind familiar to us and transmit them to our brains if they wished to do so. We could even make a pun and call this 'Cloud holography', and the cloud in this case, of course, is not owned by Apple.

Another Polish researcher, Adam Grzegorz Adamski, says that a lot of bioplasma is stored in melanin, which as most people know exists in the skin and protects us from ultra-violet radiation by causing us to get tan or brown. He says:

> Melanin is not only a semiconductor, but also a room temperature superconductor … Melanin accumulates in the cells of the nucleus, where the genetic material (DNA) is, in order to protect the genetic code from the

> damage from UV-rays … These properties of melanin reveal that it has large resources of bioplasma … With the semiconductor properties of proteins and melanin electrons can travel over long distances without losing energy … Bioplasma is understood as a dynamic system in an organic semiconductor … The total energy of the bioplasma consists of thermal motion, kinetic energy of particles, floating particles, the electric field, the magnetic field, and solitons.[14]

We can see how like so much else these studies draw heavily upon the early pioneering work by Albert Szent-Györgyi, who was the first person to insist that the body contained organic semiconductors, as I have already described. Just as the work of Alfvén and his followers has revealed the complex, living reality of outer space, and the interactions there of plasma and electromagnetism, so his fellow Nobel laureate Szent-Györgyi and his followers have revealed the immensely and astonishingly complex operations of electromagnetism and plasma within the human body, and outside it too.

Returning briefly to the subject of biophotons, when they are seen being emitted from acupuncture points and meridian lines, they are not a sign of cancer at all, but rather an indication of the normal heightened activity in those key regions of the body. Biophoton scans actually give clear visual images of the mysterious flowing body energy (doubtless a flowing plasma) known as qi (pronounced ‘chee’) in Chinese acupuncture. These streams inside the body, which have been detected frequently, are known as ‘light-piping’, more technically described as ‘channels of light emission’. Such channels form a meridian network. This is one of the most important areas for research, since its findings clearly validate the Chinese system of acupuncture points and meridians in the body. The light pipes and the traditional acupuncture meridians are the same.

Figure 30. Biophotons being emitted along the meridians of the backs of the legs. Image courtesy of Professor Roeland van Wijk.

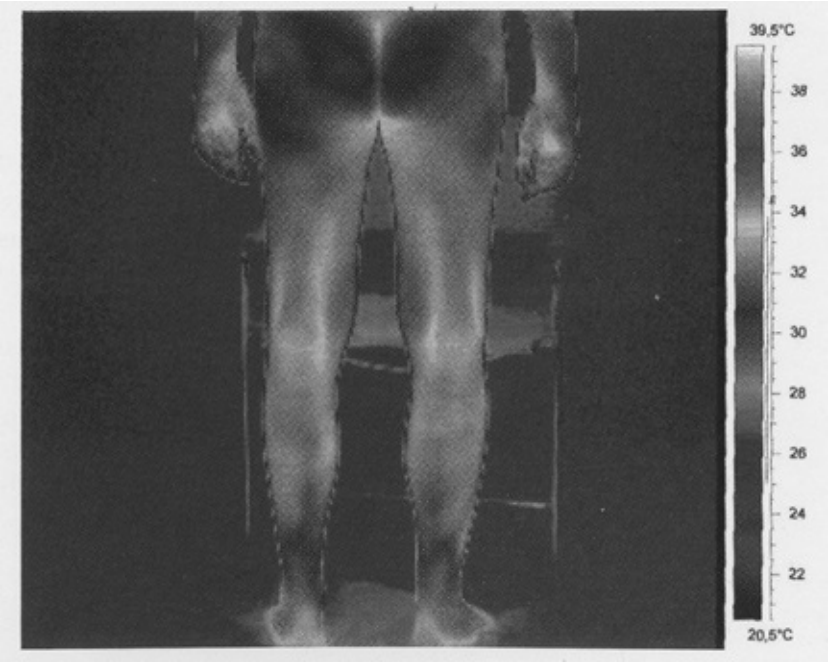


Figure 31. Biophotons along meridians of the legs seen in the standing position. Image courtesy of Professor Roeland van Wijk.

As we build up a picture of the role of plasma within human bodies and consider the idea that plasma may provide a medium for interaction with universal fields, we see again that ancient wisdom anticipated cutting edge discoveries in modern science.

16

The ‘Death Flash’ and the ‘Life Flash’

In the previous chapter we looked at the role that plasma has inside the body – forming and regulating it and maintaining health. In this chapter, we will look at it in relation to death.

It has been said that at the moment of death, a flash of light is emitted by the body. There are many reports of this. It applies to all living organisms, not only to people. The evidence concerning this flash of light is extensive, and the speculations concerning it have entered into works of fiction and film.

This is one of the most important details about the relationship between the physical body and any animating plasma body that may co-exist with it. It is what has come to be known as the death flash.

In case there are misunderstandings, I should point out that, apart from the exceptions described below, the only spontaneously emitted light from our bodies consists of biophotons, as was discussed in Chapter 15. They cannot be seen by the eye because they are what is called ultra-weak and low intensity. It only became possible to detect them at all after the laboratory devices known as photo-multipliers were invented in the 1950s.

Let us find out more about the ‘death flash’, however, because although it cannot be seen by the unaided eye either, apparently it is followed by a faint mist that is visible to the naked eye, but only for an instant, and you have to be looking intently at where it is about to happen just when it does.

The Polish biophoton researcher, the late Professor Janusz Sławinksi (1936–2016), published a summary of many of the occurrences of the ‘death flash’, technically known as ‘necrotic [from *nekros*, the ancient Greek word for a dying person or human corpse] photon emission’, with his extensive comments, in 1987.[1] In it, he says:

> All living organisms emit low-intensity light; at the time of death, that radiation is ten to 10,000 times stronger than that emitted under normal conditions. This ‘death flash’ is independent of the cause of death, and reflects in intensity and duration the rate of dying. The vision of intense light reported in near-death experiences may be related to this death flash, which may hold an immense amount of information. The electromagnetic field produced by necrotic radiation, containing energy, internal structure, and information, may permit the continuation of consciousness beyond the death of the body.

This is clearly very important information. Considering how terrified most people are of dying, you would think that this information would be more widely circulated, if only to assuage people’s anxieties. But strangely, few people have heard about it. This is puzzling to me. I think it must be because we live in a world today where intellectuals, mainstream social opinion-formers and mass media all subscribe to a rigidly materialistic view of life, and are intolerant of anyone who challenges this arid position in even the slightest way.

The first time I came across the idea of a ‘death flash’ was in a work of fiction. In his 1931 novella *The Weigher of Souls*, André Maurois adopts his own persona as the first-person narrator.[2] He says he has been a French liaison officer with the British and that the British officer with whom he shared a tent was a medic named Dr H.B. James. That is how the strange adventure begins, for the narrator comes to London after seven years of not having seen Dr James and decides to look him up.

The action is thus set in London in 1925, and the novella is consciously written in the style of an Edwardian mystery or science fiction story, heavily influenced by Conan Doyle and H.G. Wells – the reader half expects Sherlock Holmes to appear, or a time machine to be mentioned. But Maurois has a much more subtle tale to tell than at first appears. Dr James is working at ‘Saint Barnaby’s Hospital’, a very Victorian establishment on the South Bank of the Thames. London is described in the best Conan Doyle tradition as covered with fog:

> Whilst we had been dining, a thick fog had come down over the streets. The gleaming headlights of invisible cars planted it with rings of red and white light. Ludgate Circus was a landscape of nightmare. James bade me take his

> arm and guided me towards a bus … The bus crossed the river in the midst of a veritable bank of yellow cotton wool. Factory fires on that baleful shore gleamed vast and pale through the flocculent gloom … The lights of the hospital shone feebly in the enveloping cloud … My companion's nervous state seemed to be one of violent overexcitement.

James has become such a haunted and distracted person, so different from the narrator's jolly wartime friend, because he is engaged in forbidden experiments, which he carries out in the morgue of the hospital at great risk of being discovered. He has discovered that something strange happens at death and he wants to investigate it. He says he got the idea from experiments carried out by Sir William Crookes, one of Victorian Britain's most distinguished scientists, who later in life developed an interest in spiritualism (discussed earlier in Chapter 3). James explains:

> 'I once read an account, in a medical paper during the War, of an experiment made by a certain Dr Crooks [*sic* – it should be Crookes, and I see that the misspelling occurs also in the original French edition]. He described how he had weighed the corpses of animals, and had observed that, after a period approximately regular in a given species, there was an abrupt drop in weight … In a man he reckoned this fall as averaging seventeen-hundredths of a milligram. From which he concluded that the soul does exist, and that it weighs seventeen-hundredths of a milligram …
>
> 'Last year, as circumstances and hospital routine placed corpses at my disposal, it occurred to me to verify the facts registered by Crooks; and with some surprise I discovered that he had told the truth … Only, he had stopped the experiment too soon. In man the normal curve of evaporation is almost always interrupted, not once, but three times by sudden falls … The first, which you have observed to-night, takes place about one hour and thirty-five minutes after death, and is between fifteen- and nineteen-twentieths of a milligram; the second and third … follow the first at intervals of twenty minutes and one hour respectively … regarding the results of the experiment, no doubt is possible …
>
> 'Let me add that I have repeated them with animals – whence the rats which intrigued you. And there, too, Crooks's results are correct. There is always a sharp drop, but its extent is very much less than in man … Such are the facts; the interpretation, of course, admits of argument …'
>
> His pipe had gone out. He relit it and looked at me. I was careful to say nothing. He continued:

> ‘At this stage, this is what I put forward. It seems to me possible to suggest, not that the soul weighs seventeen-hundredths of a milligram, but that every living creature is animated (in your language you could almost say âme) by a certain form of energy, still unknown, which leaves the body after death. That all energy possesses mass is something admitted by the post-Einstein physicists. You know that light can be weighed, and that theoretically light could be compressed in a receptacle … Well, why not vital energy likewise?’

James decides that he wants to catch the mist that rises from a person who has just died in a glass receptacle. This is what he believes has the slight weight. And as a scientist friend of the narrator says: ‘Why shouldn’t there by “psychons” as there are electrons?”’ James wants to capture the evanescent psychic substance of a dying person, and keep it captive to study it. He makes it visible by ultra-violet light in an otherwise dark room. He succeeds in capturing the spirit of a dead rat in a glass bell jar.

The narrator sees it in the dark as a faint glow, about the size of a nut, but more elongated: ‘Going closer, I saw that the interior of this luminous kernel contained darker currents revolving extremely slowly. The whole thing reminded one of the appearance of certain photographs of celestial nebulae.’ Remember the whirling plasmoids of Bostick that we encountered earlier, which he compared to galaxies?

The story gets weirder and weirder. At last, the narrator is present at the death of a human being, and James has his glass bell jar ready. Maurois says:

> I saw a faint blue mist appearing. At first it seemed shapeless and as if diffused … (then) the vapour became condensed in a milky mass, about four inches long, the base of which was horizontal, with its rounded top following the curve of the globe. Currents of lighter and darker colour were visible in it … until they formed an object of well-defined outline … (a) ball of light.

I do not wish to spoil the enjoyment of anyone reading the novella by saying what happens as the story progresses. But it does become increasingly bizarre.

Subsequent to the appearance of this novella, and perhaps partially because of it, a legend was born that each of us has a soul that weighs 21 grams. Although

largely unknown in the English-speaking world, there were some French intellectuals who became interested in ‘the weight of the human soul’. One of these was Wilfried-René Chettéoui, who had been influenced in his thinking about the soul by studying the Siberian Shamans (about whom he published a book in 1947) and who wrote in a paper published in 1986:

> Various investigations established the weight escaping at the moment of passing to between 60 and 70 grams, The quantity of spirit is without mass, and consequently the weight of a spiritual being is almost negligible.[3]

Much better known than any experiments by Sir William Crookes were those carried out in America by Duncan MacDougall (1866–1920) in 1901. He weighed six dying human patients, five male and one female. He calculated the weight of the human soul at between six and eight ounces. He also tried to photograph the escaping human soul from dying persons. But as we now know, if one is looking for a light flash (a biophoton flash), it is too faint for the human eye or any normal camera to detect, even though it may be, as Sławinski discovered, as much as 10,000 times stronger than a biophoton is normally. But even that remains ‘ultra-weak’, as all biophoton emissions are.

One presumes that the faintly visible mist follows the ultra-weak ‘death flash’, and escapes the body by floating upwards. The ‘death flash’ presumably heralds the commencement of the process of death, and the ‘mist’ completes it. By 1907, MacDougall had refined his estimate of the weight of the soul to 21 grams (about ¾ of an ounce),[4] which is where that value originated. This was the source of the title of a 2003 film starring Sean Penn, *21 Grams*, which popularized the notion that the human soul has a tiny mass.

I might mention in passing also that the ancient Egyptians depicted the weighing of the human soul in a balance against a feather (representing Truth), and they maintained that if the soul were heavier than that feather it would be annihilated. Presumably at 21 grams it would just squeak through.

Inevitably most descriptions of a faint mist leaving the body of a dying person come from relatives or friends who have been sitting near a dying person, often in hospital. Here is a typical example of such a story, recounted by a woman who lay in one bed of a double bed room in a hospital, of what she saw happen to the

older woman in the other bed about midnight; she related this to her daughter the next day, who wrote it down:

> Late one night shortly after twelve o'clock, my mother lay awake. Suddenly, she told me, she felt her attention drawn to Mrs Melberger's bed. As she watched, she saw a white mist arise from her head. It hovered for a few seconds, then slowly began spiralling and floated away from the woman and out through the closed door of the room.

The woman then fell asleep and when she woke up in the morning the bed opposite her was empty, and the nurse told her that Mrs Melberger had died a little after midnight.[5]

Obviously it is impossible to carry out laboratory experiments on dying people in order to look for mists, so it is difficult to imagine how this phenomenon can ever be 'scientifically proved', no matter how many accounts exist. It is easy to debunk such accounts if one has fixed ideas that no such thing can happen. It is equally easy to believe everything if one has fixed ideas that anything of that kind is possible.

I have no personal experience of this. I only sat beside a dying person once, the author Rosamond Lehmann, but I summoned a doctor and left before she actually departed a short while later. (Ironically, she had a passionate belief in the survival of death and was a member of the Society for Psychical Research.) It is because people essentially believe what they like when evidence is subjective that I have excluded my own subjective information from this book.

In addition to the visual observations of a faint mist leaving the body at death, there have been other strange observations under more controlled conditions. In 1970, Ostrander and Schroeder, who interviewed many Soviet scientists, stated that some of the scientists had taken many photos of dying animals and plants using Kirlian photography and other techniques. One of the scientists involved in these studies was Professor Viktor Mikhailovich Inyushin, who as we have seen, knew the Kirlians when he was a child, and who originated the concept of *bioplasma*.

Here is what Ostrander and Schroeder said:

> [I]n the course of their extensive research with the Kirlian process, the Soviets have many times photographed the moment of death. Little by little as a plant's or animal's physical body dies, Russians saw sparks and flares of the bioplasmic body shooting out into space, swimming away and disappearing from sight. Gradually there was no luminescence at all coming from the dead plant or animal. Meanwhile, biological field detectors at a distance continued to detect pulsating force fields from the now dead body. Is this energy coming from the dispersing bioplasmic body?[6]

Although this account refers only to studies of the deaths of animals and plants, I have found an account of studies of humans in a rare book published in English in Russia shortly after the fall of the Soviet Union by Dr Konstantin G. Korotkov, then a young scientist who had only recently completed his PhD.[7] He describes his studies with colleagues using something called the 'gas discharge visualisation (GDV) technique' to study energies in living beings. The technique involves placing fingers on glass electrodes that are then supplied with a high voltage and high frequency pulse. The electric discharge around the finger produces light that is digitally photographed and sent to a computer, where special software does quantitative analysis of the numerous parameters.

Korotkov tells us in his book (I have had to make a few grammatical improvements because the English was flawed):

> Does the life of the soul end with death? What should we expect beyond the threshold of this world? These problems, which have always beset mankind, are again making their appearance on the European intellectual horizon. Religions and esoteric knowledge have always taught that death is much more than merely a transformation of living material into dead material. Now that recollections of people who have experienced clinical death [NDEs, or near-death experiences are here referred to] are becoming accepted as real, the question of survival of some vital elements is entering the realms of science.
>
> Many of the physicochemical processes occurring at the time of death are known. These changes proceed in linear fashion with the gradual process of destruction and decomposition. The Gas Discharge Visualisation technique, however, goes beyond the classical biochemical approach, to reveal some aspects of energy and information in the living body. This being so, it became of great interest to find out how this changes after death. In this

way we might gain information of how the transition from the dying state to death takes place. The experiment was organized as follows:

A special group of doctors and assistants took part in every experiment. The selected [human] body was transported to the experimental room and was placed in a definite position. The left hand was installed in a definite position on an electrode and was fixed by a special device that ensured a stationary position of the hand and the fingers during the experimental session. The discharge Kirlian photos of four fingers (excluding the thumb) of the left hand were taken every hour during the day and during the night.

Then the photos were processed in controlled conditions, scanned to the computer and from each image a set of parameters (area, average intensity, fractality, etc.) was calculated. Then graphs of these parameters plotted against time were created. As a result of this process we got for every experiment the [graph] curves of glow intensity changes in time during 3 to 6 days and were able to compare these curves.

The results were numerous, and are presented in the book in technical form with graphs. More than sixty scientific papers were also published in Russian over many years reporting these results. Here are the conclusions as briefly expressed in the book:

On the basis of these results we conclude that the energy-information activity of a person does not go to zero at clinical death. In some cases it continues to be present even as much as four days after death – a time when all biochemical processes characteristic of life will have ceased and been replaced with autolytic and putrefactive processes. It was particularly significant that the course of decline depended on the cause and nature of death. In some years these experiments had been reproduced both in our laboratory [at the Federal Technical University of St Petersburg], and in some others. The results were in principle the same …

It seems, then, that traditional spiritual teachings are right in their insistence that something of a person survives after death. These results raise not only biological and practical questions, but also philosophical ones. Our common-sense materialistic view of life and death need some correction.

Since so many people who have had near-death experiences report that they ‘floated upwards to the ceiling’ as soon as they left their physical bodies, and

looked down upon them from above, that would seem to tally with the rising mist escaping from the body. On the other hand, I have friends who came back to life after floating up to the ceiling, so does the mist get sucked back downwards again? Clearly, we are in speculative territory here.

Sławinski published a very technical article about the death flash, complete with twenty-eight equations and nine diagrams, in 2003 in the large volume of papers entitled *Integrative Biophysics: Biophotonics*.[8] In this important paper, he puts forward in great detail a model that:

> accounts at least partially for the experimentally determined properties of a stationary and necrotic [death] photon emission from an intact and irreversibly perturbed (dying) organism, respectively … (but) where do biophotons come from and where do photons of the necrotic radiation go to? … Is there any Kingdom of Light, beyond the stars, planets, plants and animals? … These questions challenge us to enrich our understanding of biophotons and the mystery of life and death …
>
> Light has been always intrinsically related to the creative power that gives birth to life. Indeed, the cell division, fertilization of an egg and the death of the cell are accompanied by PE [photon emission]. Light is considered as the unitary purposive principle which engenders the Universe [he does not say by whom, but he is presumably referring to some religious traditions and possibly the views of some scientists, especially in light of what he says next about photosynthesis] and that has the nature of first cause. It is an ultimate source of energy on Earth and a driving force of photosynthesis and other photobiological processes …
>
> Recent findings suggest that biophotons convey hidden information coded in the spatiotemporal parameters of the electromagnetic field, such as a degree of coherence … Therefore biophoton emission might deliver important information about the onset and the end of life processes … If necrotic PE [photon emission] appears to be a universal phenomenon … announcing the end of biological life, then its measurements could be a new criterion of biological death.

This is an interesting suggestion, that clinical death could be measured by this new means. It might avoid mistakes such as people being declared dead on the basis of their breathing having stopped, or their hearts having stopped beating, and then nevertheless they suddenly return to life, occasionally after having been

taken to the morgue as a corpse. Sometimes people can ‘come back to life’ after an astonishing length of time. The novelist Franz Werfel was declared clinically dead in 1943, but then came back to life forty-five minutes later, and recounted an amazingly detailed near-death experience that occurred to him during that time.[9] (He died a second time, staying dead, in 1945.) Perhaps biophoton measurements would provide a new and foolproof method of determining genuine death.

Many people reading about this will be unaware of the astonishing progress made in recent years in understanding aspects of light never previously suspected. Much of this research has been funded by governments and corporations rushing to perfect quantum computing, and some of it can help us understand how the processes involved in the death flash might work.

To take one example, a team of scientists at Stanford University in California as long ago as 2005 (which in this field seems like the age of the dinosaurs) published a paper entitled ‘Generation and Manipulation of Nonclassical Light Using Photonic Crystals’.[10] They are talking about cavities inside minute crystals capable of storing photons. At the head of this paper they inform us: ‘Photonic crystal cavities can localize light into nanoscale volumes (somewhere between a molecule and a virus) with high quality factors. This permits a strong interaction between light and matter …’ This field is now referred to as nano-photonics because, obviously, it takes place at the nano scale and is hence a branch of nano-technology. These areas of science are certainly underreported.

When considering a burst of light as weak as that of the ‘death flash’, we need to keep in mind that light can be stored, inside one of these photonic crystals, also called a ‘light crystal’. These crystals exist at the upper end of the nano-scale, meaning they are about the size of viruses. In laboratories, light crystals have been fabricated in one, two, and three dimensions. One of the reasons why so much work has been done on this is because people wish to use them to construct ‘optical computers’, by which is meant computers that employ photons for the purposes of computation.

Turning back to our main concerns, at the nano scale all organisms apparently contain countless ‘light cavities’, or nano-voids. If we have earlier been puzzling therefore about where the light would have come from that is released in the ‘death flash’, we have plenty of potential ‘light cavities’ throughout the body to choose from. Maybe the pineal gland contains one or more, for instance, as it is

known to have some unexplained light-sensitivity aspects. The main point is that light storage happens all the time, so the release of a burst of light poses no real logistical difficulty. In other words, the storage of such a body of light would be entirely normal when the organism was alive, and its release at death could be automatic. I am speaking only in general terms, as not enough is known yet to be more specific.

We don't necessarily need to know where a death flash comes from. The Polish scientist Barbara Chwirot published a paper in 1998 with the pertinent title 'Do We Always Need to Know Molecular Origin of Light Emitted by Living Systems?'[11] In this paper she says:

> … it is now commonly accepted that both the intensity and the spectrum of the ultraweak luminescence depend strongly on the physiological state of the living systems, on their state of development and on the actions of the external factors, especially those that can be considered the stress factors.

And of course, the ultimate stress factor is death.

Reports of mist arising from a dying person have been reported frequently over the years, and the subject has been mentioned in various scattered publications. But a good place to turn to for some collected evidence is the book *Glimpses of Eternity* by Raymond Moody.[12] In describing the strange mist that appears over the deathbed, Moody says:

> They describe it in various ways. Some say that it looks like smoke, while others say it is as subtle as steam. Sometimes it seems to have a human shape. Whatever the case, it usually drifts upward and always disappears fairly quickly.

Moody's book is full of accounts of deathbed experiences and things that people have seen when their loved ones were dying. One man named Tom described watching the death of his mother: 'I saw this film or transparent envelope of light close up and lift off her body going upwards and out of sight.'[13] Moody quotes a medical doctor who told him:

> I have seen mist coming up from deceased patients twice in a six-month period … The mist had depth and complex structure. It seemed to have

> layers with energetic motion in it, which is a poor description, I know, but just think of something as subtle as water moving within water.[14]

A hospice psychologist told him:

> I saw patients leave their bodies in a cloud form. I saw them rise out of their bodies and head toward these structures. I would describe these clouds as a sort of mist that forms around the head or chest. There seems to be some kind of electricity in it, like an electrical disturbance.[15]

In a 1975 book entitled *Beyond Life's Curtain*, Dr Bernard Laubscher repeats descriptions given by carers sitting beside dying persons in care homes:

> While watching at the bedside of the dying one with one or two candles burning, they had seen the formation of a faint vaporous body, an elongated whitish purplish-like cloud; parallel with the dying person and about two feet above the body. Gradually, this cloudlike appearance became denser and took on the form, first vaguely and then more definitely, of the person in the bed. This process continued until the phantom suspended above the body was an absolute replica of the person, especially the face. They noticed that there was a light all around the outline, which I could only compare to a neon tube.[16]

The neuropsychiatrist Dr Peter Fenwick and his wife Elizabeth Fenwick in their 2008 book *The Art of Dying* speak of the 'smoke', 'grey mist', or 'white mist' that leaves the body at death. An informant named Penny Bicliffe told them about what she witnessed when her sister died:

> I saw a fast-moving 'Will o' the Wisp' appear to leave her body by the side of her mouth on the right. The shock and beauty of it made me gasp. It appeared like a fluid or a gaseous diamond, pristine, sparkly, and pure, akin to the view from above of an eddy in the clearest pool you can imagine … It moved rapidly upwards and was gone.[17]

Another woman described the death of her husband:

> I turned my head to see if Keith was awake, and as I looked I saw a shimmery haze (similar to what you might see above a road on a hot

summer day) hover above Keith's sleeping head, and then it gradually rose up to the ceiling and vanished.[18]

A physician named Dr R.B. Hout was present at the death of his aunt and witnessed the following:

> My attention was called to something immediately above the physical body, suspended in the atmosphere about two feet above the bed. At first I could distinguish nothing more than a vague outline of a hazy, fog-like substance. There seemed to be only a mist suspended, motionless. But, as I looked, very gradually there grew into my sight a denser, more solid, condensation of this inexplicable vapour. Then I was astonished to see definite outlines presenting themselves, and soon I saw this fog-like substance was assuming a human form. The features of the face were very similar to the physical face, except that a glow of peace and vigor was expressed instead of age and pain.
>
> The eyes were closed as though in tranquil sleep, and a luminosity appeared to radiate from the spirit body. There was a silver-like substance streaming from the head of the physical body to the head of the spirit body, The colour was a translucent luminous silver radiance. The cord seemed alive with vibrant energy. I could see the pulsations of light stream along the course of it, from the direction of the physical body to the spirit 'double'. With each pulsation the spirit body became more alive and denser, whereas the physical body became quieter and more nearly lifeless.

Hout said that when the pulsations stopped, various strands of the cord snapped. When the last connecting strand snapped, 'the body rose to a vertical position, the eyes opened, and a smile broke from the face before it vanished from my sight.'[19]

A report published on the day of my birth, 25 January 1945, quoted an American soldier back from the Second World War as saying:

> 'I have seen ectoplasm on the battlefield. I have watched it emanate from a badly wounded soldier and then disappear as that soldier breathed his last.' One hillbilly comrade from Kentucky called it 'soul mist', revealing that many natives in his part of the country considered it quite a normal thing, although they seldom talked about it … he went on to tell how, after being

wounded by shrapnel, another soldier lay badly wounded about ten feet from him.

'I looked at him with pity, forgetting my own pain. Then in the deepening twilight I saw a strange smoke begin to curl above him as though coming from his stomach as he lay on his back moaning … Then I remembered what my friend had said about soul mist, and I watched fascinated as the ectoplasm became denser and began to flow towards me. For a moment I thought I saw in it the face of a kindly old lady. Presently it reached me and for a second I was bewildered by a strange sensation that came over me. I felt stronger. With my left arm I raised myself and began to crawl to the dying soldier. I reached for my canteen of water. The mist was still around me, and with a sudden effort I was on my feet, and beside the soldier …

'To my dying day, I shall believe the ectoplasm from the body of that dying soldier had helped me in a mysterious way. It had given me sufficient strength to save my life.'[20]

And there is not only a 'death flash', there is also a 'death signal' before that. This bizarre finding has so far only been verified at a very small scale, but it is believed to occur in the body as a whole. One of the earlier articles reporting this phenomenon known as 'programmed cell death' (PCD) was written by Michael Otmar Hengartner when he was working at Cold Spring Harbour Laboratory in New York.[21] He is now President of the University of Zurich. He reported that the deaths of cells ('cell deaths') seem to occur as a result of what he called a 'suicide program'. Further study of this strange phenomenon has been primarily done at Stanford University by Professor James E. Ferrell, Junior, and Xianrui Cheng, who is a post-doc colleague of the older Ferrell, who works at the Stanford Cancer Research Laboratory in the School of Medicine.

Ferrell and Cheng's discoveries were first announced in a press release by Hanae Armitage of Stanford, on 9 August 2018, followed the next day by the publication of a key paper by Ferrell and Cheng in *Science* magazine.[22] The press release commences by describing their discoveries like this:

In a cell, death is akin to falling dominoes: One death-inducing molecule activates another, and so on, until the entire cell is shut down, a new Stanford study finds. Inside a cell, death often occurs like the wave at a baseball game. What starts with two hands flung skyward prompts another,

> and another, until the wave has rippled far and wide across the whole stadium. This kind of a rolling surge, spurred by the activity of one or a few things, is known as a trigger wave.
>
> A new study out of the Stanford University School of Medicine has found that this phenomenon guides one of the most well-known and widespread forms of cell death: apoptosis. It's not the first time trigger waves have been identified in the microcosms of life. The cell cycle, a cornerstone of cell biology in which cells divide to make new cells, regulates production via trigger waves, too. So do neuronal action potentials, which allow neurons to pass signals via electrical impulse. And it likely doesn't end there.

One really has to congratulate Hanae Armitage, who can a write a press release worthy of a science journal in its own right.

The technical word for cell death, as we have just seen, is apoptosis. Cheng and Ferrell put a lot of effort into researching whether 'the propagation of apoptotic signals' (signals that say 'Die! Die! Die!' to cells) could possibly be chemical diffusion. But they were able to demonstrate that this was all happening by trigger waves, which act in a very peculiar way indeed. If the signals had been by chemical diffusion, they would have slowed down with increasing distance. But the trigger waves did not slow down no matter how far they travelled. In fact, they progressed relentlessly at a constant speed.

They do this by 'positive feedback' in the signal transduction (transmission of signals to cells), which allows 'signals to propagate quickly over large distances without diminishing in strength or speed. We suspect there may be other examples of trigger waves in intra- and intercellular communication.' The steady speeds of the death waves studied by Cheng and Ferrell were 30 micrometres per minute. Because the waves resemble the flows of calcium ions (which had been studied to such an extent by Peter Mitchell, who was mentioned earlier), which are ionic charged currents, we can regard them as genuine plasma flows.

In other words, death appears to take place by plasma signals, which are able to traverse cells without losing any strength or slowing down.

The body is riddled with bio-currents such as 'proton pathways', 'electron pathways', and 'ion pathways' sending signals every which way. I had intended to write a chapter about this, with emphasis on the work of Peter Mitchell, but decided it was not necessary for this book, which contains enough information

as it is. One amusing little titbit that I cannot resist mentioning, however, is what R.J.P. Williams said in *Nature* in 1995 about protons moving along proton pathways inside the body: ‘Protons move in very short hops (smaller than one angstrom unit) [one tenth of a nanometre] and require rotational movements of many donor and acceptor groups to make the process continuous.’[23]

I thought the idea of hopping protons was so funny, readers might like to have a good laugh at the thought. However, the death signals travelling at constant speed are evidently not transmitted by hopping protons, but by speedier and more reliable means.

Death signals by photons had previously been detected by the Russian scientist Vlail Petrovich Kaznacheev (aka Kaznacheyev) in a series of more than five thousand experiments carried out at his Institute of Clinical and Experimental Medicine in Novosibirsk in Siberia. In 1976, an English translation of one of his papers appeared discussing the apparent ‘paranormal transmission of death’ between cells.[24] It included this diagram of the process:

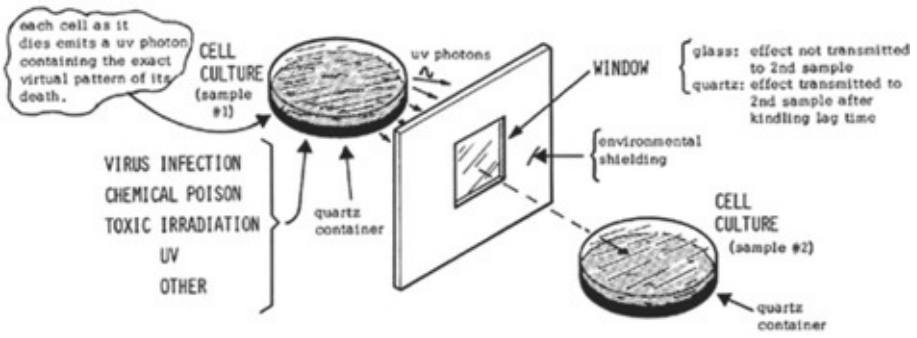


Figure 32. V.P. Kaznacheev’s diagram of the process of ‘death transmission’ between cells, published in 1976 in English. The two dishes contain portions of the same cell culture placed in two separate quartz containers, and the experiment was done in darkness. As each cell in the cell culture at left dies, he says ‘it emits an ultraviolet (UV) photon containing the exact virtual pattern of its death’. A shield with a window is set up between the two dishes of cell cultures. The UV rays pass through the window when it is made of quartz, but not when it is made of glass.

This was exactly what Alexander Gurwitsch had discovered about UV rays in the 1920s, which he called ‘mitogenetic rays’, and which are now called biophotons. Kaznacheev was thus partially replicating Gurwitsch’s original experiment, which we saw earlier, concerning the ultraviolet signals passing

between onion roots. These were similarly blocked by glass but permitted by quartz. What Kaznacheev discovered by his experiment was that if the cells in the dish on the left were killed by virus infection, chemical poison, toxic radiation, or some other means, death as if by the same means was paranormally transmitted to the cells in the right-hand dish, as long as the UV rays could pass through the window. He found out later that these death messages also can be transmitted in daylight but much more weakly.

It is not only death that has flashes and signals, it is conception as well. When a human egg is fertilized by a sperm, a light flash is seen. This has been filmed, and many people will have seen the various films of this on YouTube.[25] Although the conception flash is 'ultra-weak' in the same way that biophoton emissions are, these flashes too are caused by a wave of calcium ions going through the cell. And calcium ion flow is a form of plasma, just as we have seen in the death waves. It seems that 20 per cent of the egg's zinc is jettisoned upon successful fertilization. Anyone who is interested in this subject should watch the very dramatic moving films of the flashes. Death flashes may not have been filmed yet, but Conception Flashes most definitely have been.

What does all of this mean? We have flashes and signals to do with when physical life begins and when physical life ends. It appears that these are points when our plasma selves activate and deactivate our physical bodies. But what remains constant must be our bioplasma selves. Bioplasma bodies do not 'wear out' through physical wear and tear, it is the physical bodies that do that. Whether bioplasma bodies have other, and non-physical, ways of undergoing any kind of disintegration we do not know, but as it could not be physical, it is likely that it would take the form of an impairment or degrading rather than a total catastrophic collapse.

In recent times the development of new technology has given us vantage points from which to see ourselves and our own intelligence in a new light.

AI (Artificial Intelligence) tends to see intelligence in terms of the transmission and processing of information. When it comes to understanding and defining human intelligence, this perspective leads naturally to a focus on the flow of information rather than in the traditional way, which focused on the flow of chemical and biological processes. This school of thought is sometimes called Information Theory, and we will see what great insights it inspires in the next and final chapter.

Traditional digital computers work by considering simple either/or options and sometimes in the case of very powerful digital computers, an immense accumulation of them – the bigger the accumulation the more powerful the computer. The quantum computers currently in development, on the other hand, work on a wholly different level, because they are able to consider many more options than a simple either/or at any one time, and make multiple calculations simultaneously. And in this they are, of course, very like the human mind. We are able to consider many options at once, which is perhaps why we have free will – in a way that digital computers do not.

Crucial to the development of how these quantum computers work is the way they use plasma – another instance of plasma acting as a gateway for effects to emerge into the macro world.

Are we now able, from the vantage point created by the development of machine intelligence and quantum computers to look at our own evolution and particularly the evolution of our intelligence, in the light of plasma?

In the next chapter, we will expand our understanding of how universal fields not only influence our consciousness, but also help create it. We will also address the issue of consciousness in the Universe as a whole.

17

Our Plasma Selves

Fields contribute not only energy but information too, information that may play a vital role in triggering intelligence both in humans and in plasmas in space.

We now come to what interests everybody the most, ourselves. Is it possible that we are really much more than we think we are? So much more, in fact, that we transcend our physical bodies even while we are ‘alive’, and after we ‘die’, we are still very much around, just invisible and somewhat out of touch? There is every reason to think so. I have already made plain how rare physical, or atomic, matter is in our plasma universe. So if we have plasma bodies, it is only to be expected. After all, why should we not have plasma bodies? Most things are made of plasma, so why not us? And in this chapter I will advance this argument by describing some more details of what our plasma bodies may be like.

A very interesting angle is provided by information theory and a parallel school of thought called bioinformation. Information theory was first articulated in 1948, with elaborate mathematical precision, by Claude Elwood Shannon (1916–2001).

Building on the work of nineteenth-century logician George Boole (1815–1864), who realized that logic could be used not only as a closed system, but to solve problems in the real world, and working in parallel with another maths genius, Alan Turing (1912–1954), Shannon realized that intelligent machines could be built out of simple logic junctions with binary yes/no answers. Crucially, he saw how these machines might be used as more than just calculators, but as entities that might act in the real world. We can think of this on the model of a thermostat. If information is fed into it that the temperature of water, for example, has reached a certain level, then the thermostat will ‘act’ by switching heat on or off.

This sort of logic junction can in principle be replicated an infinite number of times, primed with different algorithms according to what its engineer wants to achieve. Increasing the information storage and processing capacity of these machines gave rise to the invention of CDs and mobile phones as well as the Voyager space missions, the development of the internet and of Artificial Intelligence.

But more important for our purposes here is that putting information theory into practice by building intelligent machines helped us to reassess what counts as intelligence. We began to see our own intelligence in a new light, less as a series of chemical reactions and more the processing and communication of information. It also became possible to recognize the operation of intelligence in other areas of the Universe, in plants for instance.

In biology, processes such as growth can be seen as occurring when information encoded in the double helix in the form of DNA is communicated at conception.

Theroots of ‘bioinformation’ go back to 1915, when a Russian scientist named Alexander Leonidovich Chizhevsky (aka Chizhevskii, and also aka Tchijevsky, 1897–1964), aged only eighteen, began a systematic study of the relationship between biological phenomena and large-scale cosmic events. By the age of twenty, he was already lecturing at Moscow University as well as at the Moscow Archaeological Institute. From 1922, however, he concentrated entirely on his biophysics work, and by 1940 he had established by experiments that various cosmic and magnetic phenomena had distinct effects on organisms.

Separately, in 1935, a group of Japanese scientists led by M. Takada showed that the rate of human blood clotting was related to solar activity. This was confirmed by later scientists. All such early work relating to electrical and magnetic influences upon the human body had a big effect on another young Russian scientist named Aleksandr Samuilovich Presman (1909–1985), who devoted most of his life and career to following up on it.

In the course of the book we have looked at hints that fields such as the electromagnetic that pervade the Universe might interact with plasma to create the conditions necessary for intelligence to evolve. There interactions are not simply a matter of energy, but the communication of information, too. This was Presman’s whole study.

After many years of work, study and experimentation, in 1968 Presman

published a book so stupendous in its summary of experimental findings by himself, his colleagues, and his predecessors, that it can be described as a classic, a milestone, and a fundamental work of reference. His book was published by the Nauka [‘Science’] Press of Moscow, and was instantly spotted in the West, so that an English translation was published in 1970 with the title *Electromagnetic Fields and Life*.[1]

A huge amount of meticulous translation and editing went into this translated book, the English of which is flawless (as I mentioned earlier, this is a very unusual feature for translated Russian scientific works). The publication was made possible by special permission of the USSR authorities. Presman was by this time at the Department of Biophysics in the Faculty of Biology of Moscow University and may also well have had special funding from America, which is not specified. The book is 336 pages long and filled with a bewildering, indeed an overwhelming, amount of detailed information. But it is the last 139 pages of the book that were to have such a powerful impact on what matters most to us, for it was in that section that Presman elaborated this concept of bioinformation within the body in such a vivid manner; it became evident that on that evidence alone, there must be such a thing as bioplasma and hence that there must be plasma bodies also.

Presman said that every human body in the upright position was essentially an ellipsoid – a sort of elongated sphere – for purposes of analysis of currents and fields. Here are his drawings showing what he meant:

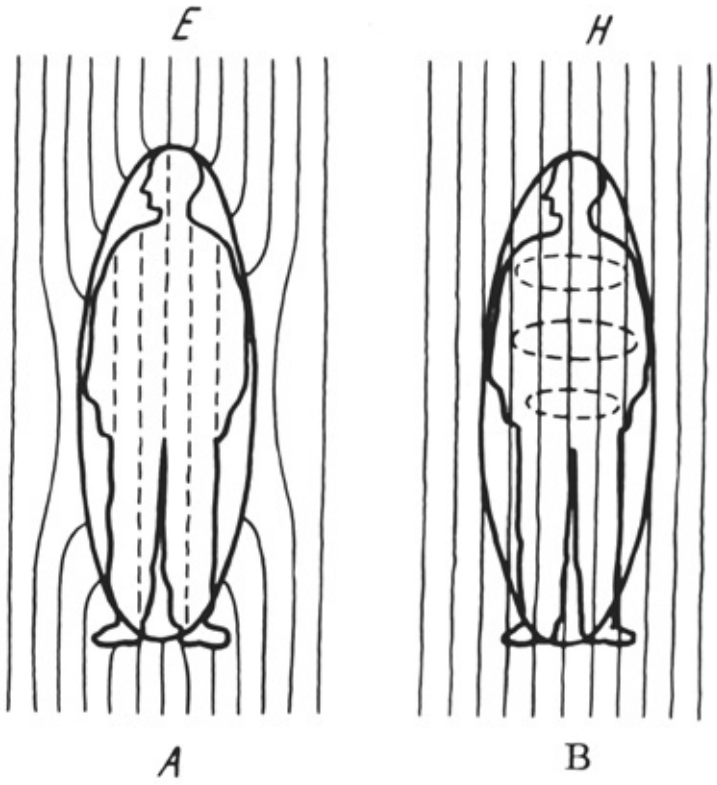


Figure 33. The standing human body is largely composed of electrically conductive water, and acts as an organic antenna, receiving waves and currents from outside and communicating them to the body's interior. It appears standing and therefore as an ellipse for the purposes of Presman's whole-body analyses and studies.

At left the man is standing in a uniform electric field and the dotted lines show the direction of the induced current within the body, which is vertical and hence parallel with the electric field lines. At right, the man is standing in a uniform magnetic field and the dotted lines show the induced current circling within his body is at right angles to the magnetic field lines. (Figure 16 from Presman's book *Electromagnetic Fields and Life*, p. 50.) As we have already seen, electric fields and magnetic fields are always at right angles to one another. For instance, if a current is flowing along a wire, a magnetic field will be created in a circle surrounding it, in other words it expands at right angles to the current.

Presman says: 'The human body is … a homogenous (in electrical properties) conducting ellipsoid.' And the major axis of the ellipse is the height of the person. (Naturally, there are countless smaller minor currents and fields within

the human body, and this portrays the body only when treated as a whole and surrounded by an external field.)

Shortly I am going to skim through the first portion of Presman's book and give extracts of Presman's comments, stripped of their data and diagrams and equations, so that you can enjoy some vivid glimpses of what he and his colleagues and predecessors had already discovered as early as 1968. Some of what you will read will possibly also horrify you. So, as they say sometimes prior to television broadcasts: sensitive persons might wish to look away now. EmF stands for 'electromagnetic field'.

In the Introduction to his book, Presman calls attention to what his studies have forced upon him in order to make sense of his findings:

> This has given rise to the need for a fundamentally new theoretical approach to the problem of the biological activity of EmFs – a theory which will not only be consistent with the experimental data but will provide a basis for their interpretation and an elucidation of the particular mechanisms involved.
>
> The application of this theory to biology has shown that, in addition to energetic interactions, informational interactions play a significant (if not the main) role in biological processes. Such interactions entail the conversion of information, its transmission, coding, and storage. The biological effects due to these interactions do not depend on the amount of energy introduced into the particular system, but on the amount of information introduced into it. The information-carrying signal merely causes the redistribution of the energy of the system itself and regulates the processes occurring in it. If the sensitivity of the receiving systems is sufficiently high, very little energy is required for information transfer …
>
> It is a valid assumption that all these special features of the reactions of living organisms to EmFs are associated with certain biological systems formed in the process of evolution for the reception of information from the environment. This hypothesis has already received experimental verification.[2]

Information is concerned with tiny bits of information as much as vast amounts. For example, every electron that arrives as a signal is thus a new piece of information, a piece of information not previously possessed.

Presman extended what he stated above, and said that information took precedence also in ‘the regulation of physiological processes’ within the body, and was crucial for ‘informational connections between organisms’, by which he means not just signalling between animals but crucially communications between people, whether direct or by distant means.

At this point, we should stop and think again about what is meant here by ‘information’. The word is not being used in the traditional sense of ‘a collection of facts’. Its use is the more modern and specialized one, prompted by information theory and relevant to what we now call IT (information technology). And that means that ‘information’ is being used not solely in the sense of passive information, which is only of use to conscious beings who receive it and make of it what they will, but in the sense of active information, which, when received, triggers an action of some kind, as in the example we saw earlier of the thermostat.

When conceived of in this way, ‘information’ is another word for ‘a signal’, or taking it further, as ‘an activator’, like pulling a switch. All hormones in the bloodstream convey information of this kind, as do our nerves when they sense that the fire is hot and trigger a response of our withdrawing our hands from the hot stove.

Here then are some of the findings of Presman extracted from his lengthy accounts, starting with some important information on the environment in which we live:

> In the earth’s atmosphere there is an electric field (Ee) in a direction normal to [at right angles to] the Earth’s surface so that this surface is negatively charged and the upper atmosphere is positively charged. The strength of this field depends on the geographical latitude …

Presman realized that he had to try and figure out more about how the body plasma worked and how it received and transmitted information. He made maps of the distribution of surface electrical potential over the body to help him understand what was going on. Here are his maps of the bodies of a lizard and a man:

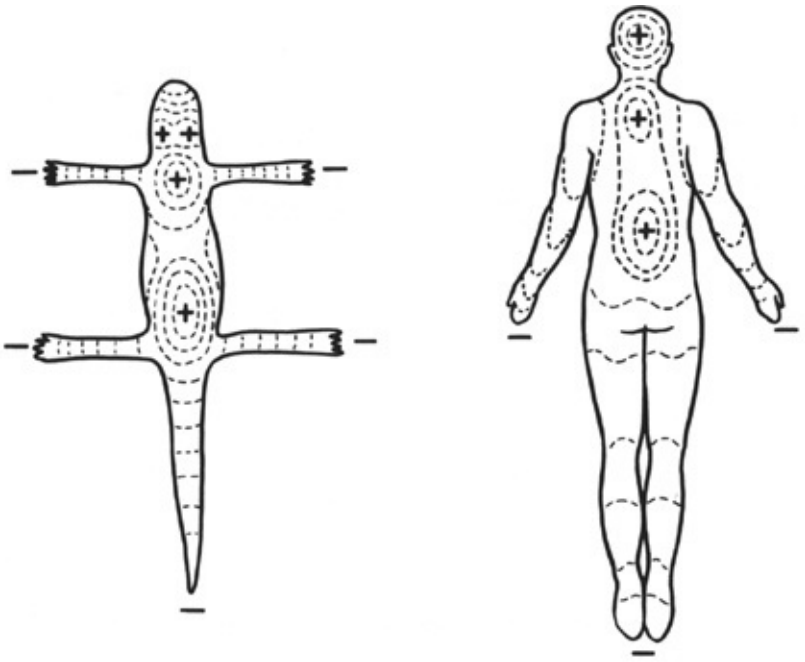


Figure 34. Presman's maps of the distribution of surface electric charge as it occurs on the body of a lizard and the body of a man. (From *Electromagnetic Fields and Life*, p. 237, fig. 93.) Key points for the man are the brain and the spinal cord.

Presman's investigations led him to conclude that DNA molecules are generators of radio-frequency signals and that RNA molecules (one of the four believed to be essential for all forms of life, with a role in coding and decoding genes) are amplifiers of those signals, whereas enzymes and amino acids are effectors of those coded signals. The cell wall he regarded as a noise filter. He believed that at a fundamental level protein synthesis resulted from 'interactions within the organism and its interactions with environmental EmFs'. In other words, electromagnetic fields carry information that activates molecules containing information, which in turn generate signals carrying information, which then trigger life processes within the body.

I cannot emphasize enough that Presman's reconceptualization of biology as orchestrated information flows could not be further from the purely chemical viewpoint. I am aware of how passionately and virulently many biologists hold to their exclusively chemical preconceptions. Through my years of friendship with Peter Mitchell, I heard from him so many times accounts of his twenty-year struggle to overthrow what he called 'the bag of enzymes school of thought' in

biology. Before Peter revolutionized the science, following in the footsteps of Presman, biologists believed that the use of energy in the body was purely chemical. Cells were these ‘bags of enzymes’ that interacted purely by chemical diffusion.

Peter was able to prove that current flows across membranes were what mattered, and that energy usage had structure and direction – in other words, it transmitted triggering information. And since, as I mentioned earlier, Peter believed that measurements of ‘energy’ are really records of transactions, his revolution that won him the Nobel Prize was in its underlying premises surprisingly similar to Presman’s, though I do not think he had come across Presman’s work.

For both Peter and Presman, transactions are essentially information exchange. They viewed bodily signals as the transmission of information. And what Presman concluded was going on was information transmission and reception both within and without every organism by electro-magnetic means.

This brings us closer and closer to the true nature of our plasma selves. In working out the details of this, Presman drew upon the ideas of the Austrian biologist Paul Alfred Weiss (1898–1989), who in turn had drawn heavily upon the ideas of my old friend Joseph Needham (1900–1993) with whom I collaborated on my book *The Genius of China*,[3] and with whom I travelled to China in 1986, the only Western collaborator of his ever to do so.

Weiss was famous for his lengthy book *Principles of Development.*[4] Because of Weiss, Presman was encouraged to ask ‘why a free cell, which can extend in so many directions, often advances steadily in one direction to the exclusion of others’, and ‘how do cells recognize one another?’ It was clear to Presman that these were consequences of information transmission within the body. He believed that this was because ‘of the existence of diverse interconnections within the living organism by means of EmFs’. And then, having arrived at this view, he turned to the work of Albert Szent-Györgyi for help in figuring out how all this happens. A summary of Szent-Györgyi’s ideas has already been given at length in Chapter 14, but the key point here is that Szent-Györgyi viewed the body electronically and insisted that it contained organic semiconductors that modulate and control the current flows and informational signals.

It was at this point that Presman adopted the term bioinformation. He says:

> Signals transmitted in the animal world by methods of as yet unknown physical nature have recently been called bioinformation. There are grounds for believing that in several cases such signal transmission is effected by EmFs of various frequency ranges. This is borne out, firstly, by the high sensitivity of animals of the most diverse species to EmFs, and especially by the fact that EmFs can act as … stimuli for the elaboration of conditioned reflexes. Secondly, it has been found that people exposed to EmFs experience various sensations and that some animals have special EmF receptors. Thirdly, EmFs of various frequencies have been recorded in the vicinity of isolated organs and cells, as well as close to entire organisms.[5]

At this point, I must bring in the entirely separate work on these ideas of my old friend David Bohm, whose ideas we have already encountered in Chapter 14, one of the most brilliant and original scientists of the twentieth century. An American colleague and close friend of Einstein's when Einstein was in exile in America, David then went into exile himself.

I first met David in London in 1982, and in that same year I published the first autobiographical account of him ever to appear, in the *New Scientist* magazine.[6] David was so shy, he had never been profiled before. It took me ages, assisted by his wonderful wife Saral, to persuade him to let me take his photograph. Saral realized that people found the correct spelling of her name confusing, so she often called herself Sarah Bohm. If it were not for her, David would never have survived his many years of bad health and the horrible stress, anxieties, persecution, penury, vilification, and despair that he went through during his lifetime as an exile, dragging himself from country to country trying to find somewhere to come to rest, which ended up being London.

My wife and I later became very close to the Bohms and saw them many times. David was always desperately ill and Saral was afraid he would die at any moment of his terrible heart ailments. I never knew anyone to take as many pills every day as he did. He had a tea trolley entirely covered with boxes of different pills, and had to rootle through them to find the right ones, which he did while discussing quantum theory.

As a young American scientist, David had been enjoying the prospects of an excellent academic career at Princeton University, where he was a colleague of Albert Einstein, who admired David a great deal.

During the war, David Bohm conducted research into plasma. When he saw the movement of particles in plasma, it struck him that they were behaving in concert in the way living creatures do. It seemed to him that there must be some underlying field or dimension that was interacting with these particles, resulting in life and a form of intelligence.

This vision of intelligence in plasma became a paradigm for David Bohm as he developed a scientific and philosophical account of the Universe that made him a senior figure in the second wave of theoretical physicists in the quantum revolution.

In 1951, he published what many still consider the finest existing textbook on the standard interpretations of quantum theory.[7] But then politics intervened. David's PhD supervisor had been Robert Oppenheimer, who came under political investigation by Congress for possibly being a communist. David was not himself a communist (although he was certainly very left wing), and he did not want to be called before the Congressional Committee to testify against his former supervisor. So he fled America and settled in Brazil. That was the beginning of the rest of his life in exile, with some years spent also in Israel (he and his wife were both Jewish, though non-practising).[8]

It was David Bohm who moved the concept of 'information' forward into a whole new dimension. From the 1980s until his death on 27 October 1992, David continued to elaborate the most revolutionary ideas on this subject. As we have seen, Presman was concerned with biology and biophysics, whereas David was concerned with physics and mind. The key to David's innovation is in his own elaborate and individual concept of active information. Earlier I spoke generally of passive and active information, but that was from my own limited point of view, based upon what seemed to me common sense. It is now time to see what a real scientific genius does when he gets his hands on the idea of active information.

Let us start with this startling remark by David's protégé in this particular field, the Finnish philosopher of science, Paavo Pylkkänen. He says that, according to David Bohm '… not only the behaviour but also the very being of particles [are] based on the activity of information.'[9]

That is a very big claim. It puts active information at the heart of everything.

David's alternative interpretation of quantum theory is often famously known as the causal interpretation. In the classic formulation of quantum mechanics, the interactions of waves and particles have uncertain outcomes. The position and other qualities of particles can therefore only be expressed in terms of probability rather than of certainty. It was thought in the standard view that this will always and inevitably be the case, because it reflects the way the Universe is made.

Albert Einstein was sceptical of this and so was David Bohm. In his formulation, cause and effect holds true in the quantum world as it does in the macro or everyday world, but we cannot calculate results with certainty because we don't have all the information. There are 'hidden variables', and he saw these as being hidden in the information contained in the waves, as the formof a signal. He stressed that form, having very little energy, enters into and directs a much greater energy. It puts form into it, i.e., it informs it; hence, inform-ation. In other words, uncertainty is not a quality of the physical universe. It only arises because we don't have enough information.

David Bohm's interpretation of quantum mechanics, based upon what he called 'hidden variables', is perfectly valid in terms of all experimental results, and the difference between it and the standard view is a difference of interpretation. He first published it in January of 1952, in a series of two papers in the *Physical Review*.[10] Those papers had a big impact upon Louis de Broglie (1892–1987, Nobel Prize for Physics 1929) in France, as a result of which de Broglie also abandoned the 'standard' interpretation of quantum mechanics, with tremendous repercussions in the world physics community, and which greatly added to David's scientific status.[11]

So David's focus on information as the driving force at the heart of the Universe helped throw a startling new light on the central problem of quantum mechanics, which has been a matter of debate and generated a spectrum of views over the last hundred years. To explore further the mind-bending ideas of David Bohm, it is helpful to start by contemplating how a small energy charge can, by the transmission of information, trigger wholesale changes in an entity with much larger energies. Here are some comments he made in a 1987 book:

> The basic idea of active information is that a form, having very little energy, enters into and directs a much greater energy.[12] This notion of an original

> energy acting to ‘inform’, or put form into, a much larger energy has significant applications in many areas beyond quantum theory.
>
> Consider a radio wave, whose form carries a signal – the voice of an announcer, for example. The energy of the sound that is heard from the radio does not in fact come from this wave, but from the batteries or the power plug. This latter energy is essentially ‘unformed’, but takes up its form from the information within the radio wave. This information is potentially active everywhere, but only actually active when its form enters into the electrical energy of the radio.
>
> The analogy with the causal interpretation [of quantum mechanics] is clear. A quantum wave carries ‘information’ and is therefore potentially active everywhere, but it is actually active only when and where this energy enters into the energy of the particle. But this implies that an electron, or any other elementary particle, has a complex and subtle inner structure that is at least comparable with that of a radio … nature may be far more subtle and strange than was previously thought.[13]

A lot of the force of his thinking comes from his focus on what we don’t know rather than what we do. He uses his colossal mathematical and scientific imagination to map new territories. Here David is saying that events in the Universe, including at the quantum level, unfold in the way they do because of an exchange of information between fields and particles that may contain a lot of information and mechanisms, which at the moment we have little idea about. In fact, we can scarcely begin to dream about them.

In 1979, the twenty-year-old Finnish undergraduate student at the University of Uppsala in Sweden named Paavo Pylkkänen (quoted above) became interested in David Bohm’s ideas. The following year, he was able to meet him at a conference in England. Throughout the early 1980s, Pylkkänen encountered David at other conferences and then in 1984–1985, when he commenced a Masters’ thesis at the University of Sussex, he was able to meet and discuss David’s ideas with him in greater detail. In 1988, Pylkkänen commenced a PhD course at the University of Helsinki, with the subject being David’s interpretation of quantum mechanics and its potential importance for cognitive science (that is, how we think).

In 1990, with grants from Finland, he was able to become ‘an academic visitor’ at both Oxford and David’s own Birkbeck College of the University of

London. This made it possible for him to have plenty of conversations with David and with David's closest collaborator and academic friend, Basil Hiley, who was also at Birkbeck. This period coincided with David's publication in 1990 of a brief but essentially final version of his ideas about how his version of quantum theory related to the functioning of the human mind.[14]

Pylkkänen was thus very much in the right place at the right time. In July of 1992, Pylkkänen completed his thesis and submitted it to the University of Helsinki, only three months before David's death. If David had lived longer, they would probably have written a book together.

Pylkkänen's thesis was published in 1992 by the University of Helsinki.[15] His abstract at the beginning of the book commences like this:

> The first aim of this study is to analyse, evaluate, and extend David Bohm's (1990) theory of the relation of mind and matter, based upon his ontological interpretation of quantum theory. [Note: Ontology is a branch of metaphysics dealing with the nature of being. In Bohm's interpretation, uncertainty arises as a problem of perception, not a problem with the nature of reality or being.] The second aim is to consider the relevance of this theory to the philosophy of cognitive science.
>
> This interpretation postulates that elementary particles are guided by a field containing active information. Bohm suggests that in certain key ways the activity of information at the quantum level is similar to the activity of information in ordinary human subjective experience, and he uses this similarity as a basis for his mind-matter theory.

What Pylkkänen is pointing to here is that Bohm sees some of the bizarre behaviour described in quantum mechanics in the common human experience of consciousness. This is important for the main theme of this book because, as we have already noted, human brains (like quantum computers) contain complex plasma, and plasma may be a medium by which uncertain and bizarre quantum phenomena enter the human experience.

In 2006, Pylkkänen published an ambitious book entitled *Mind, Matter and the Implicate Order*.[16] The 'implicate order' is the phrase that had been used by Bohm for decades to describe aspects of his evolving theories to do with the self-ordering qualities of the Universe, analogous in some ways to Prigogine's ideas

of dissipation, which we looked at in Chapter 3. This book carries forward all his thoughts on David's ideas, and his Preface commences like this:

> I have been planning to write a book ever since I finished my PhD dissertation … in 1992. For various reasons it has taken me a long time to do this. I started writing notes in February 2000 … This book deals with topics that have been variously neglected and even 'forbidden' in academic circles during much of the twentieth century. One such issue is conscious experience, the study of which was famously suppressed in behaviourist psychology and even in traditional cognitive science, and has only recently become the focus of intense research in a number of fields …
>
> Yet another traditionally 'forbidden' topic to be discussed in this book is connected with physics and has to do with the interpretation of quantum theory. To some extent, the suppression of discussion about the meaning of quantum theory is connected with the above-mentioned suppression of metaphysics in general, for quantum theory was initially interpreted in the 1920s in the strongly anti-metaphysical climate of logical positivism … making it 'forbidden' to try to sketch the nature of reality at the quantum level …
>
> I have chosen in this book to focus … strongly upon David Bohm's views. For it seems to me that Bohm was one of the few twentieth-century thinkers who had a good grasp of not only quantum physics (which was his original field of expertise and which he indeed helped to develop), but also the natural sciences more generally, as well as philosophy and consciousness. He saw the importance of trying to understand the connections between these areas and was indeed developing a new 'big picture' …

Pylkkänen is thus very much the heir to David's ideas linking quantum theory with the workings of the human mind. And again central to those ideas is David's concept of active information

Let us get down to greater detail of what the active information theory of David Bohm really suggests in relation to quantum mechanics, and why it is vital for the purposes of this book. Pylkkänen says that David and his colleague Basil Hiley in a joint publication had made:

> … a radical suggestion: the quantum field contains something at least analogous to information. Remember that this is information for the electron, not information for us. Information is seen as an objective aspect of reality and it is thought to be generally active … the first reason to postulate active information at the quantum level is that the effect of the quantum field upon the particle field depends only on the form of the field (the information encoded within it), not upon its amplitude. [Amplitude for a wave is the height of the wave in one ripple, from the bottom to the top of the wave, which scientists ponderously call 'a measure of its change over a single period'.]
>
> The form of the field informs [that is, directs the particle by means of the information it provides] the energy and movement of the particle. This is analogous to the way the form of the radar wave informs the energy and movement of a ship on automatic pilot, the way the form of the DNA informs the activities in a cell and the way the form of a shadow in a dark night can give form to the physiological state of a person who perceives and interprets it [by getting scared].[17]

In other words, David Bohm is arguing that there is crucial information hidden not only in individual particles but also in fields – and that the entire Universe is triggered by the interaction between them.

To put it another way, a particle such as an electron contains a lot of information, some of which is triggered into action when the particle interacts with an underlying field. Of course, scientists already knew that the behaviour of particles is changed by interactions with underlying fields, but Bohm's supreme mathematical imagination enabled him to suppose that large amounts of information in a simple seeming particle might interact not only with the fields we already know about, but also with another as yet unknown field, another dimension, something that might even be a cosmic intelligence beneath the fields we know about and ordering them. He called this the Implicate Order and he believed and described in the language of science how the Explicate Order, the Universe we see and experience with our senses, could unfold out of the Implicate one.

He understood this unfolding process to work like a hologram, a way of looking at the Universe he shared with his friend and colleague Karl Pribram, whose work we touched on earlier. A hologram is a record of what an object

looks like at every angle. In technology we are all familiar with holograms on bank notes and credit cards. They are made up of light beams, which have been organized to act in concert and deflect off the object that is to be depicted, in order to generate information on what it looks like. The same pattern of beams can then be reproduced to create a 3D image of the object even when it isn't there.

An important part of this analogy for our purposes is that if you break a hologram into bits, each bit will contain an image of the entire object. What David Bohm is saying is not only that the entire universe is a hologram, in the sense of being an unfolding of an intelligent 'implicate order' that underlies everything, but that this driving, ordering process is equally present everywhere in the Universe. It underlies our intelligence, the intelligence we see in animals and plants, and the intelligence we saw in the movements of plasma near the start of his scientific journey, which we are now beginning to understand.

David's focus on the information – rather than the energy – that fields transmit by means of their form brings us to the subject of the work of Rupert Sheldrake. I first met Rupert in 1981, and he and I have been friends now for four decades, as well as my wife Olivia and myself also being family friends of the Sheldrakes (we knew Rupert's wife Jill Purce for more than a decade before we knew him, and their two sons are just as much our friends as their parents are). Rupert and I both knew David Bohm from the early 1980s, but we did not mention it to each other during David's lifetime, and only discovered it later.

Rupert and David were very active together in helping one another with their respective ideas during the years they knew each other, and they took part in conferences together, none of which I attended, alas, as I was very distracted during that period with my work on the history of Chinese science, as a colleague of Joseph Needham. Rupert has published so many books and papers that he is widely known, and it would be impertinent of me to try to summarize his brilliant findings in the field that he calls morphic resonance, which is based upon 'form fields'.

Rupert's background was as a biologist, not as a physicist, and he has told me he does not go in for attempting to formulate physics theories. He had hoped that David Bohm could provide the physics basis to explain morphic resonance, but David was unable to do so, despite the good will between them. There is no doubt in my mind that Rupert's work on the transmission of form by 'morphic

fields' is connected somehow with Bohm's transmission of form by 'the form of the field' as mentioned a moment ago. And both are involved in the communication of information as form. Rupert's book *The Science Delusion* (known in America as *Science Set Free*, 2012) is a brilliant analysis of what is wrong with 'mainstream' science, as the ultra-conservatives of science like to call themselves.[18]

An interesting description of the invisible soul was given by the French philosopher René Descartes (1596–1650), who called it *une chose qui pense*, which the English philosopher of science Joseph Glanvill (1636–1680) translated as 'a thinking substance'.[19] This excellent turn of phrase from the seventeenth century is well worth hanging on to. For if I were to find one phrase that I believe sums up the nature of our plasma bodies, as well as the Kordylewski Clouds themselves, it would be to say that those information-laden entities must truly be a thinking substance.

If all entities are essentially plasma entities that from time to time 'become physical', or 'become embodied in atomic matter', then the thinking substance of each entity will have certain information requirements for survival, and these will vary considerably. There are two extreme cases one can mention. The first is moths, which have the ability to detect a single molecule in the air and trace it back to its flower. A more familiar example is to be found in predatory birds such as hawks and falcons. The fantastic eyesight of these birds enables them to spot tiny rodents such as mice from extreme altitudes, upon which they then suddenly swoop. The visual acuity of these birds is Nature's rival to modern military satellites, which we are anecdotally informed (and it may even be true) can read a car licence plate from several miles above us.

All of these phenomena display the extremes of information-capture. And sometimes information-capture can occur by paranormal means without even trying, when the desperation of the situation is sufficiently intense. I shall give one example from my own life. During my time as a consultant at board level to the telecoms company Cable & Wireless, my wife Olivia and I and our aged dog Kim, a border collie, shared an office at C&W. Kim lay on her silk eiderdown at Olivia's feet beneath her desk. Animals were supposed to be banned from entry in C&W buildings, and Kim was the only canine intruder who ever evaded this prohibition. But one day a grumpy executive made an official complaint about there being a dog in the lift with him.

The matter was judged to be so serious that it was entered onto the agenda of the next board meeting of the Directors of Cable & Wireless. (Yes, this is true.) The director with whom I was associated was Jonathan Solomon, who unknown to the other directors had written a book about his dog who had died, but whom he had loved beyond all measure. When they reached the item on the agenda where the fate of Kim was to be discussed, Jonathan made an impassioned speech to the board that ‘doggies are important’, to quote his own words, and the board agreed to permit Kim privileged entry to the building as a result.

This matter of great weight and importance, treated at the same level as corporate acquisitions in Asia and the Caribbean, enabled Kim to remain at Olivia’s feet, which was all Kim desired. We at that time had the entire top floor of an office building to ourselves, where we played boules and Kim chased the balls. That floor now holds the executive office of Len McCluskey, the head of the Unite Union, who is doubtless too busy to play boules.

One day we had to use a small closed room protected by a door code, and Kim came with us, as her advice was always needed. The door had been opened for us and the person had left. Olivia and I left the room briefly for some reason and the door closed behind us, leaving Kim locked in the room. Kim by then had very serious kidney issues and needed to drink lots of water, and her bowl was dry. We were told the only person with the door code might not be back until the next day. We knew that Kim could not live that long without water. No one was prepared to arrange for the door to be forced.

In a moment of intense emotion about the fate of our precious Kim, I forced myself to ‘know’ the door code, which came into my mind in some manner unknown. I punched it in and the door opened, and we were able to save Kim. This is an example from personal experience of the accessibility of information when truly needed, from a world that is probably entirely constituted of information.[20]

As this book draws near its close, I want to mention a peculiarity about himself recorded in his autobiography by Nikola Tesla. He records this:

> In my boyhood I suffered from a peculiar affliction due to the appearance of images, often accompanied by strong flashes of light, which marred the sight of real objects and interfered with my thought and action … I was about twelve years old when I first succeeded in banishing an image from

> my vision by wilful effort, but I never had any control over the flashes of light to which I have referred. They were, perhaps, my strangest experience and inexplicable. They usually occurred when I found myself in a dangerous or distressing situation, or when I was greatly exhilarated. In some instances I have seen all the air around me filled with tongues of living flame. Their intensity, instead of diminishing, increased with time and seemingly attained a maximum when I was about twenty-five years old.
>
> While in Paris, in 1883, a prominent French manufacturer sent me an invitation to a shooting expedition which I accepted. I had been long confined to the factory and the fresh air had a wonderfully invigorating effect on me. On my return to the city that night, I felt a positive sensation that my brain had caught fire. I saw a light as though a small sun was located in it and I passed the whole night applying cold compressions to my tortured head. Finally the flashes diminished in frequency and force, but it took more than three weeks before they wholly subsided … These luminous phenomena still manifest themselves from time to time, as when a new idea opening up possibilities strikes me …[21]

Here we find extraordinarily frank descriptions by Tesla of his being tormented over the years by what appear to be the visualisation and perception of his own plasma body. Our plasma bodies would necessarily be like ‘tongues of living flame’ surrounding us, because that is what plasma is like. By flames we should not, however, imagine flames producing heat, as with the flames of a physical fire. Notice that Tesla speaks of ‘living flame’, suggesting that he could see pulsations or waves within the flames, so that they appeared as if they were dynamic and ‘alive’ in some sense.

It is interesting that he sensed ‘a small sun’ within his brain. The interaction between a plasma body and a physical body would be expected to involve a node of concentrated plasma somewhere within the brain. I cannot resist the impression that Tesla experienced phenomena caused by his physical body being insufficiently insulated from his plasma body, so that he was tormented by overexposure to it. But that, of course, may explain his amazing mental powers of visualisation, invention, and inspiration.

In other words, perhaps great geniuses have an increased access to their plasma selves. Certainly psychics are always complaining of the agonies they suffer from their paranormal perceptions. Physical suffering thus seems to go

with ‘plasmic phenomena’ invading the physical. This is not at all surprising, because of the higher energies involved. This could explain feeling ‘a positive sensation that my brain had caught fire’.

It may well be that many of the great geniuses whose stories we have told in this history had a particularly intense relationship with their plasma bodies and that this is what made them visionaries.

To return to the Kordylewski Clouds, Benjamin Schumacher and a colleague named Michael Westmoreland published an important book in 2010 entitled *Quantum Processes, Systems, and Information*. They attempt to define information at the beginning of that book like this:

> Information is the ability to distinguish reliably between possible alternatives.[22]

As their book moves along, they refine this definition, a journey too detailed for us to follow here, but I would not like people to think this initial statement is where they stop, rather it is where they begin. The authors elucidate information processing at the nanometre scale, and as we will recall, the charged dust particles largely constituting the Kordylewski Clouds are nano-sized. Second, they discuss the complexity of systems needed to generate intelligence, which resonates well with the description by the eminent astrophysicist Wickramasinghe and myself outlined in Chapter 12. Summarizing their findings they say:

> We have demonstrated the connection between a complex hierarchical structure and the complex dynamics of the system. The number of hierarchical levels of the system (in our case five) is a measure for the ‘homogenous’ complexity of the system. The minimum number of hierarchical levels is a prerequisite in order to realize multi-stability, preparation, measurement, and control, necessary to achieve a complex dynamics which is equivalent to information processing.

Several experts in the new physics of information have made timely comments, which may make claims that everything is essentially information seem less shocking. In 1990, an expert in this field named Wojciech H. Zurek (*zurek* being a favourite Polish soup of mine as well as a common Polish surname) edited a

volume of Proceedings of an important conference held the year before. He prefaced it with the sentence: ‘The spectre of information is haunting science.’[23]

Two joint contributors to the Zurek volume were Werner G. Teich and Günter Mahler. They gave special attention to ‘information processing systems where the basic elements have a dimension of a few nanometres … (and) possible realizations in form of semiconductor heterostructures (“quantum-dots”) as well.’ They say that their research might be described as molecular electronics.[24] We may be forgiven for feeling a sense of déjà vu here, because this takes us back to our old friend Albert Szent-Györgyi, who was discussed at length in Chapter 14, and his – you remember correctly – molecular electronics first discussed in a book of his as early as 1957, forty-one years before Teich and Mahler’s paper was delivered.

One more paper in the Zurek volume is important for us as well, namely that by Seth Lloyd, who I gather from Google nowadays quaintly describes himself as ‘a quantum mechanic’. It is good to know that he can repair nano-sized carburettors and change the spark plugs inside electronic molecules. But what I like most about him is his paper ‘Valuable Information’ in the Zurek volume. He begins to tell us about the birds and the bees, but in fact the bees are enough:

> Information is the currency of nature. A bee carries genetic information contained in pollen to a flower, which in turn supplies the bee with ordered energy in the form of sugar, a transaction that redounds to their mutual advantage … a drop of sugar sitting by a pistil [in a flower] registers an amount of information equal to the free energy of the drop divided by the ambient temperature: the drop’s information is proportional to its calorie content. When the bee gets sugar water in return for DNA, she is getting a very good deal in food value – pollen is low calorie stuff. But the flower is not getting the worst of the bargain.
>
> Although the DNA the flower gains is a diet item compared with the sugar water given up, the information that it contains is of high quality, refined by natural selection through generations, and essential to the flower’s ability to reproduce. As a result, the flower places a higher value on the small amount of information in the pollen than on the large amount of information in the sugar. Value depends not only on the amount of information, but on how difficult that information was to produce.

> Down the years, far greater resources have gone into producing flower DNA than the sunlight and soil that went into making today's drop of sugar water. A process such as evolution consists of many interactions and exchanges of information, and the genetic make-up of a species contains, in edited form, information about past interactions between species and environment: genetic information registers experience.'[25]

The scientists concerned with this information theory stress the need for multiple hierarchies of information. The Kordylewski Clouds are capable of intelligence because they are not just simple plasmas, but are dusty complex plasmas. Their interiors are so complex that they can have a number of hierarchical levels limited only by the size of the cloud. (And since the clouds are so gigantic, there could be many millions, or even billions, of hierarchical levels inside them.)

Earlier we talked about voids in complex dusty plasmas such as the Kordylewski Clouds and their role in separating out different 'organs' with distinct functions within the living entity. I want to mention here some revolutionary work on voids, which suggests that voids may have other, more mysterious functions.

In my earlier book *Netherworld*,[26] (known in the USA in a new title bestowed by the publisher there as *Oracles of the Dead*), I discussed at very great length the importance of voids, stressing that the founding father of void studies was the crystallographer Victor Goldschmidt. It was he who identified the crucial importance of voids in otherwise 'solid' physical matter. He discovered that there was such a thing as systematic and highly geometrical void formation in crystals. The voids were very carefully and meticulously formed, and were not at all random. He called these carefully crafted voids 'dissolution forms'. When a dissolution form reaches complete emptiness, it is called the end-body. These voids were found to form 'void lattices', which were the 'empty' equivalents of solid lattices.

As I summarized it:

> In other words, with the end-body one reaches the final form of the void lattice, and further action by the solvent merely reduces it in size, but no longer alters its conformation. One has attained the pure void form, or we could call it the substance lattice, traced and outlined by some remaining

residues of matter, and which is the yin corresponding to the yang of the material shape.[27]

I cannot repeat here the discussion of void lattices and their crucial importance in both metallurgy and in geology, nor can I elaborate further on Goldschmidt's revolutionary work. But these voids and void lattices are so important in general, because they are manifestations of renewal. They are the destruction-lattices that empty themselves of matter so that the new can be made, as the creation-lattices exhaust themselves and come to the ends of their useful lives. In other words, forms grow and die and are replaced anew from formed emptiness that has grown geometrically and sits waiting to be filled. One is the summer and one is the winter, and rebirth takes place from ordered death in an endless process of birth, death, replacement, and renewal. Without the formation of the voids, this cycle cannot happen.

Since voids form in matter, and plasma is made of matter (just not atomic matter), we can expect that plasma clouds will be riddled with voids. This would certainly apply to the Kordylewski Clouds. These voids would serve the function of assisting in the continual regeneration of the clouds, by replacing exhausted lattices in the plasma crystals and renewing the crystals in an endless progression. Indeed, I wonder if the people working on fusion reactors have ever given any thought to facilitating void formation in their plasmas, which might help in their frustrating search (that has already lasted many decades) for a fusion reactor that works.

They won't get anywhere with a uniform plasma. They have to create voids. Presumably pulsations and harmonic resonance could be employed. The other thing, which I mentioned in Chapter 3, is the need for spaces between things, and voids clearly contribute to that. Empty spaces are needed in any large entity. Something that is completely full cannot work. There always has to be some flexibility

The first observation of a void within plasma appears to have taken place in a laboratory in 1996, as reported by G. Praburam and John A. Goree. By 1999, several papers appeared that had studied these plasma dust voids. One by Vadim Tsytovich, Sergey Vladimirov and Gregor Morfill proved that the size of the void depends upon the power input into the plasma, and that the greater the power, the larger the void.[28] Goree and Dmitry Samsonov followed with their

own paper that year, as did Gregor Morfill, Hubertus Thomas and other leading scientists. So one could say that 1999 was ‘the year of the plasma void’.

Subsequent research was relentless after that, and essentially came to a climax under the direction of the brilliant Japanese scientist Osamu Ishihara, who published the above figure.[29] In this paper, written jointly by Ishihara with his colleague Noriyoshi Sato, they said: ‘A void structure, characterized by a dust-free ordered state with a sharp boundary in a dusty plasma, was observed in microgravity conditions [in space orbit] as well as in ground-based laboratory plasmas … Voids have been observed not only in a complex plasma, but also in colloidal suspensions … In conclusion, the electrostatic attractive force between like charges in a complex plasma, where charged macroparticles are embedded in a fully ionized plasma, is shown to be responsible for the sharp boundary formation associated with a void …’

It is interesting to examine how all of this research came to be carried out, especially in light of these comments made by Ishihara in 2008:

> Professor Oleg Petrov and Dr Sergey Antipov of Joint Institute for High Temperatures of the Russian Academy of Sciences (former Institute for High Energy Densities, Russian Academy of Sciences), Moscow, Russia, visited our lab [in Japan] from December 22 to 23 2007. We exchanged the detailed information on the experiments of cryogenic complex plasma experiments. We are the only two groups in the world to carry on the cryogenic complex plasma experiments.[30]

Another important development is the report published in August of 2021 in *Nature* that at last a material has been discovered that is a natural ‘topological superfluid’.[31] The implications of this are enormous, and an entire new area has now opened up that relates to our concerns. If only it were possible to discuss this further.

But these matters go way beyond what we have space to consider here.

In the final chapter, we will bring together the arguments to show that plasma in space may well have evolved intelligence billions of years before the evolution of humans.

18

Wrapping up the Universe

As we wrap up the Universe we will consider how parts of the Universe seem to be self-organizing, how complex structures emerge, and how the way things slow down and fall apart – the Second Law of Thermodynamics – is by no means the whole story. Highly unstable charged entities such as dusty plasmas throw out dissipative structures over vast distances. In other words, leading scientists have been looking at the way that there are fundamental tendencies in the Universe towards greater and greater complexity – towards the high levels of complexity necessary for intelligence.

In trying to understand how human consciousness and intelligence works, classical science has tended to concentrate on chemical reactions in the brain. In the second half of the twentieth century, many leading scientists shifted the focus to an interaction between matter and subatomic matter in the brain and external fields, such as electromagnetic fields. It is well established, for example, that birds follow migratory paths by interacting with the Earth's magnetic fields. Could this be one small example of a universal phenomenon?

It is also well established that artificial electromagnetic fields from phone masts can have a deleterious effect on human health and behaviour. But could natural electromagnetism on the Earth and more widely in the cosmos have a much more fundamental, indeed essential role in forming and informing animal and human minds? Plasma's unique sensitivity to fields would seem to make it uniquely suited to this kind of interaction. And we have already begun to question whether there is plasma in the brain.

Similarly in recent times the creation of artificial intelligence and quantum computers have helped prompt new perspectives on human intelligence and mind in two main ways. AI tends to see intelligence in terms of the transmission and processing of information. When it comes to understanding and defining human intelligence, this leads naturally to a focus on the flow of information

rather than the flow of chemical and biological processes (information theory). Unlike traditional digital computers, which work by considering simple either/or options, albeit an immense accumulation of them – the bigger the accumulation, the more powerful the computer – the new quantum computers work much more powerfully, indeed on a whole different level, because they are able to consider many more options than a simple either/or at any one time, and indeed make multiple considerations such as these simultaneously.

(It seems not to have been recognized yet that this operates by means of what I call ‘informational void creation’. When one alternative is chosen over another, this creates an information void in the form of the rejected alternative. However, that void can be filled again by shifting one’s choice to that alternative. With multiple choices taking place, the traditional ‘one’ and ‘zero’ of normal computing can be replaced by ‘empty’ and ‘full’ as concepts, with shifting but parallel geometries of information lattices and information void lattices side by side, continuously changing, the dynamics of these parallel lattices being plotted and manipulated by non-linear equations. This can be studied in reduced form by plotting the mechanisms of memory retrieval. This may sound simplistic, but it is actually the best basis for the construction of a geometry of alternatives in the theory of quantum computing. Someone needs to mathematize it.)

And in this they are, of course. very like the human mind. What makes the development of these new quantum computers work is the way they use plasma – so again we come back to this new way of trying to understand human intelligence and consciousness. Could it be that plasma in the human brain, the human body, has played a vital part in its evolution?

We have seen a great deal of information and learned the life stories of some of the great heroes of science who have brought us this far, despite the fact that many of them were called crazy before they won their Nobel Prizes. Let us now try to bring together a summary of what all of this means.

The first and most important thing is what I have stressed since the very beginning of this book, namely that physical matter is very rare in the Universe and is not the predominant component of what exists. The obvious conclusion is that if the Universe is full of life forms, including intelligent ones, the majority of them will not be made of physical matter. They will instead be made of plasma. And that may include us. I am suggesting that we are all made of plasma, and that our physical bodies are temporary vehicles for us to operate in

the physical world for the short periods of time that our fragile bodies can permit, considering how quickly they wear out, how prone they are to accidents, and how vulnerable they are to disease.

But that has been made amply clear at an earlier stage of this book. What we need to do here is to explore more thoroughly how living entities can come to be in a plasma universe. We are so used to being immersed in a world of physical matter that it is a great struggle for us to free ourselves from the encumbrances of stuff. ‘Stuff’ is a wonderful word used mostly in America to refer to anything that encumbers one, or gets in the way. On the other hand, ‘stuff’ can sometimes be useful. It is because ‘stuff’ has no actual definition that it can be used so readily as an idea.

So let us free ourselves from our physical ‘stuff’ and let our minds roam free.

It is unavoidable to conclude that if the Universe is made of 99.9 per cent plasma, then life forms in it must also be 99.9 per cent made of plasma. So we need to understand such life forms urgently.

It is indeed difficult for us, being what we are (or should I say, being what we think we are) to imagine that a diffuse charged dusty plasma cloud could possibly be a living being. But what if you were such a cloud and saw us? You might think: ‘what thick, clumsy, awkward objects those things are that move upon the Earth! I wonder if they could possibly contain any elements of life in them. They may simply be moving lumps of protoplasm with four protrusions sticking out like viruses have, and everyone knows that viruses are not alive’.

Everything depends upon dust. This sounds so inglorious that it is difficult to grasp, because we are used to thinking of house dust and the need to clean the house, and also in my case to dust my books. But in order for a plasma to come alive, it needs dust. It gives the particles something to cling onto. Ten thousand electrons can cling to a single dust particle. So when you consider how many dust particles there are in a dusty plasma cloud, and if you imagine 10,000 electrons attached to each one, giving each dust particle the electric charge of 10,000 electrons, gigantic electric charges beyond any power station or power network on Earth can gather in a single cloud. The huge electromagnetic forces of the clouds are inconceivable to our tiny little minds, and even the bravest equation trembles at the thought of the number of exponents appearing in it, each one carrying so many zeroes, it is enough to make a person faint.

So we get it: things are different in space.

One key to all these clouds coming alive is also in the supply of ready food. For plasma entities, that means a reliable flow of particles. Plasma clouds eat particles, in the way that whales eat plankton. Please note that whales are the largest mammals on Earth, but they eat the smallest food. Plasma clouds may be huge, but they too can eat their own ‘space plankton’, namely charged particles and ions.

And it so happens that suns and stars are, as the English say, ‘just the ticket’. For they are spewing out particles continuously, and one aspect of this has been known for a very long time. I am referring to sunlight as the source of energy for plants. If plants can eat sunlight, then why can’t plasma clouds do so too? Of course, I am not suggesting chlorophyll in plasma clouds, I am suggesting the absorption of energy from the particles consisting of the solar wind.

The huge electromagnetic forces in the charged clouds are so much more powerful than gravity that they suffice to hold everything together, even if the cloud is extremely diffuse. We must never forget that electromagnetic forces are more powerful than gravitational ones by a factor of 10 followed by 39 zeroes. We should therefore never underestimate the power of electromagnetism to hold things together, a perpetual embrace.

Now we can see that it is not difficult to conceive of these large, charged, dusty plasma clouds becoming things.

How do they become living things?

We have examined the anatomy of complex dusty plasma. At this point I would like to refer the reader back to what I wrote in Chapter 12 about how the ‘electromagnetic strength’ of the Kordylewski Clouds could arise, which holds them together. I explained how spinning dust grains like incredibly small rice grains (which range in size between a micrometre, which is one millionth of a metre, and a nanometre, which is one thousand times smaller than that), each with a north pole and a south pole, can collectively by their spinning generate gigantic amounts of energy. They are like billions upon billions of microscopic power generators. And it is these that generate the energy which creates the structure and internal organization of the cloud.

We have seen they do in fact become filled with crystalline structures like the structures in organic life, double helixes capable of storing information, filaments to conduct currents like nerves in animal bodies, semiconductors

capable of acting as Josephson Junctions in the same way these things work in animal bodies, voids that separate different organs enabling them to perform different functions within an overarching system, as our organs do in our bodies.

You can have a hot pocket next to a cold pocket, and they will not disturb one another. Much of the cloud in space needs to contain superconductive currents, and that is easier at low temperatures, in what is called a cold plasma. But because of sheaths, you can have all that going on at cold temperatures, while at the same time having internal sheathed pockets and currents operating at extremely high temperatures.

We have also seen that the voids have regenerative capacities. We have seen that these plasmas contain seething patterns of interacting fields and currents and that these are driven to very high levels of complexity by interactions with complex dust within. There may be as yet barely understood particles involved in this drive to create complex patterns such as magnetic monopoles and tachyons.

We have looked at various theories to explain how the drive to complexity arises in the Universe as whole, and which may be pertinent to the evolution of life in plasma. We looked at Prigogine's theories of dissipative structures. There are theories of emergence and self-organization, which describe how complex things grow spontaneously and unpredictably so they become greater than the sum of their parts. And we looked at David Bohm's theory of the Implicate Order, of an ordering faculty that lies beneath the universal fields we know about.

How might complex dusty plasmas be intelligent – like plants, humans or quantum computers are intelligent?

The light that information theory throws on the nature of intelligence shows that plant life can be extremely intelligent and that plasmas may be intelligent in the same way. Plasmas compete for food, so there may also be a survival of the fittest factor driving their evolution. Like intelligent entities, plasmas may cooperate as well as compete, so that long-range-order events may involve not only communication but cooperation in the process of achieving the complexity necessary for intelligence. We have seen that ball lightning, which is made of plasma, often behaves in an intelligent manner.

We have seen that the role plasma plays in helping our own intelligence to evolve and function at high levels may also play out in plasmas in space, and

that conditions may have been right for this billions of years before conditions became right for the evolution of life on Earth.

I am also suggesting that the predominant forms of life in the Universe are inorganic. The organic life forms of our planet are a footnote, not the main text, of the message of the Universe.

Just as information theory and the invention of digital computers caused us to reassess the nature and potential of intelligence, so too the development of quantum computers has opened up new horizons. Quantum computers contain plasma to help harvest the weird phenomena of the quantum realm in order to generate intelligence far greater than any digital computer. Complex plasmas also have these properties. We have seen ball lightning move through solid objects, which is an example of the phenomenon of quantum tunnelling happening in the macro world.

We have seen gigantic filaments made of plasma carrying superconducting currents with energy and information. We have seen that these plasmas contain elements that work like Josephson Junctions, used to control and fine-tune the flow of energies and information in machine intelligence, so they may have intelligence we can hardly begin to imagine.

But we have also seen that our bodies have many of the plasma features and that in addition to our meat bodies, we also have plasma bodies, and these interact with universal fields. What does this say about our own potential intelligence?

More and more is being discovered about how the human brain works. We now know that individual neurons are not the elements of the brain, it is groups of neurons that are. And these in turn operate both in parallel and in a distributed sense (in other words, not solely in one area of the brain, but distributed across regions of the brain). This kind of brain processing is called parallel distributed processing. Another name for it is connectionism. (I have written about this at very great length in another book, so cannot repeat it here.)[1]

What is important for our purposes here is that intelligence emerges from the human brain not by chemicals next to each other interacting by physical proximity, but by connections over a distance. Similarly it is the concept of long-range order that is crucial to the integrity of any plasma cloud in space. This is what occurs when a very large collection of disparate particles suddenly comes

together and forms a coherent entity, which extends its central control over a long distance, somehow imposing long-range order. This goes against a lot of ‘conventional thinking’, because it suggests action at a distance.

Isaac Newton became nearly hysterical when people spoke of action at a distance. In *Principia Mathematica* (1713), he called it ‘a philosophical absurdity’. Albert Einstein was puzzled by it and called it ‘spooky action at a distance’. He and two colleagues formulated a famous concept in physics called the EPR Paradox (the ‘E’ being for Einstein and the ‘P’ and the ‘R’ being for the other guys). This was published in 1935 and dealt with particles coordinating their momenta when very far apart, so far in fact that they would have to exchange the information with each other by sending signals at greater than the speed of light. Since Einstein himself developed Special Relativity, which insists that the speed of light must be a universal constant that cannot be exceeded, he had a special interest in this unsolved paradox of physics. I myself have entered the Special Relativity debate on the side of the speed of light as co-author of a paper with my friend Otto Rössler, which was a great honour, because he is one of the world’s most famous chaos theory scientists, and the discoverer of the Rössler Attractor.[2]

The phenomenon of non-locality, as they call it, which was raised by this paradox, has so far been proved to occur over distances of fifty kilometres, and the phenomenon is no longer denied. A special case of non-locality is the now-fashionable subject of quantum entanglement. Entanglement has become a buzzword. What it means is that at the microscopic quantum level, things far apart can still be in contact, in other words can be ‘entangled’ with each other and interact. And the point about a huge plasma cloud that becomes an entity through coherence achieved despite non-locality is that is elevates the quantum state from the microscopic to the macroscopic, in other words from the tiny to the huge. The entire cloud becomes a macroscopic quantum entity.

So how is it possible for quantum phenomena to operate at these huge sizes? We were told for decades that quantum phenomena occurred only at microscopic levels. But things have now changed.

I suspect that the answer to all this is what I discussed earlier, namely active information. Information does not have any energy or any mass. It is thus immune to the speed of light restriction, which applies only to matter, waves, and so forth. In order to extend across vast distances, information can exceed the

speed of light quite happily without breaking any ‘laws’. A distributed information network would act as a unifying factor to enable the cloud to achieve stability as an entity. In fact, the vast amount of information in itself might knit a filamentary network of connected elements constituting a brain, in which information processing would be inevitable.

As David Bohm and his close colleague Basil Hiley stated in 1993:

> We have seen that nonlocality is contained in all the interpretations of the quantum theory that we have discussed so far … (and) our own ontological interpretation also contains nonlocality as a basic feature.[3]

‘Long-range order’ is an example of one of the outcomes that entanglement generates. This extraordinary phenomenon means that particles or things very far apart indeed can be closely coordinated and can behave as if they are all part of one centrally controlled organism. This is what is known as quantum entanglement, which we have already mentioned.

Sometimes a system can suddenly undergo a change, known in the jargon as a phase transition, and millions of apparently separate things in the system instantaneously begin to act as one. Imagine one million people sitting in bars and pubs around the world drinking casually with their friends, and suddenly at the same instant they all stand to attention and give a salute, even though they do not know one another, have never met and never will meet. This is a phase transition, and is also referred to as the sudden onset of long-range order. No one is entirely sure how these things can happen in the natural world, but they do. And we now know that this form of coherence by means of long-range order can happen within plasma crystals. This means that both information and energy can come from far away

Because of entanglement, not only can parts of giant dusty complex plasmas communicate with each other and form coherent patterns over distances, but giant dusty complex plasmas at the opposite sides of the Universe might in principle cooperate in the evolution of their intelligence.

Conclusion

We have seen in this book that the Universe is over 99 per cent plasma.

We have seen that dusty complex plasma interacting with electromagnetic fields can evolve sufficient complexity to count as ‘alive’.

We have seen too, in certain cases, that complex dusty plasmas contain such high levels of complexity, including quantum phenomena, that it may reasonably be speculated that they are also intelligent. The Kordylewski Clouds hovering over the Earth may well be vastly more intelligent than human beings, or indeed all human beings put together, including all of those who have ever lived, so vast are the potential computing powers of the huge clouds, which together are nine times the size of the Earth, so that in size they dwarf our planet and its moon.

We have seen that plasma may be a medium by which the bizarre behaviour of particles and waves in the quantum realm may erupt into the human or macro realm, for example in the manifestation of lightning balls.

We have explored the role of plasma in the human body, showing that we may have a plasma body that shapes and sustains our physical body. We ourselves are in a sense plasmoids, and our dense matters bodies made of those rare things, atoms, are like ‘smart overcoats’ that we discard when we die.

The quest has only just begun. This book is intended to inform you of what is possible. Once you grasp this, you can begin to realize what you really are.

Notes

Chapter 1: The Discovery of the Clouds

1. Kazimierz Kordylewski, *Acta Astronomica*, 11, 1961, page 165.
2. Judit Sliz-Balogh, András Barta, and Gábor Horváth, ‘Celestial Mechanics and Polarization Optics of the Kordylewski Dust Cloud in the Earth-Moon Lagrange Point L5, Part I: Three-Dimensional Celestial Mechanical Modelling of Dust Cloud Formation’, subsequently followed by an Erratum and by a Part II: ‘On Imaging Polarimetric Observation for the Existence of Kordylewski Dust Cloud’. These were all in the *Monthly Notices of the Royal Astronomical Society*, 480, 2018, 5550; and 482, 2019, 762–70. In summarizing their observations, the conclusion of this astronomical team for Part II was: ‘… the only explanation remains the polarized scattering of sunlight on the particles collected around the L5 point.’
3. Robert Temple and Chandra Wickramasinghe, ‘Kordylewski Dust Clouds: Could They Be Cosmic “Superbrains”?’, in *Advances in Astrophysics*, Vol. 4, No. 4, November 2019, pp. 129–32.

Chapter 2: Exploring the Nature of Plasma Clouds and Their Energy

1. Wang Zhehui, et al., ‘Physics of Dust in Magnetic Fusion Devices’, in Padma Kant Shukla, Lennart Stenflo, and Bengt Eliasson (eds.), *New Aspects of Plasma Physics*, Proceedings of the 2007 ICTP Summer College on Plasma Physics, World Scientific, Singapore, 2008, pp. 395–6.
2. Ions were recognized soon after we learned about the existence of atoms. In 1834 the British chemist Michael Faraday identified and named this new subdivision of matter: things which were ‘almost atoms but not quite’. Because these tiny particles were detected travelling from one electrode to another in aqueous solutions, and because the act of going between things seemed to be their main characteristic at that time, Faraday looked for a Greek word to do with going or travelling. He chose the Greek verb *ienai* (a form of *eimi*), which means ‘to go, come to, go across, go (along a road)’, the neuter present participle of which was ion. And so he called them ‘ions’.

3. The definition of a qudit is a bit complicated. Such a unit is considered to be a ‘unit of quantum information by a superposition of d states, where d is an integer greater than 2.’ That explains what the ‘d’ in qudit stands for.
4. Osamu Ishihara, ‘Final Report on Study of Cryogenic Complex Plasma’ submitted on 27 October 2008 to the US Research Laboratory in Japan known as AOARD, declassified by the US Department of Defense and included in the publication entitled *Charged Colloidal Structures in Plasmas*, no date. In his experiment, Osamu first created the plasma in his lab and then injected the dust particles into it, hence his particular emphasis of the interaction of the two components.

Chapter 3: A Brief History of Plasma Research

1. In 1875, Crookes invented the vacuum tube, which came to be known as ‘Crookes tubes’. You might say that we owe the entire electronic age to him. The original radios and television sets were full of those odd vacuum tubes. (In Britain they were commonly called ‘valves’.) When one ‘blew’ it had to be replaced, like a light bulb, and if it were only in the radio, you would go to a radio parts shops and there would be shelves full of little thin cardboard boxes of different sizes. The man would rummage through his shelves and find the right one, take it down and hand it to you, saying: ‘Here you are, this is the one you want.’ Most people simply replaced the radio ones themselves. But it was more hazardous to open a television set, thanks to the dangers of possible electrocution, so the television repair men would come to replace the tubes in those, because they knew how to open TVs and handle the tubes safely. Even well into the 1970s, it was still possible to find valves (vacuum tubes) in small shops in most towns and buy them easily. In the 1990s, my wife Olivia and I wanted to keep an old radio set from the Second World War working and we succeeded in finding the right valve.
2. Nikola Tesla, *My Inventions: The Autobiography of Nikola Tesla*, Cosimo Classics, New York, 2011, p. 80. The work was originally published in February–June and October 1919, in installments in a journal entitled the *Electrical Experimenter* (an American technical science monthly established in May 1913).
3. Irving Langmuir and Lewi Tonks, ‘Oscillations in Ionized Gases’ in *The Physical Review*, Second Series, Vol. 33, No. 2, February 1929, p. 196, footnote 5.
4. David Albertovich Frank-Kamenetsky (aka Kamenetskii), ‘Plasmic

Phenomena in Semi-Conductors, and Biological Effects of Radio Waves', in *Proceedings of the USSR Academy of Sciences* [*DAN, or Doklady Akademii Nauk SSSR*], Vol. 136, No. 2, Moscow, 1961. (Presumably in Russian.) In 1963, he published a bold book insisting that plasma was the fourth state of matter (fourth after the gaseous, liquid, and solid states, which had been the traditional three states of matter until plasma was discovered). David Albertovich Frank-Kamenetsky (aka Kamenetskii), *Plasma – der Vierte Aggregatzustand*, Progress Verlag, Moscow, 1963.

5. Gary S. Selwyn, J. Singh, and R.S. Bennet, 'In Situ Laser Diagnostic Studies of Plasma-Generated Particulate Contamination', in *Journal of Vacuum Science and Technology*, A, 7, pp. 2758–65.
6. 'Like complex fluids, complex plasmas belong to the group of so-called soft matter … Originally the name "complex plasma" was chosen in analogy to "complex fluids"; since complex plasmas can be regarded as the fourth state of soft matter, very much like ordinary plasmas can be regarded as the fourth state of ordinary matter … They are responsible for fundamental astrophysical processes such as the formation of the solar systems and planets … In particular, the question about the structure of self-organized systems emerges as a key issue …' Patrick Ludwig, Michael Bonitz, and Jürgen Meischner, 'Complex Plasmas', in Michael Bonitz, Norman Horing, and Patrick Ludwig (eds.), *Introduction to Complex Plasmas*, Springer Verlag, Heidelberg, 2010, pp. 6–8. In the quote under bullet 2010, soft matter was referred to, and that dusty complex plasmas were types of soft matter. So what is soft matter?

   There is a useful book on just this subject by Masao Doi (*Soft Matter Physics*, Oxford University Press, 2013). His very first chapter is entitled 'What is soft matter?', in which he says:

   > Soft matter includes a large variety of materials, typically composed of polymers, colloids, liquid crystals, surfactants [such as detergents and emulsifiers], and other mesoscopic [intermediate-sized, in other words between nano scale and micrometre scale] constituents … Condensed states of matter are usually classified into two states, the crystalline state where the molecules are ordered, and the liquid state where the molecules are disordered. For certain materials, molecules form a semi-ordered state between crystal and liquid. Such materials are called liquid crystals … As we have seen, soft matter includes a large class of materials … What is common in the above materials is that they all consist of structural units that are much larger than atoms …

> soft matter consists of large molecules or assemblies of molecules which move collectively … the fundamental structural units of soft matter are very large.

7. News item: ‘Bacterial Mimic Spins and Swarms’ in *Nature*, Vol. 575, No. 7784, 28 November 2019, p. 568.
8. Torben Ott, Patrick Ludwig, Hanno Kählert, and Michael Bonitz, ‘Molecular Dynamics Simulation of Strongly Correlated Dusty Plasma’, in Michael Bonitz, Norman Horing, and Patrick Ludwig (eds.), *Introduction to Complex Plasmas*, Springer Verlag, Heidelberg, 2010, p. 232 (Figure 10.1).
9. Hamish Gordon, et al., ‘Causes and Importance of New Particle Formation in the Present-Day and Pre-Industrial Atmospheres’, in *Journal of Geophysical Research: Atmospheres*, 122 (16), 2017, pp. 8739–60.
10. Robert Wagner, et al., ‘The Role of Ions in New Particle formation in the CLOUD Chamber’, in *Atmospheric Chemistry and Physics*, 17, 2017, pp. 15181–97.
11. Dominik Stolzenburg, et al., ‘Rapid Growth of Organic Aerosol Nanoparticles over a Wide Tropospheric Temperature Range’, in *Proceedings of the National Academy of Sciences of the USA* (colloquially known as ‘PNAS’), Vol. 115, No. 37, 11 September 2018, pp. 9122–7. Winkler’s Appendix to this paper may be separately obtained by download from the PNAS website.
12. Christina J. Williamson, et al., ‘A Large Source of Cloud Condensation Nuclei from New Particle Formation in the Tropics’, in *Nature*, Vol. 574, No. 7778, 17 October 2019, pp. 399–403.
13. The ancient Greek mystics when discussing what mystical writers such as the Theosophists call ‘the subtle body’, in other words the soul, called it the *lepton ochēma* in the ancient book called *The Chaldaean Oracles*, the word *ochēma* meaning not ‘body’ but ‘vehicle’. This use of the word *lepton* gives it an extended meaning, which one could call ‘lighter than light’, since lightness has here been stretched to mean so light that it is barely material at all. (Or one might say it was their way of trying to give a name to what we call plasma, the existence of which they intuited but did not yet understand.) The name *baryon* was thus invented to describe the particles that were very different from electrons, such as protons and neutrons, and which are so much heavier than electrons, having so much more weight, or as one might more correctly say, rest mass. The proton, for instance, has 1836 times more rest mass than an electron, is thus heavy, or as the Greeks would have said, *barys*, ‘weighty’. In 2016, I published a lengthy paper

explaining why protons are exactly 1836 times heavier than electrons, which people interested in more detail on this subject can download from my www.researchgate.net entry, as my explanation was entirely new and had never been suggested before. There are very many types of baryons known now, but we cannot go into such a complicated discussion or give the lengthy lists of them here. The name baryon comes from the ancient Greek word *baros*, which means 'weight'. Electrons are small, fast, and light, and they are in a different class of particles known as leptons, from the ancient Greek word *leptos*, which means 'small' and also 'light, as in faint breezes and light wine'. Coincidentally, the Greeks also used lepton to describe the size of dust particles

14. T.D.C. Bevan, et al., 'Momentum Creation by Vortices in Superfluid 3He as a Model of Primordial Baryogenesis', in *Nature*, Vol. 386, No. 6626, 17 April 1997, pp. 689–92.
15. Vadim Nikolaevich Tsytovich, Gregor Eugen Morfill, Vladimir E. (Yevgenyevich) Fortov, N.G. Gusein-Zade, Boris Aleksandrovich Klumov, and Sergey Vladimirovich Vladimirov, 'From Plasma Crystals and Helical Structures towards Inorganic Living Matter', in *New Journal of Physics*, Vol. 9, 2007, pp. 263ff. (11 pp.)
16. Sadruddin Bankadda, Vadim Nikolaevich Tsytovich, Sergey I. Popel, and Sergey Vladimirovich Vladimirov, 'Self-Organization in Dusty Plasmas', in Yoshiharu Nakamura, Toshiki Yokota, and Padma Kant Shukla (eds.), *Frontiers in Dusty Plasmas*, Proceedings of the Second International Conferences on the Physics of Dusty Plasmas 1999, Elsevier, Amsterdam, 200, pp. 123–34.
17. Vadim Nikolaevich Tsytovich, 'Evolution of Voids in Dusty Plasmas', in *Physica Scripta*, Vol. 2001, T89.
18. Vadim Nikolaevich Tsytovich and Gregor Eugen Morfill, 'Non-linear Collective Phenomena in Dusty Plasmas', in *Plasma Physics and Controlled Fusion*, Vol. 46, No. 128, B527.
19. Vadim Nikolaevich Tsytovich and Gregor Eugen Morfill, 'Non-linear Collective Phenomena in Dusty Plasmas', in *Plasma Physics and Controlled Fusion*, Vol. 46, No. 128, B527.
20. Sergey Vladimirovich Vladimirov, 'Dynamic and Static Structures in Dusty Plasmas', in *Plasma Physics and Controlled Fusion*, Vol. 49, No. 5A, S20.
21. Vadim Nikolaevich Tsytovich, Gregor Eugen Morfill, Vladimir E. [Yevgenyevich] Fortov, N. G. Husein-Zade, Boris Aleksandrovich Klumov, and Sergey Vladimirovich Vladimirov, 'From Plasma Crystals and Helical Structures towards Inorganic Living Matter', in *New Journal of Physics*,

Vol. 9, 2007, pp. 263 ff.

Chapter 5: Great Balls of Fire

1. Mark Stenhoff, *Ball Lightning: An Unsolved Problem in Atmospheric Physics*, Kluwer Academic and Plenum Publishers, New York and Dordrecht, 1999.
2. C. [Cecil] Maxwell Cade and Delphine Davis, *The Taming of the Thunderbolts: The Science and Superstition of Ball Lightning*, Abelard-Schuman, London, 1969.
3. And because ball lightning has often been associated with poltergeist phenomena, and poltergeists have so often been associated with the strange emotional energies of teenage girls, it seems to me that it is not impossible that poltergeist-related ball lightning might be created by intensely neurotic teenage girls' own abnormal energy fields.
4. I have no view on the matter. Robots can certainly be organic. Clunky metallic robots are a childhood fantasy. It is possible that the proponents of 'transhumanism' know all of this very well. After all, I suspect that DARPA is well aware of what I am suggesting. And they probably assume that the clouds are hostile, if only because DARPA assumes everyone and everything is hostile. It is, after all, the job of the security agencies to be paranoid. And they certainly do not let us down in that. Plus, there's a lot of psychosis thrown in. When you get a paranoid psychopath, then you have the real thing, the perfect security agent.
5. Stanley Singer, *The Nature of Ball Lightning*, Plenum Press, New York and London, 1971 (reprinted 1972 and 1978); James Dale Barry, *Ball Lightning and Bead Lightning: Extreme Forms of Atmospheric Electricity*, Plenum Press, New York and London, 1980; Mark Stenhoff, *Ball Lightning: An Unsolved Problem in Atmospheric Physics*, Kluwer Academic/Plenum Publishers, New York, 1999.
6. Yoshi-Hiko Ohtsuki (ed.), *Science of Ball Lightning (Fire Ball)*, Proceedings of the First International Symposium on Ball Lightning (Fire Ball), 4–6 July 1988, World Scientific Publishing Company, Singapore, 1989. The paper by Singer and Barry is 'Ball Lightning – the Continuing Challenge', pp. 1–18.
7. Paul Sagan, *Ball Lightning: Paradox of Physics*, iUniverse, Inc., New York, Lincoln, Nebraska, and Shanghai, 2004. The book is copyright by Paul Snigier, and it appears that Paul Sagan is a nom de plume (the book is dedicated to Carl Sagan, which may be relevant to the choice of nom de

plume); I have been unable to make an unambiguous identification of this author.

8. Ibid., p. 284.
9. Abrahamson, John (ed. and contrib.), *Ball Lightning Theme Issue, Philosophical Transactions A of the Royal Society*, London, 2002. (Contains contributions by John Abrahamson, Alexander Vladimirovich Bychkov, Vladimir L. Bychkov, Celia I. Merzbacher, Stanley Singer, and D.J. Turner.
10. Some of their interesting scientific ideas about ball lightning will come into our discussion later in connection with the nature of complex plasmas. I shall not even attempt to summarize the contents of this fascinating book, as it would take too long, except to point out that it consists of contributions by six separate scientists of high repute, and should be studied carefully by anyone intending to study ball lightning.

    The other source I should mention appeared piecemeal during 2015, and consists of a series of booklets in English translation by two Russian scientists of the Institute of Informatics Problems of the Russian Academy of Sciences in Moscow, named Vladimir Pavlovich Torchigin and Alexander Vladimirovich Torchigin. Vladimir Torchigin is the head of the Department of the Problems of Design of Information Computing Systems of High Parallelism at his Institute. Alexander Torchigin is the son of Vladimir Torchigin, as is a third Torchigin at the Academy, who has not written about ball lightning, Sergey Vladimirovich Torchigin. The English translations are grammatically imperfect in many places, and one must make allowance for that fact in reading the booklets.

    In one of their booklets, the two Torchigins point out that there have been more than 2000 papers and reports about ball lightning published, containing more than 200 theories of what ball lightning is, and then they say: ‘But none of these theories seems to have gained general acceptance because they fail to explain all observed characteristics of the phenomenon.’ They also mention that as little as 20 years ago some scientists still doubted the existence of ball lightning. However, they point out that as there are now more than 10,000 recorded accounts of ball lightning, there can be no doubt that it exists! (Vladimir Pavlovich Torchigin and Alexander Vladimirovich Torchigin, *Clue of Ball Lightning Puzzles: Ball Lightning Is the Light Rather than Matter*, no publisher named so privately published, 2015, pp. 5–6.)

The word ‘the’ in the title is an example of the imperfect grammar of the text. Errors with the use of definite articles are perhaps the single most common error made by non-native translators into English. The theories of Vladimir Torchigin are very interesting and novel. He believes that ball lightning is made out of trapped light rather than plasma. However, he says (and I have slightly improved his grammar): ‘… there is usually no plasma within Ball Light after its generation. There is certainly no plasma after Ball Light penetrates through windowpanes because plasma cannot penetrate through glass.’ (Vladimir Pavlovich Torchigin, *Ball Lightning Physics: No Plasma and Electricity Are Required*, no publisher so privately published, 2015, p. 198.)

Torchigin is erroneous here, but may be forgiven for not knowing about the most recent findings, which are known only to a small number of scientists at the moment. The latest discoveries about complex plasmas are so astounding that we now know that they can indeed penetrate not only glass but any form of solid dense matter. I wish to make the point that the Torchigins have done a good service by discussing confined and trapped light within the context of ball lightning. As we will see later, the creation of ‘a new kind of light’ and the ‘confinement of light’ have now both been accomplished in the laboratory, and ironically, the most exciting part of this work has taken place recently in Russia, though because it is known to such a small number of specialists, it is not yet known to the Torchigins.

We will see later when we come to the full explanation of complex plasmas, which is what I believe that we all are as living entities, that the instinct followed by the Torchigins in attempting to explain ball lightning as confined light without the presence of any plasma is useful and has important and indeed essential insights to offer, because ‘confined light’ is indeed part of the answers we are seeking, but within the contexts of highly complex plasmoids.

11. Pyotr Leonidovich Kapitsa, ‘O Priroda Sharovoi Mulnii’ (‘The Nature of Ball Lightning’, *sharovoi* being ‘ball’ and *mulnii* being ‘lightning’) in *Doklady Akademii Nauk S.S.S.R.* [*Proceedings of the USSR Academy of Science*], Vol. 101, No. 2, 1955, pp. 245–8. An English translation of this article was published in 1961, in: Donald J. Ritchie (ed.), *Ball Lightning: A Collection of Soviet Research in English Translation*, Consultants Bureau, New York, 1961, pp. 11–15.
12. He believes radiation that is reflected off the surface of the Earth causes

interference patterns as a result of which ‘standing waves are set up, and at a distance equal to λ, the wavelength, multiplied by 0.25, 0.75, 1.25, 1.75, etc., there will be antinodes fixed in space at which the intensity of the electric field is doubled as compared with that of the incident wave. Because of the increased intensity in the neighbourhood of these surfaces, conditions will be suitable both for the formation of an initial [electric] discharge as well as for the further development and maintenance of the ionization in the cloud in which the ball lightning is formed.’ (I should explain that the Greek letter *lambda* above is the standard symbol used in physics for ‘wavelength’.)

13. Eugene Paul Wigner, *Symmetries and Reflections: Scientific Essays*, Indiana University Press, USA, 1967, pp. 82–90.
14. Harry Jones, *The Theory of Brillouin Zones and Electronic States in Crystals*, second revised edition, North-Holland/American Elzevier, Amsterdam, 1975.
15. D. Müller-Hillebrand, ‘Ball Lightning’, in Samuel C. Coroniti (ed.), *Problems of Atmospheric and Space Electricity: Proceedings of the Third International Conference on Atmospheric and Space Electricity, 1963*, Elsevier, Amsterdam, 1965, pp. 457–9; the photo is Figure 2 on p. 459.

Chapter 6: When Heaven Was Young

1. *Pistis Sophia*, edited by Carl Schmidt, translation and notes by Violet Macdermot, The Coptic Gnostic Library, Vol. IX, Brill, Leiden, 1978, pp. 184–7. (The textual reference is Book Two, Chapters 83 and 84.) There is an earlier translation of this work by G.R.S. Mead, which is also very good. The Brill volume is 806 pages, because the *Pistis Sophia* is immensely long.
2. This is related in *The Apocryphon of John,* for which see below, footnote 11.
3. In one translation known as the Darby Bible Translation, the bush is described as a thorn-bush. Commentators point out that the Hebrew word for the bush is *seneh*, which is the name of a thorny bush, a species of acacia, common in Sinai. But the original Hebrew language version is lost, and *seneh* is a translation into Hebrew from the Greek Septuagint where the Hebrew translator has used creative licence. (*Seneh* is thus a product of reverse-engineering by a Hebrew translator who has added it, thinking that he was thus being helpful to readers.) In the Septuagint, which is the oldest text of Exodus in existence, the Greek word for the bush is *batos*. That

means a bramble, in other words a wild raspberry or blackberry bush, not any other bush or plant such as buckthorn or acacia.

Theophrastus, the colleague and successor of Aristotle, was the founder of scientific botany, and the authoritative expert on Greek botanical terminology of the fourth century BC, taking precedence even over the herbalist Dioscorides, who lived AD 40–90 and was three centuries later. In his *Peri Phytōn Historias*, III, xviii, 4, Theophrastus explains that *batos* is a broad term for bramble-like plants.

He says: ‘Of the bramble (*batos*) again there are several kinds, showing very great variation; one is erect and tall, another runs along the ground and from the first bends downwards, and when it touches the earth, it roots again; this some call “the ground bramble”. The “dog’s bramble” (the wild rose that we today call the dog rose, thus continuing the ancient Greek name associated for unknown reasons with dogs) has a reddish fruit like that of the pomegranate, it is intermediate between a shrub and a tree; but the leaf is spinous.’ (Theophrastus, *Enquiry into Plants*, translated by Arthur F. Hort, Loeb Classical Library, Harvard University Press, Vol. I, 1916, pp. 270–1.)

Obviously the Burning Bush could not have been either the creeping bramble or the dog rose, and can only be the one that is ‘erect and tall’. As for the masculine noun *batos* meaning a blackberry bush, it is worth noting that the neuter noun *baton* specifically means ‘a blackberry’. The other word for a prickly shrub, often applied to buckthorn for instance, was *rhamnos*, and there was also the word *philukē*, which referred to an evergreen prickly shrub. It seems therefore that if the Septuagint had intended a prickly shrub other than the bramble, such as buckthorn, the word *rhamnos* would have been used instead of *batos.* And if acacia had been meant, its Greek name *akantha* would have been used. Hence the translation of *batos* as *seneh* was evidently incorrect.

It seems that in the earliest surviving text we are stuck with the unlikely and somewhat inglorious bramble, which sprawls at the sides of most English roads and hedges and from which country children pick berries to make jam in the autumn. Somehow, that is extraordinarily mundane for a divine epiphany. It is hardly surprising, therefore, that we are never told this by theologians, as the idea that Moses went up onto a mountain in order to converse with a burning blackberry bush is unimpressive.

4. It is necessary to say more about the mysterious ‘Angel of the Lord’, since

this anomaly in both the Jewish and Christian religious traditions is usually ignored. Who and what was the ‘Angel of the Lord’? This divine entity of the burning bush, who was not ‘the Lord’ but was someone or something else closely associated with ‘the Lord’, was known in very ancient Judaism (which testifies to the antiquity of the Moses account, I might add), but had been either forgotten or banished as heretical by the time of the sect of Judaism known as the Sadducees, who were the ‘Temple Jews’ of the Jerusalem Temple against whom Jesus struggled so energetically.

The Sadducees were a very vicious and murderous ruling theocratic sect. Biblical scholars have discovered that during the lifetime of Jesus, the Sadducees arrested and executed more than 6000 Jewish rabbis of the Pharisee sect, solely because they were rivals for control. The Sadducees were therefore a violent, bloodthirsty mafia using religion as their pretext for control over society. What the Sadducees did to the more mystical Jews such as the Gnostics was probably even worse than the massacres of the Pharisee rabbis, though the numbers of Gnostics within reach of Jerusalem was much smaller. Some of them, the Essenes, had fled to live in caves beside the Dead Sea, in order to avoid being murdered by the Sadducees.

The seizure and execution of Jesus was part of a wider and uniform purge by the Sadducees of all the Jewish rabbis or religious leaders who in any way challenged the Sadducees’ monopoly of power. I could elaborate on this subject and explain the real significance of the ‘overturning of the tables of the moneychangers in the Temple’ by Jesus, but this is not the place to do so, interesting as the subject is. North of Jerusalem lay the region of the Samaritans, who were a branch of the Jewish people who had escaped the control of the Jerusalem Temple mafia. They preserved some of the more ancient Jewish knowledge and traditions that the Sadducees had thrown overboard. Among these was the tradition and explanation of ‘the Angel of the Lord’.

The Dutch Biblical scholar Jarl Fossum was the first academic who explored in depth this fascinating information, which he articulated in his PhD thesis of 1981 (supervised by the famous Professor Gilles Quispel, one of the world’s leading Biblical scholars) and in the same year in an article in a scholarly anthology, Fossum, Jarl, ‘Samaritan Demiurgical Traditions and the Alleged Dove Cult of the Samaritans’, in Roelof van den Broek and Maarten Jozef Vermaseren (eds.), *Studies in Gnosticism and Hellenistic*

Religions Presented to Gilles Quispel on the Occasion of His 65th Birthday, Brill, Leiden, 1981, pp. 143–60.

This was later followed by his book, *The Name of God and the Angel of the Lord: Samaritan and Jewish Concepts of Intermediation and the Origin of Gnosticism*, J.C.B. Mohr, Tübingen, 1985, which was based on his thesis. The ancient Jewish conception preserved by the Samaritans was that 'the Angel of the Lord' was the divine entity who actually created the bodies of men, while 'the Lord' infused spirits into those bodies. As Fossum puts it: '… the creation of the body of Adam from the earth is ascribed to the Angel of the Lord, while the infusion of the spirit into this corpus is a work assigned to God …'

The Samaritans claimed to know the actual name of the Angel of the Lord, which was Kebala, which means 'the Secret'. They maintained that it was the Angel Kebala who really resided in the sanctuary of the Temple, not God himself (who remained in Heaven), and that Kebala was the mediator between God and humankind. Moreover, his glowing or burning nature is suggested by the Samaritans calling Kebala 'the Glory who fills the Tabernacle', and they say that he also manifested himself as Glory at the door of the Tent of Meeting in the passage of Exodus that commences at 21, 42 (ibid., pp. 143, 157–9). The Samaritans claimed that Kebala abided at Bethel, which means 'House of God', on top of Mount Gerizim.

I cannot go further into this interesting ancient variation of Judaism, which has been lost now for nearly 2000 years, but I wanted to offer this information to help explain the identity of 'the Angel of the Lord' for justly puzzled readers. A few years before Fossum's important researches into the Samaritans, Alan F. Segal had partially addressed the problem in his fascinating book *Two Powers in Heaven*, in which he speaks of numerous early Jewish sects (when Judaism was not yet forcibly unified by a central theological authority at the central Jerusalem temple), who insisted that God had a divine deputy (a lesser god) who did all his work for him regarding the Earth and humans.

Probably the most frequently occurring name for this entity is Metatron. Segal also quotes numerous rabbinical sources regarding further details of the myth or legend of the ascent of Moses up the mountain. Some of these contain further plasmic details. For instance, there is a strong Jewish tradition that Moses was taken up from the mountain to heaven in a 'cloud', and a text known as the Pesikta Rabbati (20, 4), says:

> ‘Then a troop of angels of destruction, strong and mighty, who are set round about the throne of glory, met him. When Moses reached them, they sought to burn him with the breath of their mouths. What did the Holy One, blessed be He, do? He spread something of his own splendour about Moses … (this) prove(s), according to Rabbi Nahum, that the Almighty spread about Moses something of the splendour of the presence of God, which is His cloud.’
>
> Alan F. Segal, *Two Powers in Heaven: Early Rabbinic Reports about Christianity and Gnosticism*, Brill, Leiden, 1977, p. 145.

One is tempted to wonder if the ancient Jews somehow realized that the Kordylewski Clouds existed, perhaps as a result of telepathic shamanic journeys. One could even construe these ancient Jewish ideas as suggesting that the Kordylewski Clouds are indeed Metatron. The subject of Metatron, who was traditionally the highest of the angels in both mystical Judaism and Islam, is especially intriguing considering that there was an ancient Jewish tradition that there were two Metatrons. One was called Prince of the Countenance and the other was called Yahoel. And one ancient text says that ‘the Ancient of Days’ mentioned in the Biblical Book of Daniel is really Metatron.

Metatron is also mentioned in the book 3 Enoch, and Enoch was said to be transformed into (or absorbed into) Metatron when he was raised in his ball of fire to the heavens. In that book, Metatron is also said to have seventy names, of which the first and chief was Yahoel (sometimes abbreviated as Yol). The Muslim name of Metatron is Mitatrush, which means ‘the angel of the veil’. In the mystical Jewish book *The Apocalypse of Abraham*, Yahoel is described as ‘the spiritual teacher of the Patriarch’ (Abraham), who taught Abraham the whole of the Torah.

The great scholar Gerschom Scholem concludes that Metatron, whose original name was Yahoel, was ‘the highest of all created beings’. The name Yahoel was a ‘mystic name’ according to Scholem and thus had no etymological meaning. The suffix el is, I am told, an honorary termination for the name of any angel, and means ‘lord’, used in the polite sense only, not in the literal sense of ‘the Lord’. As for Yaho (the part of the name that precedes the honorific el), Scholem points out that it is an abbreviation of the name YHWH, i.e., Yahweh, whom we call in English Jehovah. But he stresses that the intention was not that Yahoel was meant to be Jehovah, but

that his high status was meant to be signalled by the fact that his mystic name contained the name of the supreme God.

Scholem says that this explains the puzzling passage in the Book of Exodus (XXIII, 20 ff.): 'Beware of him for my name is in him.' And in The Apocalypse of Abraham, Yahoel is quoted as saying to Abraham: 'I am called Yahoel … a power in virtue of the ineffable name that is dwelling in me.' And Jewish Gnostic literature makes explicit that Yahoel was not Yahweh, but was 'the lesser Yaho', (Gerschom Scholem, *Major Trends in Jewish Mysticism*, Schocken Publishing House, Jerusalem, 1941, pp. 66–9). That is essentially the same as saying that he was the Angel of the Lord, who as we know appeared as a glowing ball, so that we may assume that Yahoel was one, too.

This subject could be discussed at very great length indeed, to the great discomfort of 'normative rabbinical Judaism', as Gerschom Scholem (whom I was fortunate enough to know) called the dominant Judaism that exists in our contemporary world. The earliest name for God in Judaism appears to have been Elohim, and there is no escaping the embarrassing fact that that name is plural. In other words, there is little indication that the earliest Judaism was monotheistic, and 'the Angel of the Lord' was apparently left over from the earliest Judaism and only awkwardly accommodated in orthodoxy.

5. Another translation of these passages may be found in the book *1 Enoch: A New Translation*, by George W.E. Nickelsburg and James C. VanderKam, Fortress Press, Minneapolis, Minnesota, USA, 2004, pp. 34–6.
6. It was G.R.S. Mead who spotted and translated this fragment of a lost work by Damascius, which he found in the tenth-century Byzantine encyclopaedic lexicon named the *Suda*, which until contemporary times was mistakenly called 'Suidas'. (Refs: p. 194 of Bekker's edition of 1854, or I. 850 f. of Bernhardy's edition of 1853.) See G.R.S. Mead, *The Subtle Body*, J.M. Watkins, London, 1919, p. 80 and note. The fragment comes from a lost work entitled *Life of Isidorus.* Isidorus was the husband of Hypatia and friend of Proclus and Marinus. What a pity that work is lost!

   Mead's translation of this passage by Damascius first appeared in the quarterly journal he edited named *The Quest*, Vol. I, No. 4, July 1910, pp. 708–9, where he inserted some of the Greek words of the text as part of an extended discussion of the terminology used. To discuss the many points arising from all of this would unfortunately be out of place here.
7. Translation by G.R.S. Mead; see Mead, op. cit., p. 88 and note. A more

recent translation has also been published since Mead's time; see Philoponus, *On Aristotle's 'On the Soul'*, I, 1, 18. 27–33, translated by Philip J. van der Eijk, *Philoponus on Aristotle's 'On the Soul I.1–2'*, Cornell University Press, Ithaca, New York, USA, 2005, p. 34.

His translation reads: '… there is yet another body eternally attached to it [the pneumatic body], which is celestial and therefore eternal, which is called luminous or astral. For as the soul belongs to the cosmic entities, it must have a share assigned to it which it manages, being part of the cosmos; and if it is always in motion and always has to be active, it must have a body eternally attached to it which it will keep alive always; this is why they say the soul always has the luminous body, since this is eternal.' On pp. 123–4, van der Eijk's footnote 183 gives a lengthy historical survey of this concept of a 'radiant' or 'luminous' body, citing Plotinus, Porphyry, Iamblichus, Synesius, Hierocles, Proclus, and numerous modern scholars who have discussed the subject. We do not have space to survey this fascinating subject here.

8. *The Apocalypse of Adam* (the fifth and final tractate from Nag Hammadi Codex Five), edited and translated by George W. MacRae, in *The Coptic Gnostic Library: Nag Hammadi Codices V, 2–5 and V with Papyrus Berolinensis 8502, 1 and 4*, ed. by Douglas M. Parrott, Brill, Leiden, 1979, pp. 151–95. See also Charles W. Hedrick, *The Apocalypse of Adam: A Literary and Source Analysis*, Wipf & Stock Publishers, Eugene, Oregon, USA, 2005, for further background and analysis of this tractate.
9. *Marsanes* (from Nag Hammadi Codex 10), introduced, edited and translated by Birger A. Pearson, in *The Coptic Gnostic Library: Nag Hammadi Codices IX and X*, ed. by Birger A. Pearson, Brill, Leiden, 1981, pp. 229–347.
10. *The Paraphrase of Shem* (Tractate One of Nag Hammadi Codex Seven), introduced and translated with commentary by Michel Roberge, Brill, Leiden, 2010.
11. *The Apocryphon of John* (from four sources: Nag Hammadi Codices II, 1; III, 1; and IV, 1, as well as Papyrus Berolinensis 8502, 2), edited and translated by Michael Waldstein and Frederik Wisse, Brill, Leiden, 1995. The Noah passage may be found preserved in three slightly varying versions on pp. 162–5, all three of which specifically mention the 'luminous cloud'.
12. He also postulated the existence of something he called pneuma, which existed and intermingled with things here on earth and was, for instance,

present in animal and human sperm. These ideas are expressed in Aristotle's lengthy zoological works, which few people today ever read. I had to read them all thoroughly because I was asked to do a general review of them for *Nature* some years ago. (Robert Temple, 'The Roots of Nature', in *Nature*, Vol. 359, No. 6395, 8 October 1992, pp. 489–90.) This article may be downloaded from my researchgate.net entry. In it, I reconstructed the outline of his 'lost' zoological work, *Close Investigations of Things According to Kind a*nd I also surveyed all of the botanical works of Aristotle's successor and friend, Theophrastus.

Before writing that article, I read closely every word in translation of Aristotle's surviving zoological writings and Theophrastus's botanical writings, all the footnotes, and checked lots of the original text with particular attention to the vocabulary, as I went along, which was an immense task, frankly, but well worth it. I do not believe that many classical scholars have ever done that. As for reading them all the way through in Greek, I have known a few scholars (such as Alan Gotthelf) who did that for the zoological works, but they did not extend their efforts to the botanical works as well.

Pneuma and aithēr were related, but aithēr was the pure form, which was restricted to the higher levels of reality, and pneuma was that lower and distinctly impure form that intermingled with and helped to animate ordinary matter. Aristotle's concept of pneuma had a big influence on early Church Fathers and Christian theology, helping to inspire the Christian concept of the logos as the 'word of God' and Jesus as the aethēric being who became pneumatic to save us by bringing some of the aithēr down into corrupt matter to infuse it with light. These concepts inspired the Gospel of John in the Bible, and permeated even more thoroughly the ancient Gnostic texts. But these subjects are all another story that we cannot discuss further here.

13. Aristotle also stated that he believed there were exceptions to the parallel postulate in geometry, thus anticipating modern relativity theory. And he discovered the Eustachian tubes in the human ear approximately 1900 years before Bartolomeo Eustachi (1500–1574), to whom the discovery is normally attributed, and after whom they are named. For an account of this, see Robert Temple, 'Aristotle as Anatomist and Dissector: The Marvels of Nature', in *Helix: Amigen's Magazine of Biotechnology*, Vol. II, Issue 2, Bugamor International BV, Almere, Netherlands, 1993, pp. 49–55. The text is Aristotle, *Historia Animalium*, Book One, 502a17-502b27. This article

may be downloaded from my Researchgate entry or from my personal website. But enough of Aristotle, that is, if one can have enough of Aristotle.

14. The Chinese texts for these passages, with translations and comments, may be found in Herbert A. Giles, 'The Remains of Lao Tzu', in *The China Review: or, Notes and Queries of the Far East*, China Mail, Hong Kong, Vol. XIV, issue for March and April, 1886, p. 244.
15. Olivia Temple and Robert Temple, *The Sphinx Mystery*, Inner Traditions, Rochester, Vermont, USA, 2009, p. 393.
16. John Coleman Darnell, *The Enigmatic Netherworld Books of the Solar-Osirian Unity*, Academic Press Fribourg, Switzerland, 2004, p. 365, footnote 389.

Chapter 7: Kristian Birkeland's Miraculous Discovery

1. Harald Falck-Ytter, *Aurora: The Northern Lights in Mythology, History and Science*, Bell Pond Books, Hudson, New York, USA, 1999, p. 49. This is the English translation of *Das Polarlicht*, Stuttgart, 1983.
2. Aristotle, *Meteōrologikōn* (*Meteorology*, but often referred to in Latin as the *Meteorologica*), Book One, Chapters 4 and 5, 341b1-342b24. See Aristotle, *Meteorologica*, trans. by H.D.P. Lee, Loeb Classical Library, Harvard University Press, 1952, pp. 28–39.
3. Falck-Ytter, op. cit., p. 45.
4. Aristotle, op. cit., Chapters 3 and 4, 340b25-7 and 341b1-24, pp. 19–23, 29–31 ('We maintain that the celestial region as far down as the moon is occupied by a body which is different from air and from fire … what we are accustomed to call fire, though it is not really fire … We must suppose therefore that the reason why clouds do not form in the upper region is that it contains not air only but rather a sort of fire … immediately beneath the circular celestial motion comes a warm and dry substance which we call fire. We must think of the substance we have just called fire as extending round the outside of the terrestrial sphere like a kind of inflammable material …')
5. Heraclitus, *Homeric Problems*, ed. and translated by Donald A. Russell and David Konstan, Brill, Leiden, 2005, Book 23, p. 45.
6. Plutarch, 'Life of Lysander', Chapter 12, in *Plutarch's Lives* (in four vols.), trans. by Aubrey Stewart and George Long, Bohn's Classical Library, George Bell & Sons, London, 1895, Vol. 2, pp. 294–5.
7. Lucius Annaeus Seneca, *Questiones Naturales* (*Natural Questions*), trans.

as *Physical Science in the Time of Nero: Being a Translation of the* Questiones Naturales *of Seneca*, by John Clarke, with Notes by Sir Archibald Geikie, Macmillan and Co., London 1910, pp. 37–41; more recently, Seneca, *Naturales Questiones*, 2 vols., trans. by Thomas H. Corcoran, Loeb Classical Library, Harvard University Press, 1971–2, Vol. I, pp. 73–83.

8. Pliny, *Natural History*, Book Two, Chapter 26 or 27 depending on the edition. In Bohn's Classical Library, trans. by John Bostock and H.T. Riley, Henry G. Bohn, London, 1855, Vol. 1, pp. 60–1, it is Chapter 27. In the Loeb Classical Library, trans. by H. Rackham, Harvard University Press, Vol. 1, p. 241, it is Chapter 26, which becomes 27 in the middle of a sentence. Puzzled by this, I checked the earliest translation done in Elizabethan times by Philemon Holland, of which I am fortunate to own copies of both the first edition of 1601 and the second edition, which appeared in 1635, and there it is Chapter 27, and the passage is found on p. 17.

   Holland's translation reads: 'There appeareth in the Sky also a resemblance of bloud, and (than which nothing is more dread and feared of men) a fiery impression, falling from out of heaven to earth, like as it hapned in the 3 yeare of the 107 Olympiad, at what time King Philip made all Greece to shake with fire and sword.' The Bohn's translation reads: 'There is a flame of a bloody appearance (and nothing is more dreaded by mortals) which falls down upon the earth, such as was seen in the third year of the 103rd Olympiad, when King Philip was disturbing Greece.' The Loeb translation says: 'There also occurs a yawning of the actual sky, called *chasma*, and also something that looks like blood, and a fire that falls from it to the earth – the most alarming possible cause of terror to mankind; as happened in the third year of the 107th Olympiad, when King Philip was throwing Greece into disturbance.'
9. Falck-Ytter, op. cit., pp. 54–5.
10. Jean-Jacques d'Ortous de Mairan, *Traité Physique et Historique de l'Aurore Boreale* (*Physical and Historical Treatise concerning the Aurora Borealis*), Pierre Mortier, Amsterdam, 1735, 393 pp., with 17 folding plates. On the title page it is stated that the book is composed of a 'suite' of papers delivered to the Académie Royale des Sciences (in Paris) in 1731. I have an original copy of this book.
11. I have a copy also of this German edition, which appears in Wolf Balthazar Adolph von Steinwehr (1704–1771), translator and editor (with some

commentary), Vol. 9 of *Der Königliche Academie der Wissenschaften in Paris Physiche Abhandlungen … welcher die Jahre 1731, 1732, in sich hält*, Breslau, 1753. (Please note that Wikipedia is incorrect in listing the year 1760 as publication date for this volume, though it may have been reprinted then perhaps.) The de Mairan material extends from p. 248 to p. 564. De Mairan is called von Mairan in this volume.

The Aurora Borealis in German is called *die Nordlichtern* (the Northern Lights). Only 9 of the 17 plates that appear in the 1735 French volume are found in this German edition. This series of volumes in German is essentially a translation of the Proceedings of the Royal Academy of Sciences in Paris. It should be noted that the 1731 publication by the Academy in Paris was used for the translation, and not the 1735 book, which may have been expanded and provided with additional illustrations. I have not compared the 1731 publications with the 1735 volume, so cannot state anything authoritatively about variations in the texts.

12. Knud Leem, *Beskrivelse over Finmarkens Lapper* (*An Account of the Lapps of Finmarken*), Copenhagen, 1767. A reproduction of Leem's engraving was published by Lemström, Vol. 1, p. 238, and is reproduced from that on this book's website. For Lemström, see footnote 17 below.
13. Sir Humphry Davy, 'Of Electrical Attraction and Repulsion, and Their Relations to Chemical Changes', in *Elements of Chemical Philosophy*, London, 1812.
14. Baron Karl von Reichenbach, *Researches on Magnetism, Electricity, Heat, Light, Crystallization, and Chemical Attraction in Their Relation to the Vital Force*, translated and edited by William Gregory, Parts I and II, London, 1850, p. 5.
15. Ibid., pp. 445–51.
16. Arthur-August De La Rive, 'Nouvelles Recherches sur les Aurores Boréales et Australes et Description d'un Appareil', Extrait des *Mémoires de la Societé de Physique et d'Histoire Naturelle de Genève*, Vol. 16, 2nd Part, Geneva, 1862.
17. Karl Selim Lemström, 'On the Periodic Variations in Some Meteorological Phenomena, Their Connection with the Changes of the Solar Surface and Their Probable Influence on the Vegetation', in *Finsk Tidfkrift*, 1878. This article is in Swedish.
18. Sophus Tromholt, *Under the Rays of the Aurora Borealis in the Land of the Lapps and Kvaens*, edited by Carl Siewers, 2 vols., Houghton Mifflin, Cambridge, Massachusetts, USA, 1885. The section entitled 'On the Aurora

Borealis' is found in Vol. 1, pp. 192–288, with numerous illustrations.

19. Adam F.W. Paulsen, *Résumé des Travaux de l'Expédition Internationale Danoise Faits a Godthaab (Groënland Occidental) 1er Aout 1882–31 Aout 1883* [1 August 1882–31 August 1883], Danish Meteorological Institute, Copenhagen, 1884.
20. Nils Adolf-Erik Nordenskiöld, 'Sur les Aurores Boréales Observées Pendant l'Hivernage de la Véga au Détroit de Behring (1878–9)', in *Annales de Chimie et de Physique* (*Annals of Chemistry and Physics*), Sixth Series, Vol. 1, Paris, January 1884, pp. 5–72. His earlier publication in Swedish was 'Om Norrskeneen under Vegas Öfvervintring vid Berings Sund (1878–9) af A.-E. Nordenskiöld': extracted from *Vega-expeditionens Vetenskapliga Iaktagelser*, pp. 403–53 of Vol. 1, Stockholm, 1882. Nordenskiöld published a mammoth account of the Vega Expedition in 5 volumes, as well as a popular summary in 2 volumes, but these extracts related to the Aurora Borealis, as they appeared first in the original Swedish and then in the French translation.
21. Kristian Birkeland, in *Archives des Sciences Physiques et Naturelles* (*Archives of the Physical and Natural Sciences*), Geneva, June 1896 (in French). Perhaps Birkeland chose this journal because in its earlier incarnation it had published de la Rive's account of the aurorae in 1862, thirty-four years before; see footnote 16 above.
22. Kristian Birkeland, *Expedition Norvegienne 1899–1900 pour l'Étude des Aurores Boreales Resultats des Recherches Magnetiques* [*sic*. some acute accents omitted from title as printed], Jacob Dybwad, Christiania [now called Oslo], Norway, 1901. See p. 39, where in a footnote Birkeland refers to the article published by himself in the *Archives des Sciences Physiques et Naturelles* (see footnote 16 above). I have not found or consulted the original article and do not have its title and pagination.
23. Alv Egeland and William J. Burke, *Kristian Birkeland, The First Space Scientist*, Astrophysics and Space Science Library 325, Springer Verlag, 2005.
24. Lucy Jago, *The Northern Lights*, Penguin Books, London, 2001.
25. Kristian Birkeland, *The Norwegian Aurora Polaris Expedition 1902–1903*, 2 vols., Christiania [now Oslo], Vol. 1, 1908, and Vol. 2, 1913.
26. Alexander Piel, *Plasma Physics: An Introduction to Laboratory, Space, and Fusion Plasmas*, Springer Verlag, Heidelberg and Dordrecht, 2010, p. 7.
27. Kristian Birkeland, *Norwegian Aurora Polaris Expedition 1902–1903*, 2 vols., Christiana [now Oslo], Vol. 1 and Vol. 2, 1908, 1913.

Chapter 8: The Cosmic Web

1. I should point out that all power transmission lines on Earth are double, either in the form of a ‘two-wire line’ or a single wire inside a tube, which is known as a coaxial cable. (Transmission lines can of course be multiple, but they must at the very least be double.)
2. John P. Cullerne and Anton Machacek, *The Language of Physics: A Foundation for University Study*, Oxford University Press, 2008, p. 51.
3. This reminds me of the Berry Phase in physics, named after Michael Berry, a professor at Bristol University. He showed that if you mathematically transport a vector (the technical name for a line in a diagram showing the direction of a certain force, and which can actually be drawn with an arrow showing that direction) along the surface of a sphere from point A to point B, by the time it gets there it is not straight any more but is at a slight angle, because its path has curved due to moving along the spherical surface. (Berry’s student John Hannay demonstrated that this is true in classical physics as well as in quantum physics, and the angle is named after him as the Hannay Angle.) I mention this because if we consider the spiralling aspect of the electric field, introducing as it does a curved path rather than a straight one, perhaps the introduction of that curvature causes the small deflected angle of the Hall Effect to appear, and the angle of the Hall Effect is therefore related to the Hannay Angle because of the curvature.
4. Anthony L. Peratt, *Physics of the Plasma Universe*, 2nd edition, 2015, p. 373.

Chapter 9: The Cold Sun

1. Lang, Kenneth R., *The Cambridge Encyclopaedia of the Sun*, Cambridge University Press, 2001, p. 111.
2. Arthur J. Hundhausen, ‘Plasma Flow from the Sun’, in Oran R. White (ed.), *The Solar Output and Its Variation*, Colorado Associated University Press, Boulder, Colorado, USA, 1977, pp. 36–9.

Chapter 10: Invisible Earth

1. Thomas Gold, *The Deep Hot Biosphere*, Copernicus, Springer Verlag, New York, 1999. He did not remain connected with plasma research, however, as he had other interests such as cosmology and, towards the end of his life, deep carbon stores beneath the surface of the Earth. Tommy was also a founder, with Fred Hoyle and Hermann Bondi, of the steady state theory of

the Universe, which neither he nor Fred (whom I also knew well) ever abandoned, though of course they held to it in a modified form to take account of the many objections made against it by cosmologists determined to believe in what Fred had derisively named ‘the Big Bang’, a name that has stuck and unfortunately is still taken seriously, along with the ridiculous theory to which it is attached.

In 2017, I published a paper proposing an alternative explanation of what is known as ‘the cosmic microwave background radiation temperature’, the primary basis for the Big Bang Theory. Robert Temple, ‘A New Explanation for the Cosmic Microwave Background Radiation Temperature’, in *Journal of Cosmology*, Vol. 26, No. 11, 2017, pp. 14790–803.

Chapter 11: Radiant Matter, Plasma and Plasmoids

1. Winston Harper Bostick, ‘Experimental Study of Ionized Matter Projected across a Magnetic Field’, *Physical Review*, Vol. 104, No. 2, 15 October 1956, pp. 292–9, plus seven pages of captioned plates.
2. Robert Temple, ‘Is Particle Mass a Function of Degrees of Freedom?’, in *Journal of Cosmology*, Vol. 26, No. 3, January 2016, pp. 13995–14090; see p. 66 of the paper.
3. E.G. Harris, R.B. Theus, and Winston Harper Bostick, ‘Experimental Investigations of the Motion of Plasma Projected from a Button Source across Magnetic Field’, *Physical Review*, Vol. 105, No. 1, 1 January 1957, pp. 46–50.
4. Winston Harper Bostick and Lyman Spitzer, *Plasma Physics: Selected Reprints*, American Association of Physics Teachers, 1963.
5. Winston Harper Bostick, ‘Plasmoids’, in *Scientific American*, Vol. 197, No. 4, October 1957, pp. 87–94.
6. Winston Harper Bostick, ‘Experimental Study of Plasmoids’, in Bo Lehnert (ed.), *Electromagnetic Phenomena in Cosmical Physics*, Proceedings of the International Astronomical Union Symposium No. 6, held in Stockholm, August 1956, Cambridge University Press, 1958, pp. 86–98 (includes one and a half pages of discussion at the end, including further elucidations by Bostick).

Chapter 12: Plasma Comes Alive

1. Kaushik Roy and Prasanta Chatterjee, *Nonlinear Structures in Dusty*

Plasma, Lambert Academic Publishing, Saarbrücken, Germany, 2012, p. 2.

2. I have discussed the Kelvin Scale at some length in my scientific paper of 2017 about the cosmic background radiation: Robert Temple**,** 'A New Explanation for the Cosmic Microwave Background Radiation Temperature', in *Journal of Cosmology*, Vol. 26, No. 11, 2017, pp. 14790–803.
3. Mazuo Minami, Chikara Kojima, Takeo Ohira, and Osamu Ishihara, 'Microwave Measurement of Decaying Plasma in Liquid Helium', Appendix One to Osamu Ishihara, 'Final Report on Study of Cryogenic Plasma in Superfluid Liquid Helium', submitted to AOARD 23 August 2005, declassified by the US Department of Defense. The Appendix was released for publication in *Transactions on Plasma Science of the IEEE*, August 2005 (8 pp.)
4. Ibid., p. 4.
5. Norman R. Bergrun, *Ringmakers of Saturn*, Pentland Press, Edinburgh, 1986. The late Norman Bergrun was a scientist who had an entirely different explanation for the 'spokes'. In 1986, he published his book *Ringmakers of Saturn*, which suggested that not only the spokes of Ring B but the whole of Ring A of Saturn were being artificially created by mysterious cylindrical craft of extraterrestrial origin, possibly manned by intelligent robots. Both in his book and in many later talks, some of which can readily be found on the internet, Bergrun has shown photographs of strange cylinders of enormous size orbiting Saturn, which are spewing out what he calls 'streamers'. He claims that these are plasma streamers, although he does not appear to have any idea as to why this is being done.

   His idea of strange cylindrical craft emitting streamers of plasma arose from a chance personal observation that he made of such a craft in the atmosphere off the coast of California in September 1971, which was also viewed by his wife from a separate location. By triangulating their observations, he and his wife were able to place the 'UFO' at a distance of sixty miles off the coast of Monterey Bay. Bergrun calls these craft 'EMVs', for electromagnetic vehicles. Although this all sounds very fanciful, I was told in 2015 by a friend who knows top scientists and officials at DARPA, the Defence Advanced Research Projects Agency of the US Government (by far the most advanced 'weird science' organization or agency in America, which developed stealth aircraft, among other things), that the DARPA people not only know of but accept and worry

about the intrusive cylindrical craft, which they accept are ‘not of this Earth’.

They may come from ‘another world’ ‘another dimension’, ‘the future’, or whatever you like, but they do not come from any human civilization of the present day. Some of the cylindrical craft can be of such enormous size that no contemporary civilization on Earth would be capable of constructing anything so huge, even if it were sitting on the ground. It is apparently known and accepted by the scientists at DARPA that these craft have intimate connections with a highly advanced plasma science that is far beyond our present understanding or capacities. Apparently they also believe that they are not manned by living beings, but by hyper-intelligent robots that come from ‘somewhere else’, but no one knows where.

No living entities could accomplish these feats, as the gigantic tasks involved could only be undertaken by robots over extremely long periods of time, far exceeding any conceivable human or other organic lifespans. Just in case anybody thinks that constructing spaceships by robots is far-fetched, I can point out that we humans are already doing it. The London *Sunday Times* published on 15 August 2021 (page 9 in the ‘Money’ section) an article entitled ‘Backing the spaceships being built by robots’, which reported that the American company Relativity Space is building ‘its “Stargate” factory (which) will build rockets through 3D printing’ and assemble by robots the more than 100,000 parts that must go into each spaceship.

I mention all of this about Bergrun’s ideas in passing without personal comment, because it is not the subject of this book. However, it appears that the urgent impetus behind much of the advanced plasma research going on at the moment comes from DARPA, who are desperate to try to understand the intruders. (Another reason is that stealth aircraft can be much improved if Bose-Einstein condensate technology can be mastered for the exterior skins of the planes. That relies upon extraordinary discoveries which have been made since 2010. Although this relates to our subject, it has been necessary to remove my account of it from the book for reasons of space. The technology is named after Satyendra Nath Bose (an Indian) and Albert Einstein. Information about its basic principles can be found on the web.)

6. Douglas C.B. Whittet, *Dust in the Galactic Environment*, Institute of Physics Publishing, Bristol, Philadelphia and New York, 1992, pp. 1–2.
7. Vadim Nikolaevich Tsytovich, Gregor Eugen Morfill, Vladimir E.

[Yevgenyevich] Fortov, N.G. Husein-Zade, Boris Aleksandrovich Klumov, and Sergey Vladimirovich Vladimirov, 'From Plasma Crystals and Helical Structures towards Inorganic Living Matter', in *New Journal of Physics*, Vol. 9, 2007, pp. 263 ff.

8. Dietmar Block and André Melzer, 'Imaging Diagnosis in Dusty Plasmas', in Michael Bonitz, Norman Horing, and Patrick Ludwig (eds.), *Introduction to Complex Plasmas*, Springer, Berlin, 2010, p. 136.
9. Fred Hoyle, *The Black Cloud*, Heinemann, London, 1957. This novel concerns a large black cloud in outer space, which possesses a high degree of intelligence. This science fiction novel caused a considerable sensation with the public when it was published, and established Fred Hoyle as one of the world's major science fiction authors. Such was the popular clamour for more such intelligent science fiction from Hoyle that he was approached by the BBC and, with the BBC producer John Elliot, wrote a famous TV drama series called *A for Andromeda*, broadcast in 1961, which was followed by *The Andromeda Breakthrough* in 1962. These caught the popular imagination, and people still talk about them all these many decades later. *A for Andromeda* was made into a feature film in 2006. *The Black Cloud* has never been filmed.

Chapter 13: The Mysterious Case of the Dirty Gas

1. The first one I saw (unsigned) was in the London *Daily Telegraph*, 23 September 2015, and was entitled 'Why We Are All Under a Cloud (of Germs, That Is)'. On the same day, the BBC News website carried an article by James Gallagher, the BBC's Health Editor, entitled 'Everyone Has a "Microbial Cloud"'. Gallagher speculated: 'So should we all take extra showers?' But a British bacteriologist whom he consulted told him 'It wouldn't help.' Adam Altricher, a researcher working with Meadow, told him on the phone: 'We need to understand that we're not sterile and this is something completely natural and healthy.'
2. James Meadow, Adam E. Altrichter, Ashley C. Bateman, Jason Stenson, G.Z. Brown, Jessica L. Green, and Brendan J.M. Bohannon, 'Humans Differ in Their Personal Microbial Cloud', *PeerJ*, 22 September 2015, at https://doi.org (the International DOI Federation, or IDF).
3. Gregor Morfill, Yuri Baturin, and Vladimir Fortov, *Plasma Research at the Limit: From the International Space Station to Applications on Earth*, Imperial College Press, London, London, 2013, pp. 231–2.
4. G.M. Baule and R. McFee, 'Detection of the Magnetic Field of the Heart',

in *American Heart Journal*, Vol. 66, 1963, pp. 95–6. This was followed two years later by their paper ‘Theory of Magnetic Detection of the Heart’s Electrical Activity’, in the *Journal of Applied Physics*, Vol. 36, 1965, pp. 2066–73.

5. David B. Geselowitz, ‘On the Magnetic Field Generated Outside an Inhomogenous Volume Conductor by Internal Current Sources’ in *Transactions of the IEEE* Magazine, MAG-6, 1970, pp. 346–7.
6. David B. Geselowitz, ‘Model Studies of Electric and Magnetic Fields of the Heart’, in *Journal of the Franklin Institute*, Vol. 296, No. 6, December 1973, pp. 379–91. He then went on to become a world expert on this subject.
7. Freeman Widener Cope, ‘Activation Energies of Acceleration and Hypoxia Stress’, Report No. 5 for the Bureau of Medicine and Surgery, Naval Air Development Center, Aerospace Medical Research Department, 2 July 1970, declassified sometime subsequent to 1979.
8. W. Edward Mann, *Orgone, Reich & Eros: Wilhelm Reich’s Theory of Life Energy*, Simon and Schuster, New York, 1973, pp. 38–9.
9. David Talbot, *The Devil’s Chessboard: Allen Dulles, the CIA, and the Rise of America’s Secret Government*, Harper Collins, London, 2015, p. 56. So eager was Dulles to reach an accommodation with the Nazis before the Second World War ended that he initiated his own secret peace plan entitled Operation Sunrise, falsely claiming that he was a personal representative and close friend of President Roosevelt. In pursuit of his plan, he secretly negotiated a peace deal, entirely without authority, with SS General Karl Wolff, who had previously been Himmler’s Chief of Staff (Himmler was so fond of Wolff that he called him ‘Wolffie’).

   Wolffie was also popular with Hitler, was the principal liaison between Hitler and Himmler, and was always welcome at Hitler’s dinner parties. The Nazi High Command used to cite Wolffie as ‘the ideal Aryan’. As an old man, Wolffie recalled: ‘Hitler wanted to have me nearby, because he knew that he could rely on me completely. He had known me for a long time, and rather well.’ Despite being directly ordered by President Roosevelt not to negotiate with Wolffie, Dulles continued his own private American foreign policy by plotting a deal with Wolffie. Wolffie was in fact negotiating a potential deal on behalf of his boss Himmler. The plan of Dulles failed, but then, as they were such chums, Dulles went on to save Wolffie’s life. The sleazy details of this treasonous tale have been discovered by Talbot. See Chapter 4, ‘Sunrise’, commencing on p. 74.

10. Adam Lebor, *Tower of Basel: The Shadowy History of the Secret Bank That Runs the World*, Public Affairs, New York, 2013, passim. (See the Index for Allen Dulles, his equally pro-Nazi brother John Foster Dulles, and McKittrick.)
11. Talbot, op. cit., pp. 17, 617.
12. Wilhelm Reich, *The Mass Psychology of Fascism* (translation from the manuscript of the third enlarged edition of *Die Massenpsychologie des Fascismus*), Orgone Institute Press, Inc., New York, New York, 1946, p. 31. (The first edition of this book in German was published in 1933, the second edition in 1934. The third enlarged edition existed in German only in manuscript, and fortunately it was translated by Reich and published in English before the FBI could burn it! Presumably, however, the original German manuscript of the third edition, never published in German, was destroyed or seized by the FBI, which must have delighted America's imported Nazis.)
13. I once asked a man the first name of one of his former colleagues with whom he had jointly written a now declassified article. That is because for my bibliographies I don't like using first initials, but always like to know the first names of scientists. He denied ever knowing him, despite the fact that I have a copy of an article describing their joint work together. That shows you the fear scientists have, which is so great that they dare not admit that they have even met the people with whom they worked for years.
14. Freeman Widener Cope, 'Man in a Gas of Tachyon Magneto-electric Dipoles – A New Hypothesis', Parts 1, 2, 3, and 4, appearing sequentially in *Physiological Chemistry & Physics*, Vols. 10 and 11 for 1978 and 1979. Part I is Vol. 10, 1978, pp. 535–40; Part 2 is Vol. 10, 1978, pp. 541–5; Part 3 is Vol. 10, 1978, pp. 547–55; Part 4 is Vol. 11, 1979, pp. 87–91. Cope's fifth article was separate and entitled 'Delocalized Clouds (Wavefunctions) of Polymerized Tachyon Magnetoelectric Monopoles', in the same journal, Vol. 11, 1979, pp. 175–9. It does not appear that he published anything further on the subject, and he died young in 1983. In the notes I shall refer to Cope, Parts 1 to 5. This quotation is from Part 1, p. 535.
15. Baron (*Freiherr*) Karl von Reichenbach, *Researches on Magnetism, Electricity, Heat, Light, Crystallization, and Chemical Attraction in Their Relations to The Vital Force*, Parts I and II (including the second edition of the First Part, corrected and improved), edited and translated with a preface, notes, and appendix by William Gregory, Taylor, Walton and Maberly, London, 1850.
16. Another strange cosmic force of 'vital magnetism' was proposed in 1871 by

the supernatural novelist Edward Bulwer-Lytton, in his novel *The Coming Race*, though Cope does not mention this. Bulwer-Lytton appears to have taken his idea of vril from Reichenbach's odic force. Strangely enough, some of the occult Nazis seriously believed in the actual existence of vril, despite its having appeared in an admitted work of fiction. They apparently believed that Bulwer-Lytton knew of its true existence and revealed it in intentionally disguised form by proposing it within the context of a novel.

17. Cope, Part 3, op. cit., p. 547.
18. Paul Dirac, **'**Quantized Singularities in the Electromagnetic Field' in: *Proceedings of the Royal Society of London*, *Series A*, Vol. CXXXIII, London, October 1931, pp. 60–72.On page 71 of this paper, Dirac says: 'The object of this paper is to show that quantum mechanics doesnot really preclude the existence of isolated magnetic poles. On the contrary, the present formalism of quantum mechanics, when developed naturally without the imposition of arbitrary restrictions, leads inevitably to wave equations whose only physical interpretation is the motion of an electron in the field of a single [magnetic] pole.'
19. Dirac expanded and refined these ideas seventeen years later in 1948: Paul Dirac, 'The Theory of Magnetic Poles' in: *The Physical Review*, Second Series, Vol. 74, No. 7, 1 October 1948, pp. 817–30. In this paper, Dirac more emphatically than ever suggested that magnetic monopoles must exist. In the various discussions of magnetic monopoles that I have encountered, Dirac's paper of 1931 tends to be cited, but I do not recall anyone citing his follow-up paper of 1948, which expands the theory considerably. (Perhaps Lochak mentioned it, although I do not recall that.)

    In the 1948 paper, of which I have an original copy, Dirac says: 'In 1931 I gave a primitive theory which described the action of a pole in the field of a charged particle whose motion is given, or the motion of a charged particle in the field of a pole whose motion is given. The present paper sets up a general theory of charged particles and poles in interaction through the medium of the electromagnetic field. The idea which makes this generalization possible consists in supposing each pole to be at the end of an unobservable string, which is the line along which the electromagnetic potentials are singular, and introducing dynamic coordinates and momenta to describe the motion of the strings. The whole theory then comes out by the application of standard methods … The theory developed in the present paper is essentially symmetrical between electric charges and magnetic poles.'

This brilliant paper by Dirac seems largely to have escaped notice by his fellow physicists. Dirac's idea of a 'string' is also very suggestive. My own instinct is not to think of the string as being straight, but on the contrary that it must exist either in helical form or in toroidal form (i.e., existing on one or other of the two circularities of a toroidal surface, unless linking the two). In fact, to say that a particle is a 'string' is effectively to say that it is a filament. And filaments like to spiral helically. And because they also like to spiral as double-helixes, this might apply to those paired electrons known as 'Cooper Pairs', which are discussed later. These matters require deeper consideration than an aside in a footnote, however.

20. Georges Lochak, Harald Stumpf, and Peter W. Hawkes, *Advances in Imaging and Electron Physics: The Leptonic Magnetic Monopole: Theory and Experiments*, Elsevier, Amsterdam, 2015.
21. Ritika Dusad, Franziska K.K. Kirschner, Jesse C. Hoke, et al., 'Magnetic Monopole Noise', in *Nature*, Vol. 571, No. 7764, 11 July 2019, pp. 234–9.
22. Ibid.
23. Ibid., p. 553.
24. Herbert Charles Corben, *Classical and Quantum Theories of Spinning Particles*, Holden-Day, San Francisco, 1968.
25. Herbert Charles Corben, 'Electromagnetic and Hadronic Properties of Tachyons', in Hugo E. Hernández-Figueroa, Michel Zamboni-Rached, and Erasmo Recami (eds.), *Localized Waves*, Wiley-Interscience, John Wiley & Sons, Hoboken, New Jersey, 2008, pp. 31–41.
26. Cope, Part 3, op. cit., p. 553.
27. Cope, Part 5, op. cit.
28. Dominic J. Clarke, Heather M. Whitney, Gregory P. Sutton, and Daniel Robert, 'Detection and Learning of Floral Electric Fields by Bumblebees', in *Science*, Vol. 340, Issue 6128, 5 April 2013, pp. 66–9. And also: Gregory P. Sutton, Dominic J. Clarke, Erica L. Morley, and Daniel Robert, 'Mechanosensory Hairs in Bumblebees (*Bombus terrestris*) Detect Weak Electric Fields', in *Proceedings of the National Academy of Sciences*, Early Edition, 2016, 9 pages. Press reports on the latter appeared on 31 May 2016 in the London *Daily Telegraph*, p. 10, the London *Daily Mail*, p. 3., and the London *Times*, p. 21.

Chapter 14: Electric People

1. Robert Temple, 'David Bohm', The New Scientist Interview, *New Scientist*,

11 November 1982, pp. 361–5.
2. Richard P. Feynman, *The Character of Physical Law*, M.I.T. Press, Cambridge, Massachusetts, 1965. (This book is the transcription of a series of lectures given by Feynman at Cornell University, which were recorded by the BBC.) I do not have a page number for this quote, as I found it given by Chris Philippidis, Christopher Dewdney, and Basil J. Hiley, in their paper 'Quantum Interference and the Quantum Potential', in *Il Nuovo Cimento*, Vol. 52 B, N. 1, 11 July 1979, p. 15, where in their footnote they omit the page number for Feynman.
3. Richard Feynman, *QED: The Strange Theory of Light and Matter*, Penguin Books, London, 1985, pp. 150–2.
4. Ilya Prigogine, *Is Future Given?*, World Scientific Press, Singapore, 2003, pp. 66–75.
5. Albert Szent-Györgyi, *Electronic Biology and Cancer: A New Theory of Cancer*, Marcel Dekker, Inc., New York and Basel, 1976, pp. 18–19.
6. Albert Szent-Györgyi, *Bioenergetics*, Academic Press, New York, 1957, passim:The energy of the photon absorbed by the protein has to travel first through the protein molecule … (and) is emitted as fluorescent light … Molecules send us messages through photons … The biological energy unit … (has a) wavelength (which) corresponds to the near infrared. It is thus this spectral region which will have the greatest direct interest for the biologists … Electronic excitations give us valuable information about properties and reactions of molecules … One of the main functions of protoplasmic structures may be to generate in water those specific structures which make forms of electronic excitations and energy transmissions possible which would be improbable outside these structures. The solid matter and the water of the cell form together that unique system which has the queer property of being alive.
7. Albert Szent-Györgyi, *Bioelectronics: A Study in Cellular Regulations, Defense, and Cancer*, Academic Press, New York, 1968, p. vii.
8. Ibid., p. 21.
9. Albert Szent-Györgyi, *The Living State: With Observations on Cancer*, Academic Press, New York, 1972.
10. Andrew Marino, *Going Somewhere: Truth About a Life in Science*, Cassandra Publishing, Belcher, Louisiana, USA, 2010, pp. 337–9, and see also pp. 341–2.
11. Percy W. Bridgman, *The Physics of High Pressure*, G. Bell and Sons, London, 1949, pp. 190, 208–9.
12. C. Lobban, J.L. Finney, and Werner F. Kuhs, 'The Structure of a New Phase

of Ice', *Nature*, Vol. 391, 15 January 1998, pp. 268–70.
13. *Bioenergetics*, op. cit., pp. 34–9.
14. Freeman W. Cope, 'Evidence from Activation Energies for Superconductive Tunneling in Biological Systems at Physiological Temperatures', in *Physiological Chemistry & Physics*, 3, 1971, p. 403.
15. William A. Little, 'Possibility of Synthesizing an Organic Superconductor', in *Physical Review*, Vol. 1234, No. 6A, 14 June 1964, pp. A1416–24.
16. János Ladik and Géza Biczó, 'A Note on F.W. Cope's Paper "Evidence from Activation Energies for Superconductive Tunneling in Biological Systems at Physiological Temperatures"', in *Physiological Chemistry & Physics*, 4, 1972, pp. 495–6.
17. Freeman W. Cope, 'Biological Sensitivity to Weak Magnetic Fields Due to Biological Superconductive Josephson Junctions', in *Physiological Chemistry & Physics*, 5, 1973, pp. 173–6.
18. J.P. Marton, 'Conjectures on Superconductivity and Cancer', in *Physiological Chemistry & Physics*, 5, 1973, pp. 259–70.
19. Solomon Goldfein, 'Some Evidence for High-Temperature Superconduction in Cholates', in *Physiological Chemistry & Physics*, 6, 1974, pp. 261–9.
20. K. Antonowicz, 'Possible Superconductivity at Room Temperature', in *Nature*, Vol. 247, No. 14, 8 February 1974, pp. 358–60.
21. Freeman W. Cope, 'Superconductive Josephson Junctions – A Possible Mechanism for Detection of Weak Magnetic Fields and of Microwaves by Living Organisms' (abstract only printed) in Tom S. Tenforde (ed.), *Magnetic Field Effect on Biological Systems* (Proceedings of the Biomagnetic Effects Workshop, 1978) Plenum Press, New York, 1979, p. 87.
22. Emilio Del Giudice, Silvia Doglia, Marziale Milani, Cyril W. Smith, and Giuseppe Vitiello, 'Magnetic Flux Quantization and Josephson Behaviour in Living Systems', in *Physica Scripta*, Vol. 40, 1989, pp. 786–91.
23. Vladimir Z. Kresin and William A. Little (eds.), *Organic Superconductivity*, Plenum Press, New York, 1990.
24. Ibid., p. 18, in a paper by A.M. Hermann, H. Duan, W. Kiehl and D. Weeks entitled 'Thallium-Based Copper Oxide Superconductors'.

Chapter 15: How Our Bodies Emit Light

1. Roeland van Wijk, *Light in Shaping Life: Biophotons in Biology and Medicine*, Meluna, Geldermalsen, The Netherlands, 2014, p. 355.

2. It is for this reason that I have registered a website to preserve as much as possible of the scientific papers in all languages on the subject, and thousands of pages have already been scanned and turned into pdfs for download. All the publications in German and Russian, as well as the working notebooks, of Alexandr Gurvich (discoverer of biophotons) will be available for public download, because they are out of copyright. However, most of the material will only be accessible to a closed registered group because of copyright complications involving journals and publishers. But at least the archives will be preserved for posterity in this way. The most helpful person in making material available has been my friend Marco Bischof, whose enthusiasm is exceeded only by his profound knowledge.
3. Van Wijk, op. cit.
4. Vladimir Leonidevich Voeikov and Lev Vladimirovich Beloussov, 'From Mitogenetic Rays to Biophotons', in Lev Vladimirovich Beloussov, Vladimir L. Voiekov, and Victor Semenovich Martynyuk (eds.), *Biophotonics and Coherent Systems in Biology*, Springer Verlag, New York, 2007, pp. 1–16.
5. Strange and somewhat embarrassing support came from one of Himmler's S.S. researchers, Otto Rahn (1904–1939). Anyone interested in the bizarre career of Rahn can read about it on Wikipedia, but Wikipedia does not mention the important book by Rahn relating to biophotons, *Invisible Radiations of Organisms* (Berlin, 1936, reprinted 1944), which suggested that aging was due to the slowing and cessation of the emission of ultra-violet radiation within the body, a dubious idea. Rahn also pointed out, however, that the healing of wounds took place because of UV (ultra-violet) emissions, and that irregularities of these emissions were implicated in cancer (which we now know to be true). Rahn tried to leave the employ of Himmler, and was apparently murdered in consequence. Many of his publications were cranky, and it is thus ironical that no attention has been called to the one that was actually useful.
6. Joseph Needham, *Chemical Embryology*, Cambridge University Press, 1950.
7. Changlin Zhang, Fritz-Albert Popp, and Marco Bischof (eds.), *Current Development of Biophysics – The Stage from an Ugly Duckling to a Beautiful Swan*, Hangzhou University Press, China, no date, but 1996. (The poetic nature of the title was thought of by Zhang Changlin, who is that rare thing, a dreamy and poetic person who is also a scientist. He was based at that time in the College of Life Sciences of Hangzhou University, but today lives in the West.)

8. Kilmister, Clive W., *Disequilibrium and Self-Organisation*, D. Reidel, Kluwer, Dordrecht, 1986; Popp, Fritz-Albert, Warnke, Ulrich, König, Herbert L., and Peschka, Walter (eds.), *Electromagnetic Bio-Information*, Urban & Schwarzenberg, Munich, 2nd edition, 1989;

   Jeżowska-Trzebiatowska, Bogusława, Kochel, Bonawentura, Sławiński, Janusz, and Stręk, Wiesław (eds.), *Photon Emission from Biological Systems, Proceedings of the First International Symposium, Wrocław, Poland, January 24–26, 1986*, World Scientific, Singapore, 1987;

   Popp, Fritz-Albert, Li, Ke-hsueh ['K.H.'], and Gu, Qiao (eds.), *Recent Advances in Biophoton Research and Its Applications*, World Scientific, Singapore, 1992;

   Beloussov, Lev Vladimirovich, and Popp, Fritz-Albert (eds.), *Biophotonics: Non-equilibrium and Coherent Systems in Biology, Biophysics and Biotechnology*, Proceedings of International Conference Dedicated to the 120th Birthday of Alexander Gavrilovich Gurwitsch (1874–1954), 28 September– 2 October 1994, Moscow, Bioinform Services Co., Russia, 1995;

   Zhang, Popp, and Bischof (eds.): see preceding footnote; Chang, Jiin-Ju, Joachim Fisch, and Fritz-Albert Popp (eds.), *Biophotons*, Kluwer Academic Publishers, Dordrecht, 1998; Fritz-Albert Popp, and Lev Vladimirovich Beloussov (eds.), *Integrative Biophysics: Biophotonics*, Kluwer Academic Publishers, 2003; Shen, Xun, and Roeland van Wijk (eds.), *Biophotonics: Optical Science and Engineering for the 21st Century*, Springer Science and Business Media Inc., New York, 2005;

   Francesco Musumeci, Larissa S. Brizhik, and Ho, Mae-Wan (eds.), *Energy and Information Transfer in Biological Systems: How Physics Could Enrich Biological Understanding*, Proceedings of the International Workshop, Acrireale, Catania, Italy, 18–22 September 2002, World Scientific, New Jersey, Singapore, and London, 2003; Lev Vladimirovich Beloussov, Vladimir Leonidovich Voeikov, and Viktor Semenovich Martynyuk (eds.), *Biophotonics and Coherent Systems in Biology*, Springer Verlag, New York, 2007.
9. Marco Bischof, *Biophotonen: Das Licht in Unseren Zellen* (*Biophotons: The Light in Our Cells*), Zeitausendeins, Frankfurt am Main, 1995. Michael König, *Photonen-Diagnose: Vitalität ist Messbar – Wie Lebendig Sind Sie WirklichIich?*, Scorpio, Munich, 2014. Fritz-Albert Popp, *Biophotonen – Neue Horizonte in der Medizin: Von den Grandlagen zur Ziophotonik*, Karl

F. Haug Verlag, Stuttgart, third revised and updated edition, 2006 (originally published 1983).

10. Roeland van Wijk, Yu Yan, and Edouard Pieter van Wijk, *Biophoton Technology in Energy and Vitality Diagnostics: A Multi-Disciplinary Systems Biology and Biotechnology Approach*, Medusa Research, Qi Nanophotonics, Netherlands, 2017.
11. Viktor Mikhailovich Inyushin, 'Bioplasma: The Fifth State of Matter?', in John White and Stanley Krippner (eds.), *Future Science: Life Energies and the Physics of Paranormal Phenomena*, Anchor Books, Doubleday, Garden City, New York, 1977, pp. 115–20.
12. See for instance: Karl H. Pribram, *The Form Within*, Prospecta Press, Westport, Connecticut, USA, 2013.
13. Karl H. Pribram, *Languages of the Brain: Experimental Paradoxes and Principles in Neurophysiology*, Prentice-Hall Inc., 1971; reprinted Brooks/Cole, Monterey, California, 1977, pp. 150–9.
14. Adam Gregorz Adamski, 'Bioplasma Concept of Consciousness', in *NeuroQuantology*, Vol. 9, Issue 4, December 2011, pp. 681–91.

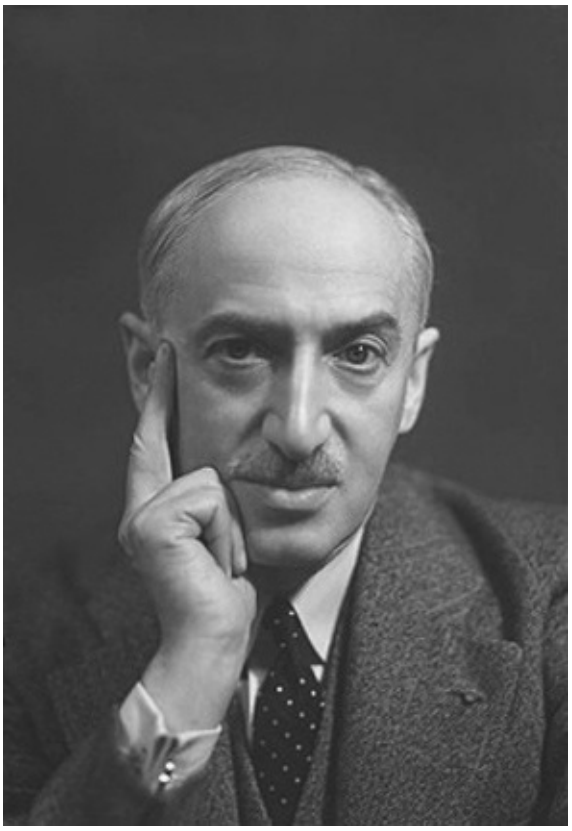
Chapter 16: The 'Death Flash' and the 'Life Flash'

1. Janusz Sławinski, 'Electromagnetic Radiation and the Afterlife', in *Journal of Near-Death Studies*, Vol. 6, Part 2, winter 1987, pp. 79–94.
2. Because I am interested in French literature (and indeed my wife Olivia and I have sponsored numerous translations of modern French literary classics into English), I have read widely in twentieth-century French fiction. One of the most congenial authors to me is the passionate French Anglophile, André Maurois. By chance, browsing in a bookshop some years ago, I came across a little book by him containing a novella bearing the strange title *The Weigher of Souls*, which is a direct translation of its original French title *Le Peseur d'Ames*. I now possess a first edition of this novella signed by Maurois, whose signature by the way is practically microscopic, so that you almost need a magnifying glass to read it. (He must have been a very modest person!)

   The book was published originally in 1931 in Paris in several simultaneous editions on different kinds of paper, and later in the same year in a version atmospherically illustrated by Francis Picabia. (I have been fortunate to acquire Maurois's own personal copy with his bookplate of this special edition. André Maurois, *Le Peseur d'Ames*, with frontispiece and eight illustrations by Francis Picabia, Antoine Roche, Paris, 1931,

unnumbered author's own *exemplaire sur japon impérial*; the bookplate says 'Ex Libris Simone Andre Maurois'. Simone de Caillevet was the second wife of Maurois and died in 1968, a year after he did. It seems that they shared their bookplate.)

Also in the same year, the English translation appeared in America in the popular highbrow magazine *Scribner's*, for March 1931. That issue announces prominently on the cover: 'André Maurois's New Novel "The Weigher of Souls" Complete in this Issue.' I also have its first edition in English as a book, published in the same year by D. Appleton & Company in association with Scribner's, in both London and New York. Despite the prominence with which this title was thus originally launched, it seems to have attracted only limited attention, which I also find curious. The French were always somewhat uncomfortable about Maurois, because he liked the English too much, and also because he was a Jew (Maurois was his pen name, and his real surname was Herzog).



André Maurois (1885–1967), the author of *The Weigher of Souls*.

Today, if you ask someone in France about Maurois, the person will either look blank or pretend to look blank. After all, grumbling about the barbaric nature of les ros bifs (‘the roast beefs’) who live across the English Channel is one of the favourite hobbies of the French, and one that they do not wish to see compromised by too much Anglophilia. Hence, it has been convenient largely to ‘forget about’ both Maurois and his contemporary French Anglophile, the novelist Valéry Larbaud, who translated James Joyce’s *Ulysses* into French.

Maurois met with tremendous literary success in Britain with his series of Colonel Bramble novels, light-hearted and comic accounts of the British soldiers during the First World War, written in a tone of great affection. Maurois had been a French military liaison officer with a British regiment just behind the Front for most of the war. He was thus unusual in that he was a French officer who spent the war in the company of British officers rather than French ones.

3. Wilfried-René Chettéoui (note that Wilfried is misspelled Wifried in this source), ‘The Process of Birth and Reincarnation Theory’, in the Proceedings and Abstracts of the 6th International Conference on Psychotronic Research held at Zagreb, Yugoslavia, 13–16 November 1986, published by the Society for Natural Sciences at Zagreb in 1987 (though no publication date is given), the volume apparently being edited by Zdenek Rejdák, p. 314. (The main title of this book is in Czech, with the English title beneath.)
4. Duncan MacDougall, ‘Hypothesis concerning Soul Substance together with Experimental Evidence of the Existence of Such a Substance’, in *Journal of the American Society for Psychical Research*, 1 (1), 1907, p. 237; also ‘The Soul: Hypothesis concerning Soul Substance together with Experimental Evidence of the Existence of Such Substance’, in *American Medicine*, 2, April 1907, pp. 240–3. A popular report of this appeared in *The New York Times*, entitled ‘Soul Has Weight, Physician Thinks’, 11 March 1907; this appeared before MacDougall’s own articles had even been published later that year. See the Wikipedia entry ‘21 Grams Experiment’. Apparently, MacDougall’s experiments of 1907 have never been repeated.
5. This account is to be found on the website: www.thebiggeststudy.blogspot.com/2012/12/the-mist-at-death.html.
6. Sheila Ostrander and Lynn Schroeder, *Psychic Discoveries behind the Iron Curtain*, Prentice-Hall Inc., Englewood Cliffs, New Jersey, USA, 1970, p. 205.

7. Konstantin Korotkov, *Aura and Consciousness: A New Stage of Scientific Understanding*, translated from the Russian by Roger Taylor, State Editing & Publishing Unit 'Kultura', St Petersburg Division of the Russian Ministry of Culture, St Petersburg, 1998; 2nd edition, 1999.
8. Janusz Sławinski, 'Photon Emission from Perturbed and Dying Organisms – The Concept of Photon Cycling in Biological Systems', in Fritz-Albert Popp and Lev Beloussov (eds.), *Integrative Biophysics: Biophotonics*, Kluwer Academic Publishers, Dordrecht, Netherlands, 2003.
9. This story about Franz Werfel is not generally known. It was told to me by my dear friend Professor Adolph Klarmann, the editor of Werfel's collected works (in German), a close friend of Werfel and the guardian and confidante of Werfel's widow, Alma Maria Gropius Mahler Werfel, whom he looked after in New York in her last years. I intend to publish more about this in a separate publication.
10. Jelena Vuckovic, Dirk Englund, David Fattal, Edo Waks, and Yoshihisa Yamamoto, 'Generation and Manipulation of Nonclassical Light Using Photonic Crystals', in *Physica E: Low-dimensional Systems and Nanostructures*, 32 (1–2), July 2005. DOI: 1016/i.physe.2005,12.135. (See arXiv website.) This paper was subsequently replaced with a revised version. Although this paper is not available on Researchgate, one can request a full text from the authors via www.researchgate.net, though it means scrolling down an immensely long chronological list of publications by Vuckovic, who seems to have been more prolific with words than either Tolstoy or Proust. (Englund has meanwhile moved to MIT, Fattal is still at Stanford, and Edo Waks and Yamamoto are not on Researchgate.net.)
11. Barbara W. Chwirot, 'Do We Always Need to Know Molecular Origin of Light Emitted by Living Systems?', in Chang Jiin-Ju, Joachim Fisch, and Fritz-Albert Popp (eds.), *Biophotons*, Kluwer Academic Publishers, Dordrecht, 1998, pp. 229–37.
12. Raymond Moody, *Glimpses of Eternity*, Guideposts, New York, 2010, pp. 101–4.
13. Ibid., p. 24.
14. Ibid., pp. 101–2.
15. Ibid., p. 103.
16. Bernard J.F. Laubscher, *Beyond Life's Curtain*, C.W. Daniel Co./ Spearman, 1975.
17. Peter and Elizabeth Fenwick, *The Art of Dying*, Bloomsbury Continuum, London, 2008, pp. 160–3.
18. Ibid., p. 167.

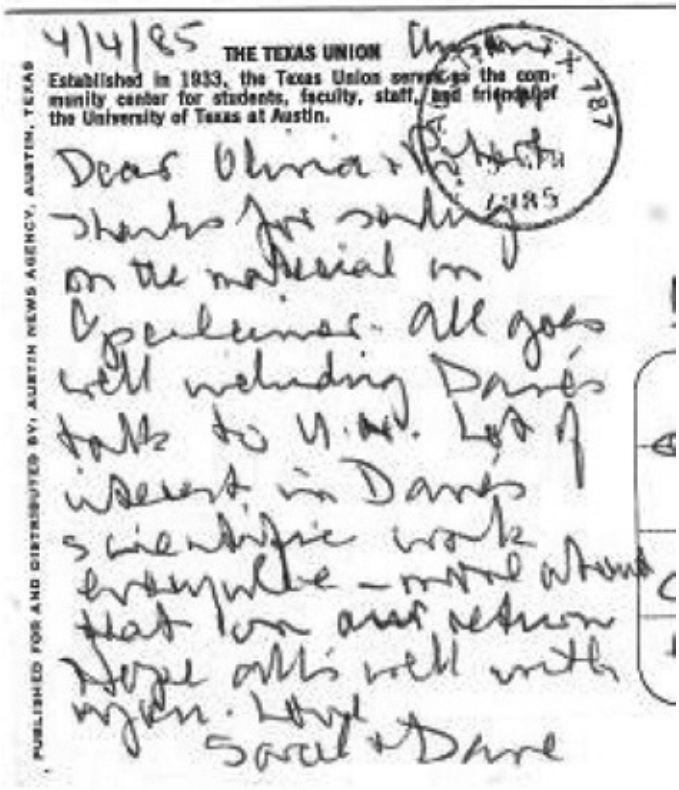
19. Reported by Dr. Robert Crookall in his book *Out of the Body Experiences*, Citadel Press, 1970.
20. Report by Ed Bodin for the magazine *Psychic Observer*, 25 January 1945. I have taken this information from a blog on the internet posted in 2010 by Michael Tymn, author of the book *The Afterlife Revealed: What Happens After We Die*, 2011.
21. Michael Otmar Hengartner, 'Out-of-Body Experiences: Cell-Free Death', in *Bioessays*, 17 (6), June 1995, pp. 549–52.
22. Xianrui Cheng and James E. Ferrell Junior, 'Apoptosis Propagates through the Cytoplasm as Trigger Waves', in *Science*, 361 (6402), 10 August 2018, pp. 607–12. Please note that although the official listing at the head of the article suggests that the paper is only five pages long, it is in fact 14 pages long in the downloadable Public Access author manuscript dated 29 November 2018, so that the reference is therefore misleading.
23. R.J.P. Williams, 'Purpose of Proton Pathways', in *Nature*, Vol. 376, No. 6542, 24 August 1995, p. 643.
24. Vlail Petrovich Kaznacheev (aka Kaznacheyev), et al., 'Distant Intercellular Interactions in a System of Two Tissue Cultures', in *Psychoenergetic Systems*, Vol. 1, No. 3, March 1976, pp. 141–2.
25. See for instance: https://www.sciencealert.com/scientists-just-captured-the-actual-flash-of-light-that-sparks-when-sperm-meets-egg (which is dated 27 April 2016).

Chapter 17: Our Plasma Selves

1. Aleksandr Samuilovich Presman, *Electromagnetic Fields and Life*, translated by F.L. Sinclair and edited by Frank A. Brown, Plenum Press, New York and London, 1970. The original Russian edition, *Elektromagnitnye Polya I Zhivaya Priroda*, was published by Nauka ['Science'] Press of Moscow in 1968.
2. Ibid., pp. 5–6.
3. Robert Temple, *The Genius of China: 3000 Years of Science Discovery & Invention*, with Foreword by Joseph Needham, Andre Deutsch, London, 2007.
4. Paul Alfred Weiss, *Principles of Development: A Text in Experimental Embryology*, Henry Holt and Company, New York, 1939. Paul Alfred Weiss should not be confused with Paul Weiss the philosopher. Later publications by Weiss, not cited by Presman, include *Dynamics of Development: Experiments and Inferences*, Academic Press, New York and

London, 1968, and *The Science of Life: The Living System – A System for Living*, Futura Publishing Company, Mount Kisco, New York, 1973.

5. Presman, op. cit., p. 249.
6. Robert Temple, 'David Bohm', in *New Scientist*, London, 11 November 1982, pp. 361–6. A whole line of type was left out, and other errors appeared in the published article. I urge people interested in David Bohm to download for free a pdf of this article with my hand corrections, including the missing line of type. It may be obtained from my entry on www.researchgate.net. Just type in my name, click on my publications, and scroll down the chronological list until you get to 1982, and there it is.
7. David Bohm, *Quantum Theory*, Prentice-Hall Inc., New York, 1951. David signed my copy of the original edition.
8. Here is a scan of a postcard that Saral sent to us, to show the nature of the friendship, sent from America on their trip there in the spring of 1985. It reads: 'Dear Olivia & Robert, Thanks for sending on the material on Oppenheimer. All goes well including Dave's talk to U.N. Lots of interest in Dave's scientific work everywhere – more about that on our return. Hope all's well with you. Love Saral & Dave.'



9. Paavo Pylkkänen, *Mind, Matter and Active Information: The Relevance of David Bohm's Interpretation of Quantum Theory to Cognitive Science*, Reports from the Department of Philosophy, No. 2, University of Helsinki, Finland, 1992, p. 66.
10. David Bohm, 'A Suggested Interpretation of the Quantum Theory in Terms of "Hidden Variables' Part I (14 pages), 15 January, pp. 166–79, and Part II (14 pages), 15 January, pp. 180–93, in *Physical Review*, American Physical Society, Vol. 85, Second Series, 1 January–15 March 1952. At the time of writing he was still based at the Palmer Physical Laboratory at Princeton, and his papers are marked received on 5 July 1951, but a note says: 'Now at Universidade de Sao Paolo, Faculdade de Filosofia, Ciencias e Letras, Sao Paolo, Brazil. (I have an original bound volume containing these papers.) So between the time of submission and publication, Bohm had had to flee the country and seek refuge in the philosophy department of a university in Brazil, where he did not even have a science position.
11. I need to explain to the reader that the aspect of David Bohm's thinking that we are dealing with here is a later outgrowth of his main ideas. I have discussed the theories of Louis de Broglie and David's impact on them at some length here: Robert Temple, 'Is Particle Mass a Function of Degrees of Freedom?', in *Journal of Cosmology*, Vol. 26, No. 3, 2017, pp. 13995–14090. Downloadable as a pdf from my entry on www.researchgate.net, under the date 2017.
12. This point relates to one of my own major points made in my lengthy 2017 paper (just mentioned), regarding the crucial importance of amplification in every aspect of science, and where I said for instance: 'Amplification in electronics turns a weak signal into a strong signal, and it does not necessarily require an amplifier, such as we in our macroscopic world employ, because it apparently occurs spontaneously at the ultra-weak level in Nature in electron streams under the influence of magnetism.' See page 20 and passim in my paper.
13. David Bohm and F. David Peat, *Science, Order, and Creativity*, Bantam Books, New York, 1987, p. 93.
14. David Bohm, 'A New Theory of the relationship of Mind and Matter', in *Philosophical Psychology*, Vol. 3, No. 2, 1990, pp. 271–86.
15. Pyllkänen, op. cit.
16. Paavo T.I. Pylkkänen, *Mind, Matter and the Implicate Order*, Springer Verlag, Berlin and Heidelberg, 2006.
17. Pylkkänen, 1992, op. cit., p. 91.
18. As is usual with Wikipedia, Rupert's entry on it is riddled with vitriol and

insults against him, Wikipedia being apparently partial to the most intensely partisan and extreme attacks on people whose names are on whatever black list it is that they consult. When people like Rupert attack the stupidities and idiocies of Establishment ideas, the Establishment strikes back. Most of the famous scientists mentioned in this book were savagely attacked during their lifetimes because they thought for themselves.

Rupert told me that when he was a student at Cambridge, he was told in lectures that there was a man named Peter Mitchell who was crazy and none of the students should pay any attention to his ideas if they should ever come across them. That is the same Peter Mitchell, my good friend whom I have mentioned before, who won the Nobel Prize after a lifetime of being called crazy and libelled even in lectures given to students at Cambridge such as Rupert. Cambridge is also the place from which Sir Fred Hoyle was driven by relentless and vicious personal attacks led by a cabal of snobbish enemies who, among other things, did not like Fred's Yorkshire accent and his lowly origins. The world of learning can be more poisonous even than the world of politics.

19. Joseph Glanvill, *Scepsis Scientifica: or, Confest Ignorance, the Way to Science*, London, 1665, p. 17.
20. For decades I have said to friends that the reason why I can walk into a library of three million books on open shelves (such as the one at my university when I was in my teens), go down an apparently random aisle, reach up to an apparently random shelf, and without looking at it pick the book I need and open it to the page I require is that I am able 'to see directly into Information Space'. Since I have been doing this all my life, when I speak of Information Space and 'the Universe as Information', my natural scepticism dissolves into something approaching certainty. In other words, even though I do not believe in belief, this I not only believe but know.
21. Nikola Tesla, op. cit., pp. 9–14.
22. Benjamin Schumacher and Michael Westmoreland, *Quantum Processes, Systems, and Information*, Cambridge University Press, 2010, p. 1.
23. 221 Wojciech Hubert Zurek (ed.), *Complexity, Entropy, and the Physics of Information: The Proceedings of the Workshop on Complexity, Entropy and the Physics of Information Held May-June, 1989, in Santa Fe, New Mexico*, Vol. VIII, Santa Fe Institute Studies in the Science of Complexity, Westview Press, 1990; reprint by CRC Press, Baton Rouge, Florida, 2019.
24. Werner G. Teich and Günter Mahler, 'Information Processing at the

Molecular Level: Possible Realizations and Physical Constraints', in Ibid., pp. 289–99.

25. Seth Lloyd, 'Valuable Information', in Ibid., pp. 193–7.
26. Robert Temple, *Netherworld*, Century, London, 2002. The relevant section of this book is the final chapter, entitled 'Higher-Order Events'; this chapter has been extracted from the book and may be downloaded from my www.researchgate.net entry under the date of 2002 (as the entries on the website are chronological).
27. Ibid., p. 354 (UK edition). I might add for those interested in the prehistories of ideas that the main ancient proponent of voids occurring in matter was the philosopher Strato of Lampsacus (335 BC–269 BC). He was the second successor of Aristotle as the Head of the Lyceum, though he could not have known him because he was only a boy when Aristotle died. His works are lost except for fragments and testimonia, which have been gathered and translated in the volume: Marie-Laurence Desclos and William W. Fortenbaugh, *Strato of Lampsacus: Text, Translation, and Discussion*, Vol. XVI of the series Rutgers University Studies in Classical Humanities, Transaction Publishers, New Brunswick, New Jersey, USA, 2011. The fragments relating to void (*kenon* in Greek) are found on pages 70–83.

    Most were preserved by Simplicius, who disagreed with him, in his Commentary on Aristotle's *Physics*. On page 79 we find Simplicius saying this: 'Strato of Lampsacus tries to show that void divides the whole of body, so that it is not continuous …' And on the same page and following we find Hero in his *Pneumatica* saying that there are voids in matter. And he adds: 'It is also clear … that there are voids in water … there are many other demonstrations of the nature of the void … every body is composed of small bodily particles, between which there are scattered voids which are smaller than the particles …'

    Part of Hero's extended discussion is directly drawn from Strato. This volume concerning Strato is part of an extended series of collections of the fragments and testimonia of the Peripatetic philosophers. I am very fortunate to have enjoyed the jolly company and warm friendship of Bill Fortenbaugh, who has been a genuine culture hero and shining light in the world of classical studies in our time.
28. Vadim Nikolaevich Tsytovich (aka Cytovič), Sergey Vladimirovich Vladimirov, and Gregor Eugen Morfill, 'Size of Dust Voids as a Function of the Power Input in Dusty Plasmas', in *Journal of Experimental and*

Theoretical Physics, Vol. 102, 2006, pp. 334–41. (The attentive reader will notice that Tsytovich is the man who has been quoted by me as suggesting that complex dusty plasmas can become life forms.)
29. Osamu Ishihara and Noriyoshi Sato, 'Attractive Force on Like Charges in a Complex Plasma', in *Physics of Plasmas*, Vol. 12, 070705 (2005). There is a drawing of a plasma void as Figure 2 in that paper. This work was done for the United States Air Force Research Agency.
30. Osamu Ishihara, 'Report on Study of Cryogenic Complex Plasma', report date 5 November 2008, submitted to the funding agency, the Asian Office of Aerospace Research and Development (AOARD), an extension in Asia of the US Air Force Research Agency, reporting to the Air Force Research Laboratory at Kirtland Air Force Base near Albuquerque, New Mexico. This Report appears in a collection of material entitled 'Charged Colloidal Structures in Plasmas', declassified and released by the US Department of Defense, no date.
31. Xiao-Qiong Wang, et al., 'Evidence of an Atomic Chiral Superfluid with Topological Excitations', in *Nature*, Vol. 596, No. 7871, 12 August 2021, pp. 227–31.

Chapter 18: Wrapping Up the Universe

1. Robert Temple, *Open to Suggestion*, The Aquarian Press, Wellingborough, Northamptonshire, England, 1989. The relevant discussion constitutes the final chapter in the book pp. 361–458. The ideas which I propounded in that chapter were praised by Professor Ernest R. ('Jack') Hilgard, Former President of the American Psychological Association, and also by Professor John Taylor, who told me that he had adopted many of my concepts and suggestions for his neural network team at Kings College London, and that I had therefore contributed towards an advance in neural network science, for which he thanked me.

   The book's publication in the USA was blocked by the CIA, as I was informed by no less than eight American publishers who had been personally visited and warned not to publish the book. This had the indirect result of giving the UK an advantage in neural network science, since no one in America was able to obtain the book (no international Amazon sales existed then).
2. This paper, entitled 'Early Einstein Completed', was published in June 2019 and may be downloaded from my www.researchgate.net entry, by looking for that date, as the entries are chronological.

3. David Bohm and Basil J. Hiley, *The Undivided Universe: An Ontological Interpretation of Quantum Theory*, Routledge, London, 1993, p. 140.

Appendix One

KORDYLEWSKI DUST CLOUDS: COULD THEY BE COSMIC "SUPERBRAINS"?

Robert Temple[1] and Chandra Wickramasinghe[2,3,4]

[1] The History of Chinese Science and Culture Foundation, Conway Hall, London, UK

[2] Buckingham Centre for Astrobiology, University of Buckingham, UK

[3] Centre for Astrobiology, University of Ruhuna, Matara, SRI LANKA

[4] Institute for the Study of Panspermia and Astrobiology, Gifu, JAPAN

Abstract

Recent astronomical observations combined with dynamical simulations have led to a possible confirmation of the existence of the much disputed stable dust clouds (Kordylewski Dust Clouds) at the Lagrange libration points of the Earth-Moon system. The new data leads to an estimate of the size of the cloud at L5 as well as of the average radii of the scattering/polarizing dust particles in the cloud's interior. The diameter of the cloud is somewhat less than 3 times the Earth's diameter, and the average grain radius is estimated at ~ 3 x 10^{-5}cm, consistent with bacterial-type cells, with a mean separation of less than 1 cm. Such grains, most likely elongated on the average (rod-like bacteria), and photoelectrically charged to a few eV, would acquire a spin through collisions with gas atoms and thus could act as emitters and absorbers of longwave electromagnetic radiation. We speculate that the entire Kordylewski Dust Cloud comprised of such particles has the potential to acquire electromagnetic connectivity with an information storage/processing capacity akin to a form of intelligence.

1. Introduction

The existence of large stable dust clouds at the Lagrange libration points L4 and L5 of the Earth-Moon system appears to have been finally confirmed by a combination of numerical dynamical simulations and polarimetric studies (Sliz-Balogh et al, 2018, 2019). An initial tentative observation of such clouds was reported in 1961 by the Polish astronomer Kazimierz Kordylewski following which they came to be known as Kordylewski Dust Clouds (KDC) (Kordylewski, 1961). The existence of these clouds has, however, been questioned for over 3 decades mainly because of the difficulty of interpreting minute enhancements of night sky brightness in relation to other possible causes. There were also early attempts to detect centimetre to metre-sized bolides in the putative KD clouds using RADAR with negative results and these have been widely considered as disproof of their existence (Roosen and Wolff, 1969; see also, Hou et al, 2015). It is clearly desirable to repeat the earlier RADAR observations and also possibly deploy LiDAR (*Li*ght *D*etection *A*nd *R*anging) measurements to look for returns from smaller particles to establish their presence.

In two recent publications Sliz-Balogh et al (2018, 2019) focussed their attention on the particular dust cloud (KDC) at the L5 point of the Earth-Moon system using sensitive polarimetric techniques. They found clear evidence that a cloud of submicron dust does indeed exist there through examination of polarized scattered light that varied with time (Sliz-Balogh et al, 2019). The cloud appeared to be “dynamic” and contained within it smaller dust clouds, perhaps displaying a cellular-like structure. Although evidence was cited to support the presence ferric and silicate particles we cannot rule out, on the basis of available evidence, the presence of a dominant contribution of carbonaceous or organic grains, as indeed is known to be predominantly present in the interplanetary zodiacal cloud, in cometary dust, as well as the interstellar medium (Hoyle and Wickramasinghe, 2000; Steele et al, 2018).
Further definitive confirmation of the existence of KDC’s is clearly desirable and we hope this will be done. It will also be important to unravel the fine structure within clouds, including their internal dynamic properties, but these cannot easily be studied from Earth. Such studies will require investigation by dedicated satellite and astronautical studies at some future date.

In this article we explore some interesting features of these dust clouds particularly if they are comprised of particles that include a significant biological component.

2. Inferred Properties of the L5 KDC

The stability and existence of a KDC at the L5 point has been modelled using 3-D by dynamical simulations, and its actual existence confirmed by means of polarimetric observations of scattered light (Sliz-Balogh et al, 2018, 2019). The inferred angular extent of the scattering dust cloud at L5 has been estimated at between θ=6 and 7 degrees. At the known distance of L5, r = 3.84 x 10^9 cm, this angular extent transfers to an average cloud diameter D given by

$$D \approx \frac{\theta}{360} 2\pi r \cong 4.35\times10^{8} \text{ cm} \qquad (1)$$

This is to be compared with the Earth's diameter of ~ 1.27x10^8 cm.

For a spherical particle of radius a (silicate grain or an organic grain typified for example by a bacterium) the cross-section for scattering of sunlight is

$$C_{sca} \cong Q_{sca}\pi a^2 \qquad (2)$$

with *Qsca* having a value close to 1 at optical wavelengths (eg. Wickramasinghe, 1973). For an assembly of such grains in the cloud the average mass scattering coefficient is thus

$$\kappa_{sca} \cong \frac{\pi a^2 Q_{sca}}{\frac{4}{3}\pi a^3 s} \approx \frac{3}{4as} \text{ cm}^2\text{g}^{-1} \approx 2.5 \text{ x } 10^4 \text{ cm}^2\text{g}^{-1} \qquad (3)$$

assuming $a \sim 3 \text{ x } 10^{-5}$cm, $s \sim 1$ g cm^{-3}.

For significant polarization effects to be observable (Sliz-Balogh et al, 2019) the scattering optical depth through the 4.35 x 10^8 cm path-length of the cloud (equation (1)) must be of order unity, say for instance, $\tau_{sca} \approx 0.3$. This converts to a mass density of bacterial dust ρ in the cloud given by the equation

$$0.3 \cong \aleph_{sca} D\rho \cong 1.09\times10^{13}\rho \qquad (4)$$

with the diameter of the cloud given by (1), thus yielding a mass density

$$\rho \approx 2.75\times10^{-14} \text{ g cm}^{-3} \qquad (5)$$

The Kordykewski dust cloud at L5 on this basis has a density which is at least 10^9 higher than the density of the ambient interplanetary dust (Allen, 1963). Losses due to the effects of solar radiation, as well as the solar wind effects and small gravitational perturbations which occur mostly in the outermost regions of

the KDC will, over long timescales, be made good by the acquisition of new dusty material from comets and the interplanetary medium. The total mass of the cloud observed by virtue of (1) and (5) is thus ~ 1.17 x 10^{12} g.

Assuming that a typical dust particle in the cloud has the size characteristics of a bacterial spore with a particle radius a ~ 3 x 10^{-5} cm and mass density ~ 1 g cm^{-3}, we therefore have an average *number* density of dust particles in the cloud of

$$n \approx 2.43 cm^{-3}. \qquad (6)$$

The mean distance between neighbouring particles is then

$$\sim n^{-1/3} \sim 0.74 cm! \qquad (7)$$

very short indeed, and yielding the possibility of inter-particle "communication" if electromagnetic signals can be exchanged. This could be made possible because the bacterial dust would be charged to a potential of a few volts due to the photoelectric effect caused by absorption of solar ultraviolet photons; and collisions with ambient gas would lead to rotation (spinning) at radio frequencies as had been discussed many years ago by Hoyle and Wickramasinghe (1970).

3. Emergent properties of KDC's

Spinning charged grains, particularly those in the form of elongated needles typified by bacilli, would be efficient absorbers and emitters of electromagnetic radiation. Most interestingly the total number *N* of such charged dust particles in a KDC (distance of < 1cm apart) would be truly vast

$$N \approx \frac{\frac{4}{3}\pi R^3}{n} \cong 2 \times 10^{26} \qquad (8)$$

With electromagnetic-wave emission/absorption across cloud dimensions as well as electrical connections (charge/current exchanges) between adjacent charged particles just centimetres apart, a KDC, might well be able to function as a gigantic computer/brain capable of storing and processing digital information. We are reminded in the present context of the well-attested cooperative behaviour of bacteria in a wide range of terrestrial settings (Asfahl and Schuster, 2017; Mitchell and Kogure, 2006).

A human brain has only some 10^{11} brain cells, and about 10^{15} synapses. A KDC (from (8)) may well have a total number of binary connections

$$\sim {}^{n}C_2 \approx 10^{52}$$

between its constituent oscillators, so defining a super-astronomical sum total for its potential computing power. This estimate exceeds the computing power available in all human brains and indeed all other intelligent life on Earth as well by very many orders of magnitude.

Finally, we refer to a few of the remarkable features that are known to characterise dusty complex plasmas and which could also play a role in the present context (eg. Bouchoule, A., 1999; Mikikian *et al*., 2018). The nucleation and growth of mainly siliceous dust within such plasmas have been documented in several laboratory studies. In our case, however, the dust nucleation process will be side-stepped and condensation within KDC's is likely to occur upon pre-existing interplanetary dust particles which we already argued will probably have a biological component. Thus, we could envisage a population of bacterial particles coated with semi-conducting siliceous mantles that may well have the effect of enhancing inter-particle electronic connectivity. Such speculations may sound far-fetched but they lie within a broad framework of possible outcomes based on known behaviour of complex dusty plasmas.

We might thus be tempted to view the Lagrange Dust Balls as highly structured "intelligent" systems capable of storing and processing "information". that they may have more surprising and unexpected features. Indeed, such huge stable entities which have presumably endured for astronomical timescales and have steadily grown in complexity over billions of year may display spontaneously evolved phenomena which might resemble those of the most highly complex living entities. This situation is not dissimilar to the brain-like like complexity of the "cosmic web" discussed by Ginsburg *et al.* (2019), although it is potentially even more impressive in its computational potential.

It is often said anecdotally that the human brain contains more neurons than there are observable stars in the night sky. But the human brain only fits inside a small skull. A stable dusty complex plasma ball of immense size which has possibly endured for aeons and experienced continual growth and expansion over countless millennia is in principle capable of developing something resembling a much more complex nervous system than a human brain with its

average lifetime of ~ 10^2 years. A complex dust cloud (KDC) which has existed for many millions of years might even have become self-aware . . . . with all that this implies. It is conceivable that Fred Hoyle's fictional Black Cloud has a reality in the context of KDC's – which of course he could not have recognised in 1957 (Fred Hoyle, 1953).

Acknowledgement

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Appendix Two

OBITUARIES

Peter Mitchell

CORRECTION: The conversation reported in the second paragraph of yesterday's obituary of **Peter Mitchell** took place in 1980, not 1950 as printed.

PETER MITCHELL was one of the most brilliant and original of Britain's men of science, though he was little known outside his field until he received the Nobel Prize for Chemistry in 1978.

Mitchell was modest, perhaps excessively so, and reclusive. He told me in 1950: "I suppose that in a few years' time nobody will even remember me." And he believed that. He hated publicity of any kind and said: "I'm really worried by having attention drawn to me as a person." Two scientists who wrote the first popular article about him in 1975 in *New Scientist* remarked: "To say more about Mitchell the man would evoke a good natured retort on the telephone asking if we intended this article to be his obituary."

Mitchell had a magically warm and conspiratorial smile; indeed, he once signed a paper to me "To a co-conspirator". The conspiracy was simple: to try at all times to defeat humourlessness and intolerance, arrogance and closed thinking. And that was what his smile said to his co-conspirators; to others of whom he was not sure, his smile said: "Are you what I hope you are?" For he never believed himself superior to a single living person and he told me: "It worries me to think of people I don't know being unhappy. What I really care about is the people who are going to be alive after I'm dead." But he also had one of the most subtle and sophisticated senses of humour I have ever encountered and liked to laugh with, rather than at, the human condition, and at no individual but himself. He was the basis for the main character in Michael Mulkay's book *Pandora's Box* which dealt with the relationship of scientists' personalities to their work.

Mitchell entirely revolutionised the science of bioenergetics by effectively standing its theory on its head. For a time he worked at Cambridge and Edinburgh universities (where he was Reader), but most of his work was done in a private laboratory, the Glynn Research Institute, an eighteenth-century mansion in Cornwallwhich he restored with his own hands from a ruin. He pretended out of modesty that his institute was funded by foundation grants, but in fact he and his brother Christopher used the wealth they inherited from their family's construction firm, Wimpey, to fund the crucial work that led to the Nobel Prize.

If Peter Mitchell had had to be subject to peer review and to apply for grants he would have had little time left for his work and would not have received any grants anyway, thus getting nowhere. The sums of money he spent or research were vast, but he could not bear anybody to know about it. At all times he wished to be the Invisible Man. He could probably not have succeeded without the enduring love of his second wife, Helen ffrench, whose passionate devotion both to Peter the man and to his work gave him the emotional support he needed, providing the protection of his privacy and the spectacular hospitality to guests, as they were needed. Helen's French provincial cooking

and Peter's connoisseurship of fine wines meant that meals at Glynn were always of Michelin-star quality.

Also crucial to Mitchell's career was Dr Jennifer Moyle, his research associate from 1948 until her retirement a few years ago, who, in 35 years, "only really ever had one quarrel with Peter". For 20 years Mitchell was ridiculed, and Jennifer Moyle was his only professional supporter. So vicious was the scientific opposition to him that students were routinely lectured at some universities about how intellectually crazy he was. He was kept out of the Royal Society for many years by jealous scientific colleagues whose own theories were threatened by his work. But in 1981 the Royal Society awarded him their highest honour, the Copley Medal, by which time he had been a fellow for seven years.

Mitchell's work is hideously complex. But, simply, it used to be thought that cell walls were like partitions on a factory floor, and that the energy absorbed by animals and humans from food, and by plants from sunlight, was somehow turned into the energy necessary to run the body by purely chemical means – the so-called "bag of enzymes" theory, which postulated random and directionless processes. But Mitchell ignored mass ridicule to prove his hunch that in fact that "there was a direction to the flame of life", as one admirer later put it. He demonstrated that currents of protons passed through cell walls, which far from being idle partitions were actually riddled with directional pathways, and that this sensible and directed form of energy transport was at the basis of all life of bodily cells.

This discovery also showed for the first time a reverse form of electricity (which he named "proticity"), which he successfully demonstrated could run an engine and which may some day become a major factor in energy processes. The discoveries were a conceptual breakthrough as fundamental in cell biology as relativity theory was in physics. Scientists are still struggling to realise all the implications, and medical results will probably eventually follow.

The last 10 years of Mitchell's life were spent largely trying to raise funding for his institute after his own money dried up. His philosophical ideas, which he wanted to pursue and elaborate, were sacrificed to this desperate fundraising task. He had as much to offer in the areas of his other interests as he had in pure science, but one lifetime is too short for such a man, and his philosophical promise tended to be known only to a few friends such as Sir Karl Popper, whom he revered. Mitchell has been called "the Socrates of Glynn Valley"; the historical Socrates restored old buildings and worked in stone as Mitchell did, and they both devoted themselves to philosophical questioning at a deeply profound level of conversation.

Peter rose far above the level of "the great man" (which, hating all pomposity he could never have been) to be in the quiet of his Cornwall retreat what I can only call a great and old soul. His nature was so kind, so gentle, so tolerant and sympathetic; he survived so cheerfully the decades of abuse from jealous and petty colleagues without rancour in his heart or blame towards anyone. However outstanding his achievements in science, his human qualities were of a higher order still.

Robert Temple

Peter Dennis Mitchell, biochemist, born Mitcham Surrey 29 September 1920, Founder and Director of Research Glynn Research Laboratories 1964-86, FRS 1974, Nobel Prize for Chemistry 1978, Chairman and Honorary Director Glynn Research Institute 1987-92, Visiting Professor King's College London 1987-89, married Eileen Rollo (one son, one daughter; marriage dissolved), 1958 Helen ffrench (two sons), died Glynn Cornwall 10 April 1992.

Appendix Three

A James Van Allen Bibliography

Compiled by Robert Temple

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