Foundations of Science

At this point Craig Isherwood invited Robert Barwick to present some essential elements of the past four centuries' scientific disputes on the nature of Universe.

In 1854 Carl Gauss' student Bernhard Riemann presented his famous habilitation dissertation, entitled, "On the Hypotheses which Lie at the Foundation of Geometry". This paper revolutionised not just geometry, but also mathematics, and, most fundamentally, physics.

Bernhard Riemann

Riemann began by addressing the assumptions of geometry: "It is well known that geometry presupposes not only the concept of space but also the first fundamental notions for constructions in space as given in advance. It gives only nominal definitions of them, while the essential means of determining them appear in the form of axioms. The relation of these presuppositions is left in the dark."

This is a description of Euclidean geometry. It is noteworthy that at the age of eleven Bertrand Russell learned the shocking truth that Euclid's axioms couldn't be proven, and it reduced him to tears.

Riemann proposed a general method for determining the truth of a set of assumptions, such as Euclid's axioms: "These [Euclid's] facts are, like *all* facts, not *necessary* [Leibniz's necessary and sufficient reason] but of a merely empirical certainty [they seem right, to our senses]; they are hypotheses; one may therefore inquire into their probability, which is truly very great *within the bounds of observation*, and thereafter decide concerning the admissibility of protracting them outside the limits of observation, *not only towards the immeasurably large, but also towards the immeasurably small*."

In conclusion of his paper, Riemann wrote three paragraphs that overturned Euclidean space forever (don't be confused by the obligatory polite nod to Newton, whose entire system Riemann is demolishing here): "Now however the empirical notions on which spatial measurements are based appear to lose their validity when applied to the indefinitely small, namely the concept of a fixed body and that of a light ray; accordingly it is entirely conceivable that *in the indefinitely small the spatial relations of size are not in accord with the postulates of geometry*, and one would indeed be forced to this assumption as soon as it would permit a simpler explanation of the phenomena.

"A decision upon these questions can be found only by starting from the structure of phenomena that has been approved in experience hitherto, for which Newton laid the foundation, and by modifying this structure gradually under the compulsion of facts *which it cannot explain*. Such investigations as start out, like this present one, from general notions, can promote only the purpose that this task shall not be hindered by too restricted conceptions, and that progress in perceiving the connection of things shall not be obstructed by the *prejudices of tradition*.

"This path [meaning the path of formal mathematics, the subject of his dissertation] leads us out into the domain of another science, into the realm of *physics*, into which the nature of this present occasion forbids us to penetrate." (Emphasis added in these quotations of Riemann.)

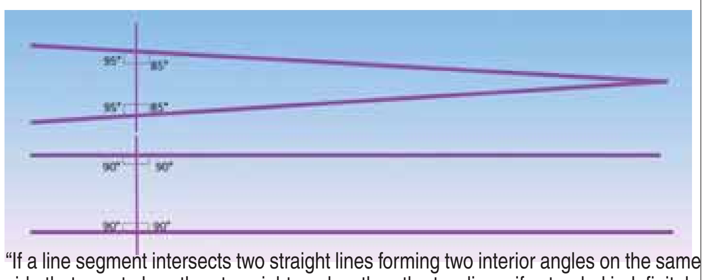
Riemann thus defines a method of investigation, which requires leaving the domain of mathematics, which is hindered by restricted conceptions, and going into the realm of *physics*, that is, the study of the physical Universe, without the formalist assumptions which are typical of any and all mathematics per se.

The Parallel Postulate

Let's look at one example that gets right to the heart of what Riemann revolutionised. Among the axioms, definitions, and postulates of Euclid is the famous fifth postulate, known as the parallel postulate **(Fig. 1)**. "If a *line segment* intersects two straight *lines* forming two interior angles on the same side that sum to less than two *right angles*, then the two lines, if extended indefinitely, meet on that side on which the angles sum to less than two right angles."

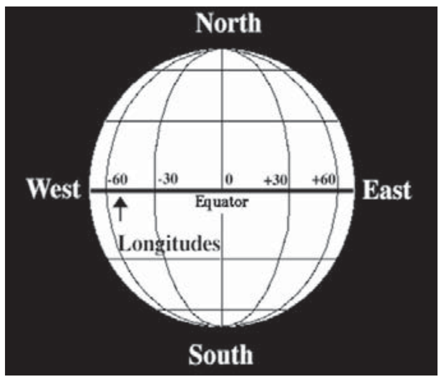
FIG.1

Euclid's Parallel Postulate



"If a line segment intersects two straight lines forming two interior angles on the same side that sum to less than two right angles, then the two lines, if extended indefinitely, meet on that side on which the angles sum to less than two right angles."

FIG.2



The postulate is written in this convoluted way, in an attempt to make this unprovable assumption plausible. That is, the statement that if the interior angles are right angles, the two lines will never meet (or will meet at the theoretical infinity), can not be proved, because you could never test it at infinity. This formalist sleight-of-hand is typical of the entire Euclidean system.

But if we leave the domain of Euclidean geometry, and look at this postulate in the real Universe, but also outside the domain of our sense perception, in the very large, as Riemann directs, what do we discover? First, let's look at lines on the surface of a sphere: take as a line segment, the equator of the Earth **(Fig. 2)**. Notice how it intersects the straight lines going north and south, which are known as longitude lines or meridians. The angle of intersection is 90 degrees; these are right angles. According to the parallel postulate, those parallel meridian lines should stay apart, always separated by the same distance between them. But, do they? No, they all meet at the North Pole and the South Pole. It is the Earth's *curvature* that shows you that the parallel postulate is wrong.

Where in the Universe is there not curvature?

Think about space: could you draw a straight line from one planet to another? **(Fig. 3)**. You might think that you could, and you might have a mental picture of space with straight lines connecting planets, but try it in the real world. Even if you could travel at the speed of light while you are drawing your line, by the time you get to the next planet, it will have moved. If your line is straight, you'll miss the target. All lines between planets will be curved. All "straight" lines on the surface of the Earth are curved. The "straightest" line connecting two points on the Earth's surface is known as a great circle **(Fig. 4)**.

FIG.3

FIG.4

Riemann's New Geometry

Riemann launched a new concept of *physical* geometry, based on the real Universe: actually a never-ending, unfolding series of higher-order physical geometries, not limited by the axioms of straight-line space. Under Riemannian geometry, physics, that is, physical action in the Universe, defined the geometry. It wasn't simply a case of replacing the axioms of straight-line space with new axioms of curved space. Riemann did away with axioms altogether.

After Riemann's breakthrough, geometry is determined by physical reality. New actions create new dimensionalities that determine new geometries. Following in the footsteps of Leibniz and his dynamics, Riemann had overturned Euclid, and thereby destroyed the fundamental assumptions, typified by the Cartesian coordinates system **(pictured on page 14)** that lay in the background of all science as practised by the oligarchy's priesthood. Pierre Curie, Einstein, and Vernadsky, as we shall see, built directly on Riemann's concept of physical space. Lyndon LaRouche called his own method of economic forecasting the LaRouche-Riemann method, and its unparalleled accuracy—no pun intended—is due to its basis in Riemann's emphasis of the primacy of physical reality, as opposed to linear projections within a Cartesian coordinate system.

With that background, and guided by Riemann's method, let's now briefly look at some natural phenomena that are fundamental to the Universe: the visible radiation called light, and other types of radiation. We'll touch on them here, to provide a foundation for the upcoming presentations.

Visible Radiation: Light

Is there a natural phenomenon more primary in the Universe, than light? The major creation stories start with the creation of light. To the empiricists, light was once considered to be instantaneous; that is, it didn't travel, but filled space all at once. Of course, they had no concept of its immense speed.

In 1676 Danish astronomer Ole Rømer was the first to prove that light travelled at a finite speed, rather than instantaneously. Rømer measured how long it took the moon Io, as it orbited Jupiter, to disappear behind Jupiter and reappear again, as seen from the Earth. Rømer found discrepancies in how long Io was out of sight, between readings taken at different times of year (he used 40 different readings).

FIG. 5

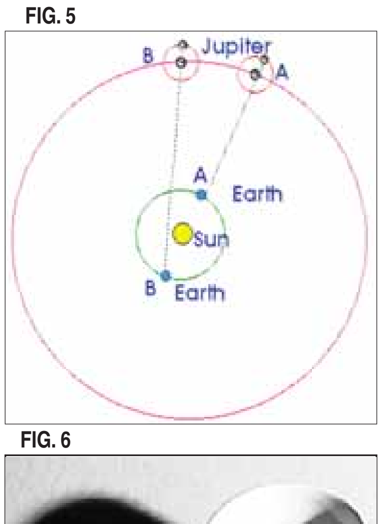


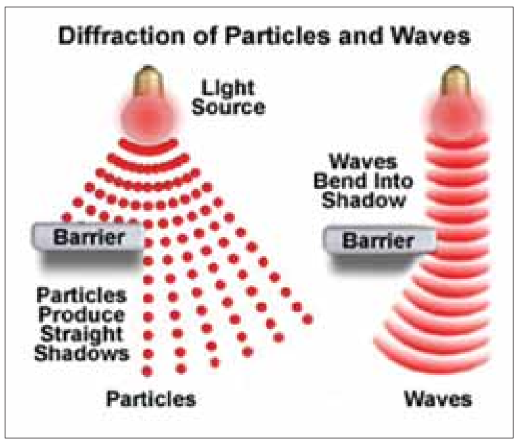
FIG. 6

This he explained by the facts that distance between Earth and Jupiter varied, as each planet moved in its orbit around the Sun **(Fig. 5)**, and that light was taking different lengths of time to traverse the different distances. In the course of refuting objections from Cartesian astronomers, who insisted that these findings must be due to physical variations in Io's orbit, Rømer even used two particular readings to calculate a speed of light—as the cause for why the light seemed to "hesitate", as Rømer put it—which was remarkably close to the modern measurement of 300,000 km/sec.

Isaac Newton, "the last of the magicians", as John Maynard Keynes lauded him, lent his adored reputation to examining the nature of light, and he insisted it was composed of particles, or "corpuscles", as he called them. Newton deduced this from his assumptions about space, the assumptions which were otherwise on display in the Leibniz-Clarke correspondence: that space is Euclidean, characterised by straight lines, and empty, and that matter comes in the form of hard balls. Because the space between one hard ball—the Sun—and the Earth was a vacuum, Newton deduced that light could not be a wave, because it was thought that a wave could not propagate in a vacuum; it needed a medium. Furthermore, and still rooted in his Euclidean view of absolute space, Newton claimed that light travelled in straight lines, as particles were presumed to do.

Newton's view was opposed by the great Dutch scientist Christiaan Huygens, a close collaborator of Leibniz. Huygens focussed on physical attributes of light that could not be explained by the particle theory. One was diffraction, evidenced in the fuzzy edges of shadows **(Fig. 6)**. Diffraction is the phenomenon of light's behaviour when it encounters an obstacle. For example, light passing through a small hole in a surface can be seen to spread out, on the other side. Huygens explained this with the insight that light travels as a wave, which is bent by the edges of the hole through which it passes, the way a wave in water is deflected when it encounters an object. The bending of the waves, seen as their spreading out, accounted for the fuzzy edges of the shadow. If light were composed of particles, then it shouldn't spread out in that way, upon passing through the hole, and the edges of the shadow should be sharp **(Fig. 7)**. Huygens was initially ignored, simply because his idea was at odds with Newton, the high priest of science. You can appreciate the difference in method: Newton's deductive logic vs. Huygens' exploration of actual physical phenomena.

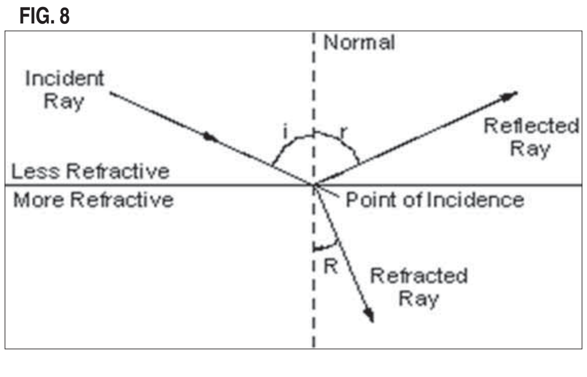
FIG. 7



Huygens Demonstrates Refraction

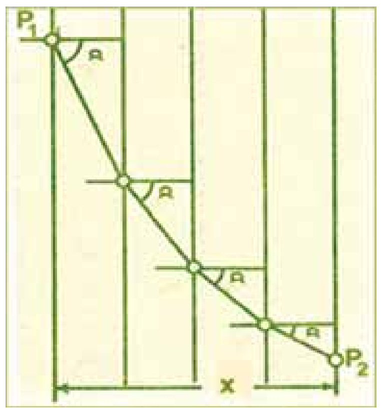
Huygens then demonstrated his theory with another example: refraction. When light passes from one medium to another, such as from air to water, it bends, or refracts, as it goes. But not all of the light goes into the new medium; some is reflected. Huygens demonstrated that this partial reflection is the property of a wave, and that if you measure the amount of light reflected and the amount refracted, it adds up to that of the original light wave **(Fig. 8)**.

FIG. 8



Newton's comeback to this was pathetic: sticking with his particles, he claimed that when the particles reached the new medium, some of them had a fit, like a toddler throwing a tantrum, and refused to travel through. Amazingly, even though this outburst showed Newton to be the kook he was, it didn't cause his idea to be ditched in favour of Huygens' insight, until a brilliant English scientist named Thomas Young, followed by the equally brilliant French scientist Augustin-Jean Fresnel, demonstrated that the interference property of waves applied to light. The zombified Newton-worshippers in the British scientific establishment bitterly attacked Young.

FIG. 9



Huygens's friend Pierre Fermat made an even more profound discovery from experiments on refraction, which is that when the light bends, it follows the path of *least time*. In Euclidean geometry, the shortest distance between two points is a straight line; in the actual Universe, the shortest distance for the light is not a straight line. Leibniz's friend Johann Bernoulli showed that if light were passed through a succession of increasingly dense media, the successive refraction bends would follow the path of a cycloid curve **(Fig. 9)**.

Anticipating Riemann by more than 150 years, these experiments showed that for light, the shortest distance was a curve. Fermat posed the question, "How does light know to take the path of least time?" This sent the Newtonians into conniptions, because it destroyed their notion of a Universe determined by hard balls, acting and reacting kinetically in straight lines, and pointed to a Universe where physical action is governed by "intention"—something that seemingly is not physical, but metaphysical.

Light is central to pretty much all areas of scientific investigation—you could say it throws light onto every subject (pun intended). Light is used both to measure the Universe, and to open a window into microscopic, nuclear, and quantum processes, all of which will feature in the presentations this weekend.

Invisible Radiation

Now, let's look at radiation phenomena that cannot be perceived as readily as visible light, but are equally fundamental to the Universe. Before I do, let me point out a little oligarchical trick.

Newton rejected Huygens's evidence that light moves as a wave, because he insisted on the formalism of Aristotle's deductive logic, and on Euclidean assumptions about space. After 100 years, when Thomas Young's work finally broke down the last defences of Newton's kookery in Britain—but only with regard to light—the highest levels of the British oligarchy, operating through the degenerate Cambridge University Apostles, set out to turn the wave theory of light and related discoveries of electromagnetism, *into a new formalism*. In other words, they tried to reduce the discoveries to mathematical formulas, serving as the basis of new rules, which they solemnly declared to be *laws*.

But, remember what Riemann had said: "[F]acts … are not necessary, but of a merely empirical certainty." That is, reducing physical reality to simple mathematical formalism removes the causes by which things happen in such and such a way, and not otherwise.

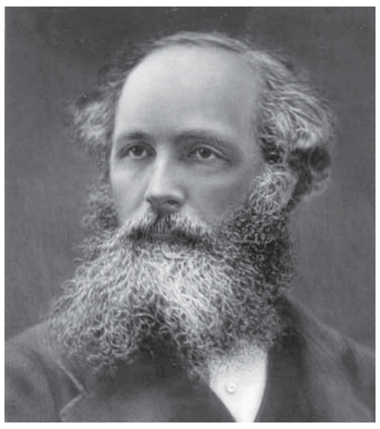
In the case of electromagnetism, the Apostles installed their member James Clerk Maxwell as the first head of Cambridge University's Cavendish Laboratory. Maxwell took all the discoveries of light and electromagnetism by Ampère, Gauss, Riemann, and others, and formalised the physical realities, established by their experimental work, to just a series of mathematical equations—Maxwell's Laws of Electromagnetism. The cornerstone of these new formal laws was that electromagnetism, which included light, must travel in waves, and waves only. As you will see in the work of Max Planck and Albert Einstein, the physical reality is much more complex. And it is probably a sign of the Creator's sense of humour, that some of the key discoveries in radiation, which turned this new formalism on its head, would be made in the Cavendish Lab.

Let's go through the basics of how other types of radiation were discovered, to set the scene for the upcoming classes. A word of caution: understood properly, the terms we use are not things, but concepts.

Cathode Rays

In the 1880s and 1890s many scientists were focussed on what happens to gases in glass tubes when most of the air is sucked out and an electrical charge passed through them. The charge would pass between electrodes at each end of the tube: the negatively charged cathode, and the anode at the other end. Strangely, this produced a fluorescent beam of light, the colour depending on what kind of gas was in the tube. Even more strangely, this beam of light could be deflected by a magnet—unlike any normal light beam. This was called a cathode ray, and the tube became known as a cathode ray tube, the technology that gave us television **(Fig. 10)**.

Luminescence and fluorescence in rocks led Henri Becquerel and Marie Curie to discover the phenomenon later called radioactivity.



Cambridge Apostle James Clerk Maxwell tried to undermine the discoveries in light and electromagnetism by reducing them to mathematical equations.

In 1886 German scientist Eugen Goldstein discovered that when he played with a cathode ray tube, in which the cathode was placed in the middle of the tube, instead of the end, other rays besides the cathode rays shot out of the back of the cathode, in the opposite direction. Because they came out of little channels drilled in the cathode, Goldstein called them canal rays. They, too, were found to be deflected by a magnet, but in the opposite direction to the cathode rays. **(Fig.11)**. These experimental results were a clue to the concept of opposite *charges.*

Ten years later, in 1896, a scientist at the Cavendish Laboratory named J. J. Thomson experimented with cathode rays and electrified plates. He showed that the rays were deflected by an electric field, as well as a magnetic field. Thomson hypothesised that the rays were in fact negatively charged electrified particles. This was the first time something smaller than an atom had been conceived. In 1898 Wilhelm Wien in Aachen, Germany, showed that canal rays were also particles, but carrying a positive charge. The electrical charge that particles carry is known as ionisation.

FIG.10

Through experimentation with the strength of the electrical fields, compared with the degree of deflection, it was discovered that the cathode ray was over 1,000 times smaller than the canal rays. The positive canal rays became known as protons, while the much smaller, negative cathode rays became known as electrons, the elementary particle of negative electricity. Much later, it was discovered that electrons, whilst they were particles, were also waves.

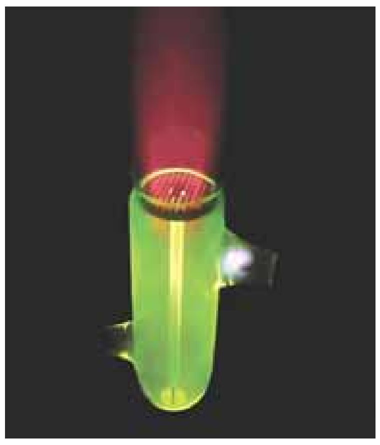
Röentgen's X-rays

Back in 1895, just before Thomson discovered electrons, Wilhelm Röentgen in Germany discovered a third type of ray emitted by cathode ray tubes. These rays lit up a fluorescent screen, but also could penetrate many materials. In a paper on this discovery, Röentgen called them Radiation X, or X-rays. They also became known as Röentgen rays.

This discovery sparked an explosion of further discoveries in physical chemistry. Each new discovery led to a cascade of still more discoveries. Röentgen's X-rays inspired French scientist Henri Becquerel to apply his knowledge of fluorescence, which was a key part of the Röentgen discovery, to discover that uranium rocks also emitted rays, which became known as Becquerel rays.

And then Marie and Pierre Curie applied a special machine Pierre had invented, the electrometer, which could accurately measure small amounts of ionisation, or charge, to discover that the Becquerel rays from uranium rocks (ore) were coming from different elements, which Marie Curie then identified. She named the ionising rays they produced, *radioactivity*.

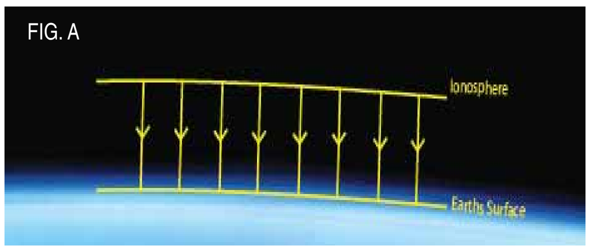
FIG.11

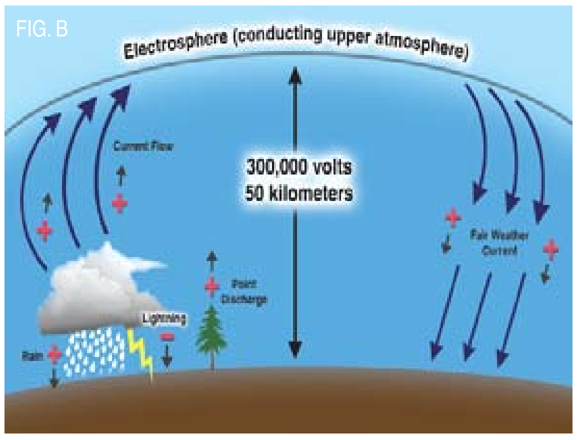


Finally, working with the Curies and using their electrometer, New Zealand scientist Ernest Rutherford showed that there were different types of radioactivity, distinguished by their penetrating power. One type of radiation, which he called alpha rays, could be stopped by a single sheet of paper. Another type, beta rays, could penetrate up to a dozen sheets of paper; these turned out to be high-speed electrons. Still another type had very great penetrating power, and could only be stopped by lead or concrete. These were called gamma rays.

Needless to say, these breakthroughs opened up an entire new era for mankind, beginning with the mastery of nuclear fission. Soon it will encompass nuclear fusion, the process by which the Sun produces energy, if we fund the work adequately. That physical changes so immense and dramatic could emerge from discoveries in the immeasurably small, is a fulfilment of Riemann's method.

Cosmic Radiation





Craig Isherwood resumed the keynote presentation at this point.

Far from being the void of Newton's Absolute Empty Space, real space is a massive, universal system of cosmic radiation, of all kinds of frequencies and all kinds of characteristics. Space, in fact, is a continuity of cosmic radiation, coming from all parts of the Universe, including out from Earth, from adjacent planets, from the Sun, and so forth. So, now I want to take a few minutes to give you a sense of what this cosmic radiation is.

Cosmic radiation can be divided into three categories:

* the various fields (electric, magnetic, gravitational, morphogenetic—radiation emitted from living cells);

* the domains of the electromagnetic spectrum (radio, microwave, infrared, visible, ultraviolet, X-ray, gamma ray, etc.);

* and so-called energetic particles (cosmic rays, radioactive decay products, etc.). They are "so-called" because their nature has not really been determined.

I will go through each of these briefly, to give you a sense of how jam-packed our Universe is.

The Electrosphere

We live in an electric field, caused by the difference in charge between the ionosphere and the surface of the Earth (**Fig. A**). The ionosphere is a shell of electrons and electrically charged atoms and molecules that surrounds the Earth, stretching from a height of about 50 km to more than 1,000 km. It owes its existence primarily to ultraviolet radiation from the Sun. The Earth, at the same time, is rich with electrons due to its physical matter.

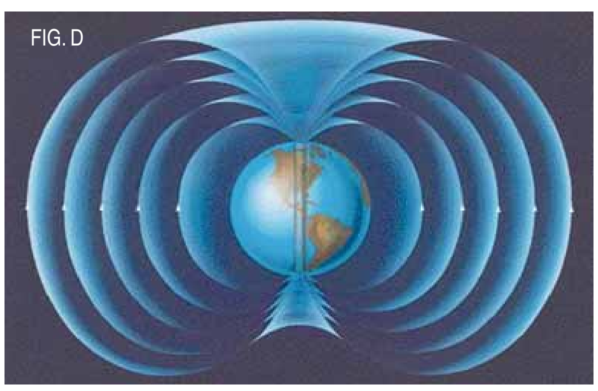
This creates an electrical potential difference of some 300,000 volts. Because the atmosphere is not a perfect insulator, there is a leakage of electricity into the atmosphere from the surface of the Earth, at a rate of 2,000 amperes at any given moment **(Fig. B)**. At this rate the Earth's charge would dissipate in less than an hour. However, lightning recharges the Earth's surface. There are about 2,000 thunderstorms taking place around the world at any one time, producing about 30 to 100 ground flashes each second, or five million flashes a day.

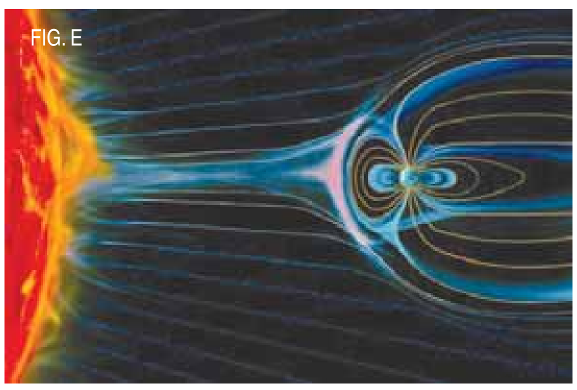
Seen from space, the Earth's electrosphere is one large humming and glowing mass of electrical energy, which helps govern living organisms' sense of time, among other things **(Fig. C)**. There is a special issue of *EIR* magazine titled "The Extended Sensorium" which gives an overview of these processes. (*Executive Intelligence Review,* Vol. 38, No. 5, 4 February 2011).

The Magnetosphere

The next field we have is the magnetosphere **(Fig. D)**. Now, a lot of people think about the magnetic fields around the Earth as being uniform and concentric. Such an image matches the notion of a Universe in which there is almost no action—as if space were empty. In reality the magnetosphere is not much of a sphere at all, but rather is a region of magnetic fields that are incredibly distorted by the Sun's plasma and wind **(Fig. E)**. The magnetosphere shields the Earth from the majority of the Sun's radiation, thereby allowing life to survive this intense radiation. The magnetosphere changes, and such events as a magnetic pole reversal, which means a shift of the north magnetic pole to the south magnetic pole, and vice versa, would be involved in an extinction event such as those which have wiped out over 95 per cent of all the living species which ever existed. During the shift the magnetosphere is greatly weakened, letting through vastly larger amounts of cosmic radiation. The effect may be more or less intense, depending on the position of our solar system in the galaxy.

Homing pigeons, which have small magnetic pellets in their beaks, like a small compass, would not survive. How would they get home? Sockeye salmon, which use the magnetosphere, the magnetic fields, to find their original spawning grounds,





would get lost at sea.

Any abrupt changes to the Earth's magnetic field have a profound effect on living organisms.

Earth's Gravitational Field

We are used to having both feet on the ground in a gravitational field, the average strength of which is 9.8 m/sec^2 of acceleration. This field is not uniform over the surface of the Earth. Here is a rotating model of the different surface gravitational fields of the Earth **(Fig. F)**. You can see on the map where gravity is the strongest (Indonesia, orange and red) and the weakest (India, green and blue). The differences occur because of the different mass densities of various parts of the surface of the Earth. Mountains do not necessarily have the greatest mass.

In **Table 1**, you can see the variation of gravity at various places on the surface of the Earth. Thus, having done away with Absolute Space and Absolute Time, you can also say that there is no such thing as Absolute Gravitation. Looking at the other planets and the Sun **(Table 2)**, you can see the enormous variations in the gravitation fields on each planet.

Again, we have evolved in this unique gravitational field of the Earth, and this raises concerns about what will happen when we are taken outside of it, for example during space travel.

Russian biologist Alexander Gurvich (Gurwitsch) studied mitogenetic radiation in plants.

FIG. F

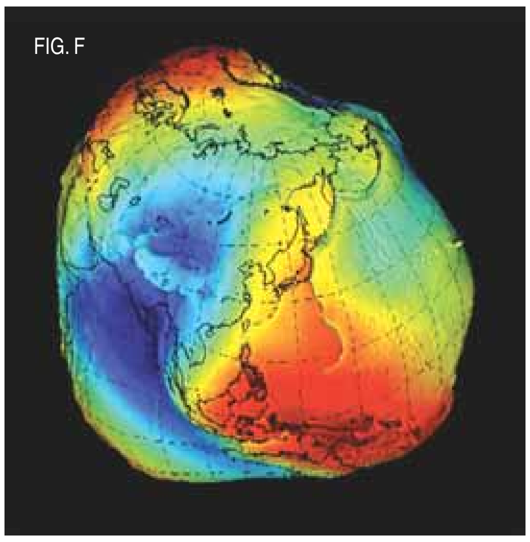


TABLE 1.

Location	Acceleration in m/s²
Athens	9.800
Auckland	9.799
Bangkok	9.783
Calcutta	9.788
Chicago	9.803
Copenhagen	9.815
Sydney	9.797
Helsinki	9.819
Jakarta	9.781
London	9.812
Los Angeles	9.796

TABLE 2.

Body	Multiple of Earth's Gravity	Acceleration in m/s²
Sun	27.9000	274.10
Mercury	0.3770	3.70
Venus	0.9032	8.87
Earth	1.0000	9.82
Moon	0.1655	1.63
Mars	0.3895	3.73
Jupiter	2.6400	25.93
Saturn	1.1390	11.19
Uranus	0.9170	9.01
Neptune	1.1480	11.28
Pluto	0.0621	0.61

Morphogenetic Fields

Morphogenetic fields, or weak radiation from living cells, have not been studied well. The Russian molecular biologist Alexander Gurvich (Gurwitsch) demonstrated that mitosis (cell division) during the development of an organism can be induced amongst other cells in the active mitosis phase **(Fig. G)**. He found that this effect is caused by radiation from one cell to another, which he called "mitogenetic radiation", or M-rays. Their energy levels are in the lower range of those characteristic of UV light radiation (which range from 3 electron-volts up to over 100 eV for extreme high-frequency UV). Other experiments have indicated the possibility that cosmic rays, under the right conditions and in water, could emit what is called Cherenkov radiation, which has characteristic energy levels of four or five eV, right in the same range as the M-rays that could induce cell division.

Electromagnetic Radiation

Our biosphere is constantly being bombarded by energy in the form of what we call electromagnetic radiation. This radiation takes the form of waves with different frequencies, wavelengths, and amplitudes. From the chart in **Fig. H**, you can see all sorts of electromagnetic radiation striking us. From the bottom upwards, the frequency gets higher, and the wavelength shorter. At the top are the powerful X-rays and gamma rays, which contain a huge amount of energy. In the middle is the small band we call visible light.

The largest portion of this radiation comes from the Sun, but, fortunately, because of the actions within the biosphere, and specifically our upper atmosphere, much of the more harmful radiation is filtered out, and we are left with only specific wavelengths of radiation reaching the surface of our planet. In **Fig. I** the yellow area of the graph measures total radiation from the Sun, including every possible wavelength of radiation, and the red areas show the wavelengths of radiation that actually strikes the Earth: infrared, visible light, and ultraviolet. In the ultraviolet region towards the left of the graph, you can see that a lot of the more harmful, higher-energy UV radiation is blocked out by our atmosphere.

FIG. G

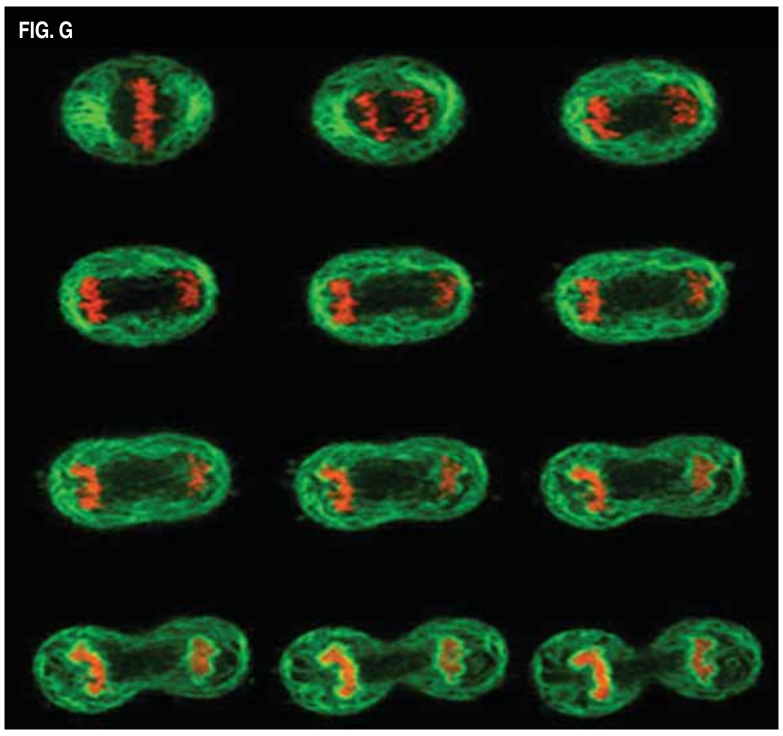


FIG. H

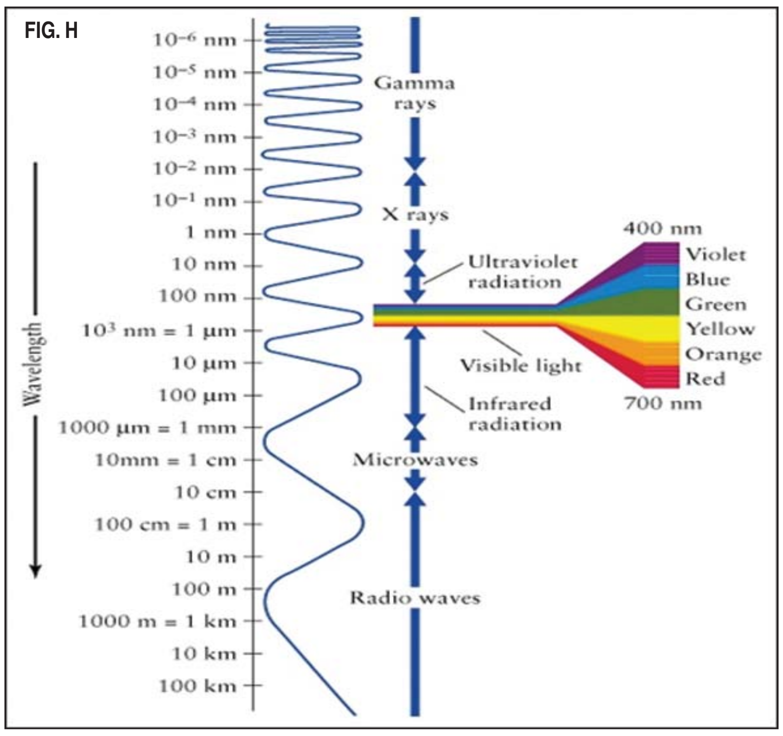


FIG. I

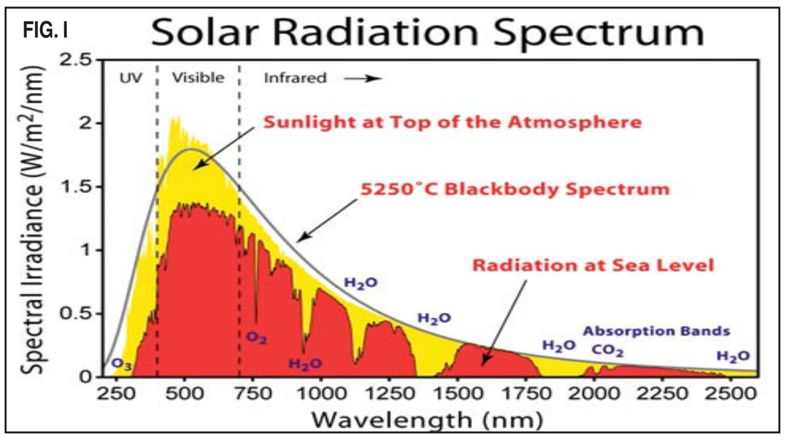


FIG. J

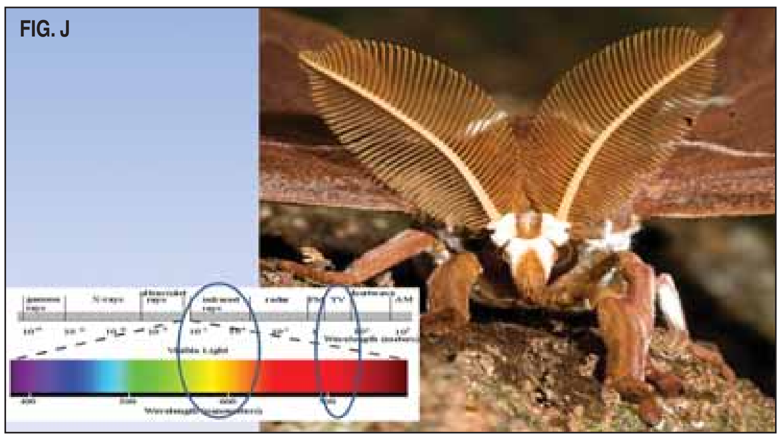


FIG. K

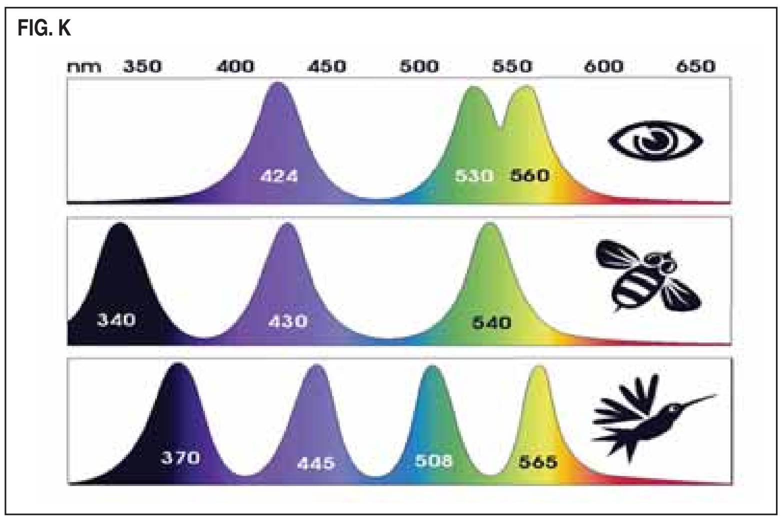


FIG. L

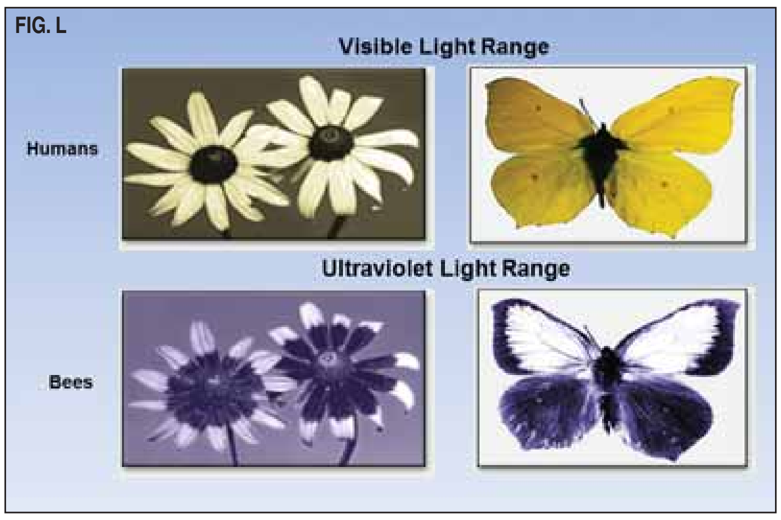
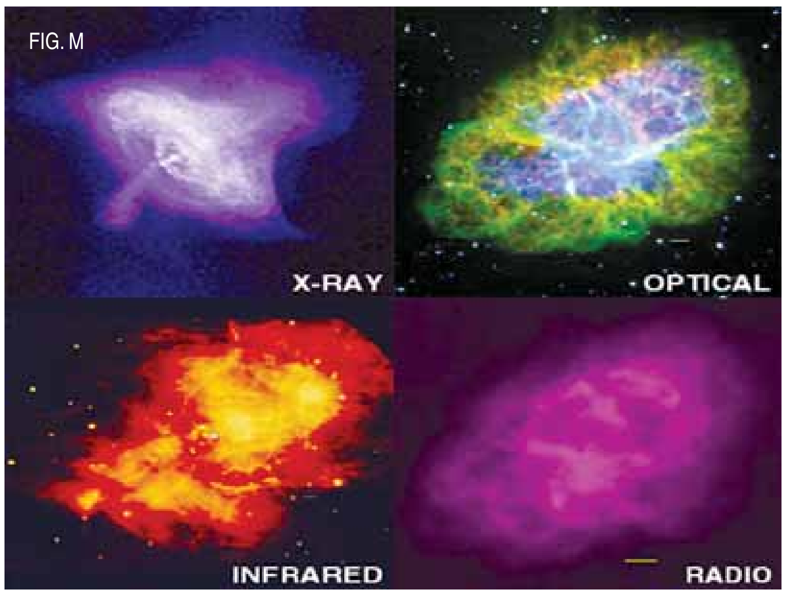


FIG. M



The various types of radiation play crucial roles in insect life. For example, the antennae on this male Hercules moth **(Fig. J)** are tuned to sense pheromones released by female moths, which vibrate at "infrared" frequencies. TV aerials tune in to a different section of the electromagnetic spectrum.

Different organisms have developed their visual sense to maximise various parts of the electromagnetic spectrum. **Fig. K** compares three of them. The human eye is sensitive to certain parts of the electromagnetic spectrum, allowing trichromatic (three-colour) sensitivity, whereas bees and birds have different sensitivities to different areas. Birds have developed four-colour sensitivity, up into the ultraviolet range, so they can see things we don't. The range of colours/radiations that we visualise overlaps what a bee would see. Thus bees, which generally have poor sight, rely on sharp contrasts within images in the ultraviolet range. **Fig. L** shows what a flower and a butterfly would look like to a bee; you can see a more distinctive bullseye than what we see, and contrasts on the wings of the butterfly that are invisible to us. Flowers have developed the most intensely reflective colours that attract the most insects.

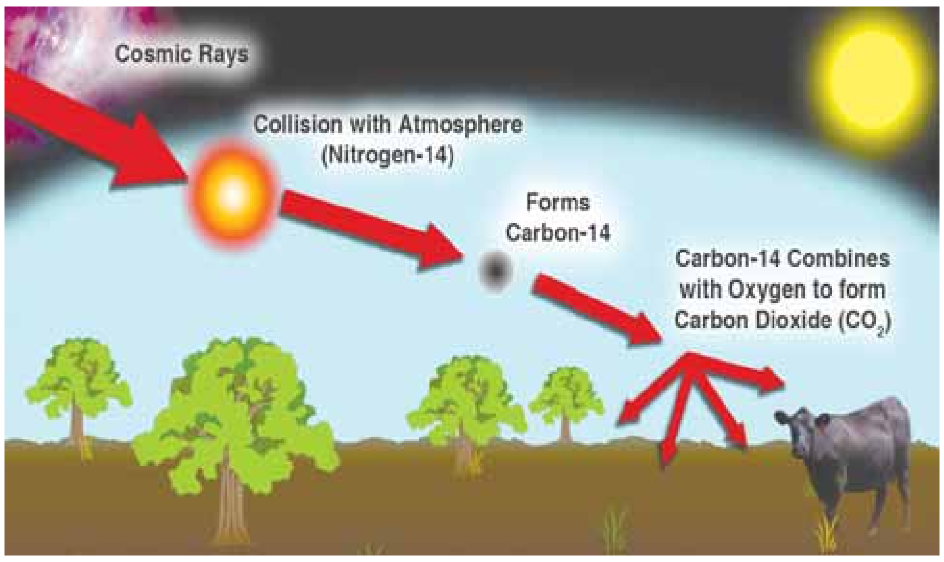
Electromagnetic radiation, such as X-rays, infrared, radio waves, and gamma rays, originates from the farthest reaches of the galaxy, from sources such as supernovae, or exploding stars. The Crab Nebula **(Fig. M)** is a supernova remnant that emits a vast array of high-energy electromagnetic radiation which reaches Earth.

FIG. N

TABLE 3.

Reaction Products of Secondary Cosmic Rays and their Lifetime Reaction	
Tritium	12.3 years
Beryllium-7	53.3 days
Beryllium-10	1,600,000 years
Carbon-14	5730 years
Sodium-22	2.6 years
Sodium-24	15 hours
Magnesium-28	20.9 hours
Silicon-31	2.6 hours
Silicon-32	101 years
Phosphorus-32	14.3 days
Sulfur-35	87.5 days
Sulfur-38	2.8 hours
Chlorine-36	300,000 years
Chlorine-38	37.2 min
Argon-39	269 years
Krypton-85	10.7 years

FIG. O



Cosmic Rays

One of the most important forms of cosmic radiation is cosmic rays. They are cosmic particles that strike the Earth individually, and not really in the form of a ray or beam of particles as visualised in 1950s sci-fi movies of cosmic ray guns.

All incoming cosmic ray particles are discrete packets of energy, related in a characteristic way to their electromagnetic source. Various particles have different levels of energy associated with them. For example, over 90 per cent are high-energy protons or hydrogen atoms, fewer than 9 per cent are helium nuclei. Another, very high-energy cosmic "ray" is the gamma ray photon, though they are quite rare; they go through anything in their path.

When cosmic rays enter the Earth's atmosphere they collide with molecules, mainly oxygen and nitrogen, to produce a cascade of lighter particles, a so-called air shower of secondary particles, as shown in **Fig. N**. These secondary particles, listed in **Table 3**, cause various reactions within the Earth's biosphere. An important one of these yields is carbon-14, a radioactive isotope. Generated in the upper atmosphere, it is found on the surface and in the crust of the Earth, and can be used to determine the age of archaeological material through so-called "carbon dating" **(Fig. O)**. When cosmic rays enter the upper atmosphere, they hit atoms and molecules, which release "neutrons". These neutrons combine with nitrogen, changing it into carbon and releasing a hydrogen atom. The carbon then forms into molecules such as carbon dioxide, which Julia Gillard calls pollution, and finds its way into the food cycle of plants and animals. As carbon-14 breaks down, or decays, at a known rate, the relative amount of carbon-14 remaining in, for example, excavated material, can be measured to determine its age.

The amount of cosmic radiation striking the upper atmosphere evidently correlates with cloud-formation (**Fig. P**). It may well be that an increased amount of cosmic radiation causes regularly greater cloud cover to occur, and hence cooler temperatures and ice ages are possible on the Earth.

The position of our solar system within the galaxy **(Fig. Q)** determines the amount of cosmic radiation we are exposed to, a radical fluctuation whose effects can be seen in extinction cycles on Earth. Of all living species ever to have existed on Earth, 95 per cent have died out **(Fig. R)**. The LaRouche PAC website (www.larouchepac.com) and our publications, such as the *Australian Alert Service*, have covered this subject extensively, and I encourage you to look there and learn more.

Our solar system is now moving out of the relative "protection" of its position in our Milky Way galaxy, into a new position, above the plane of the galaxy. This exposes the Earth to more radiation than we have been used to, since man has been on the planet. We face the threat of mankind becoming extinct, unless we enact a Glass-Steagall two-tier banking reorganisation, and start a crash science-driver programme to figure out how to deal with this reality.

FIG. P

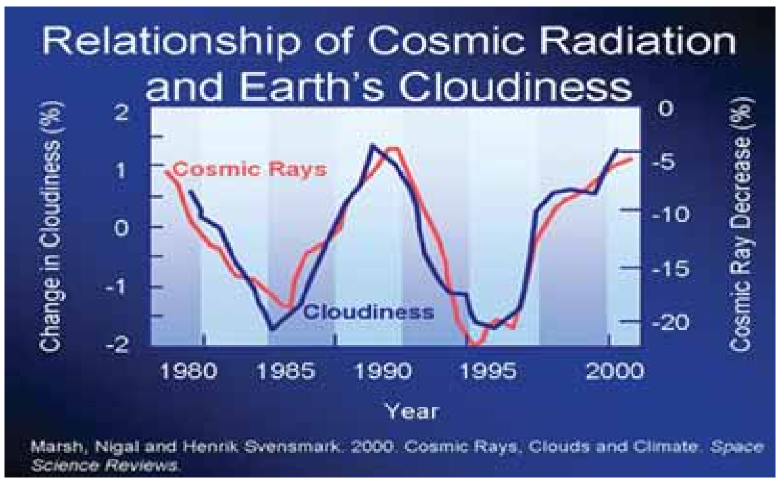
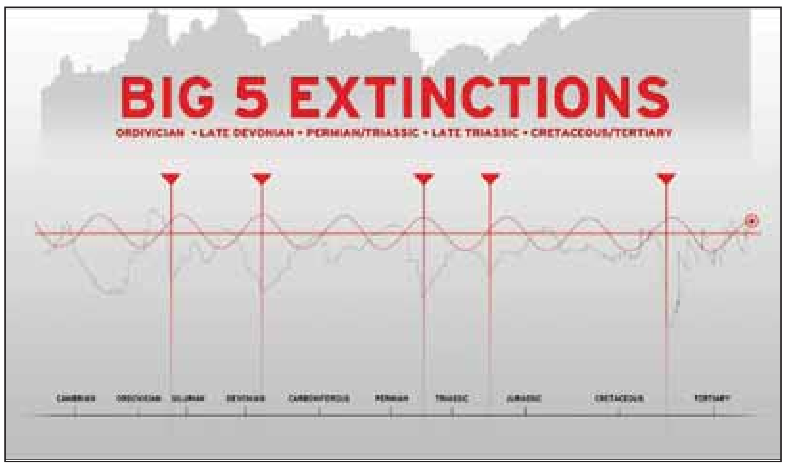


FIG. Q

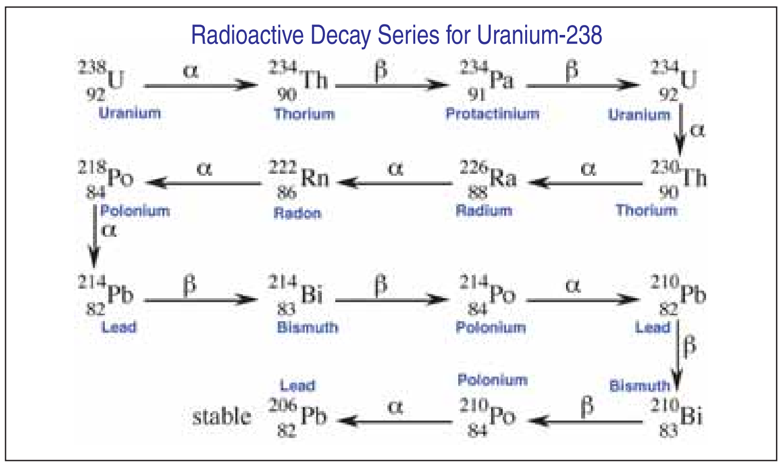
Our Milky Way galaxy moves through the Universe face-on, not edge-on like a frisbee. As the solar system moves above the galactic plane, it is "out front" of the moving galaxy, and the Earth is exposed to a greater density of cosmic radiation.

FIG. R



Mass extinctions coincide with our solar system's movement to galactic "north", above the plane of the galaxy (horizontal orange line), every 62 million years. It's been some 65 million years since the last one.

FIG. S



Radioactive uranium-238 emits alpha and beta radiation as it undergoes 15 steps of radioactive decay to become the stable element lead-206.

FIG. T

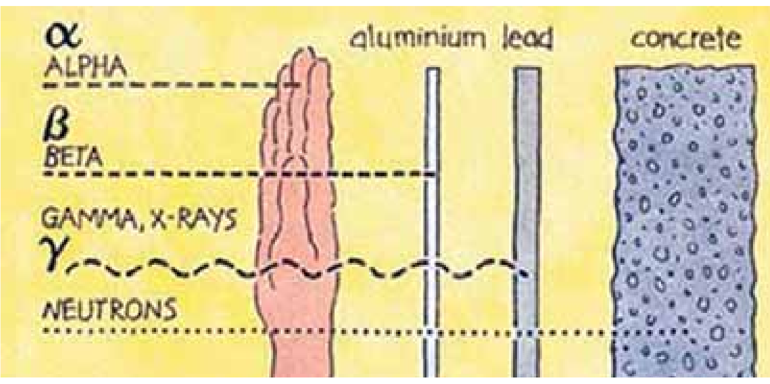
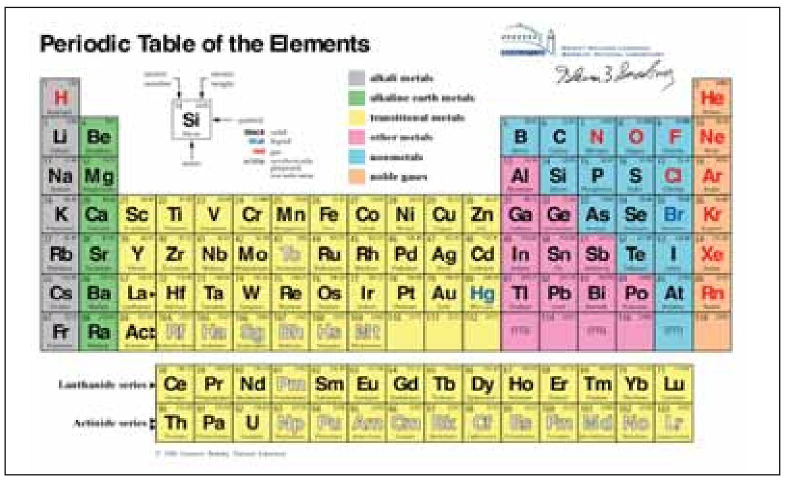


FIG. U



Radioactive Processes

The last form of cosmic radiation we have to look at is radioactive processes. Radioactivity, or radioactive decay, is the process whereby certain elements transform themselves into new elements by releasing energy. This energy can come as discrete particles or wave energy, but what actually happens is not known with certainty. **Fig. S** is a chart of the radioactive decay process of uranium, which becomes a more stable element, lead. It takes approximately four and a half billion years for half of the uranium to convert to stable lead, but some of the individual transformation steps only take fractions of seconds. The Greek letters alpha (α) and beta (ß) represent the type of radiation that is given off, which can be determined by its physical effects. The third type of radiation, gamma (γ) rays, is not shown here, on this graphic.

Alpha particles are relatively slow and heavy, and have what is called a low penetrating power. They can be stopped by a single piece of paper. These alpha particles have a high ionising power, which means that when they collide with atoms or molecules in the atmosphere, they can knock off negatively or positively charged particles, creating a charged form called an ion. The changed electrical effects can be measured using various types of sensitive instruments such as the Geiger counter.

Beta particles have medium penetrating power, they can be stopped by an acrylic substance like Perspex. Beta radiation has less ionising power than alpha radiation.

Gamma radiation, often described as high-energy waves, or bursts of photons, has a high penetrating power, so it takes a lot of concrete or lead sheeting to stop it. Gamma rays do not have great ionising power, but they may cause other atoms to emit particles which ionise their surrounding molecules. **Fig. T** shows the different penetrating powers of the different forms of radioactive emissions.

Over the billions of years that cosmic rays have been interacting with our Earth, they have hugely influenced the development and arrangement of the elements, which we conceptualise in Dmitri Mendeleyev's Periodic Table of Elements, on our planet **(Fig. U)**.

From what I have laid out in this summary form, showing the enormously powerful fields in which we live, the vast array of different electromagnetic radiations with which we live, and also these highly charged particles called cosmic rays, and radioactivity, I think you can begin to see that space is far from empty!