THE PHYSICS OF ULTIMATE REALITY:

Introduction and Summary

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This is a book about the future of science, based on the belief that science, like every other aspect of human culture, evolves. It evolves in two quite different ways, first described by Thomas Kuhn in his landmark book of 1962, *The Structure of Scientific Revolutions*, on which there will be much more to say. "Normal science" (Kuhn's term) develops through incremental steps, small and large, which explore reality within the framework of knowledge and beliefs prevailing at the time. This framework, to which he applied the term "scientific paradigm", can usefully be regarded as the unwritten constitution of science at any one period. It establishes a norm of orthodoxy within which research is organised and during which contradictions and unanswered questions of various kinds can be usefully ignored for a while. Eventually, however, these anomalies accumulate to the point where they become too heavy for the then existing structure of laws and principles to bear, whereupon it undergoes a slow collapse until some individual or a group proposes a new paradigm, a different framework of understanding which is eventually accepted as a new orthodoxy.

In his later writing Kuhn dealt at some length with the difficulty of finding a precise definition of paradigm and bemoaned the fact that it had been so widely adopted and so loosely used that it had lost its significance: it is, for instance, quite usual now to talk about new paradigms in retailing and hairdressing. Kuhn was addressing events which affect only the community of scientists, which he defined very tightly as those who regularly read professional journals, but even within this narrow context an authentic paradigm may be difficult to identify. His touchstone is twofold, namely, the degree of trauma and the extreme sense of discovery that goes with encountering a new paradigm, but his emphasis is on the first, which he likens in more than one place to a religious conversion. The way in which these two quite opposite reactions – resistance and enlightenment - can coexist in a science, but not in one individual, is an intriguing question in the sociology of science and will be dealt with in the section "What is a Paradigm?" In periods of change radical enough to be considered paradigmatic peer group review, the standard method for evaluating scientific novelty, is counter-productive, for the obvious reason that the experts are experts in what is now being challenged and have a vested interest in keeping the existing paradigm intact. There is thus an inherent inertia in any paradigm and change comes about only when those with exceptional curiosity confront assumptions which previously were considered as unquestionable. Restructuring cannot happen until the beginnings of a new paradigm have been seen and have gained a critical measure of acceptance by the scientific community and, more particularly, by those who are considered to be its leaders. A genuine paradigm shift is a re-laying of foundations, and the bigger the structure that has been built on the old, the more resistance there will be to the new.

That there is need for change in science as currently understood and practiced is widely acknowledged, but on examination it will usually be seen to be for change without too much disturbance of the existing paradigm. Among the few who urge the need for radical, paradigmatic change was the physicist Heinz Pagels, one time director of the New York Academy of Science, and his words may serve to summarize the challenge that the book sets out to address – emphasis added:

> *Much of our current scientific thinking about microscopic physics and cosmology is probably wrong and will have to be discarded. Maybe in the future there will be a major revolution in physics* <u>that will revise *our whole idea of reality*</u>*. We may look back on our current attempt to understand the origin of the universe as hopelessly inadequate, like the attempt of mediaeval philosophers trying to understand the solar system before the revelations of Copernicus, Kepler, Galileo and Newton. What we now regard as* <u>'the origin of the universe'</u> *may be the temporal threshold of worlds beyond our imagining.* [1]

It is possible to see paradigm change happening at different levels, the deepest of which is when it challenges the definition of physical reality assumed by the scientific community, for when this happens, science itself must change and the role, indeed the identity, of the scientist comes into question. One can detect a historical progression in the theories of reality put forward in the past by Plato (428-348 BC), his pupil Aristotle (384-322 BC), Nicolai Copernicus (1473-1542) and Albert Einstein (1879-1955). Great names like Kepler and Newton, who have contributed so much to science, have been omitted from this select list because they took over an existing world view and improved or justified it, rather than replacing it. Historically, philosophers have recognized two theories of reality, which spring from different temperaments. Plato's reality was dualistic - the changing world of normal experience and a hypothesized realm of ideal forms where, so to speak, the unchanging blueprints of everything were to be found. For the Platonist the latter is the real reality. By contrast, Aristotle's reality was unitary and in the here and now, his universe, centred on our home planet earth and bounded by a fanciful structure of concentric crystalline spheres, the region of the stars, outside of which was a vaguely creative non-physical stuff called the "quintessence". It was all very vague because philosophers at that time had no way of knowing anything about what was above the earth or at the heart of matter.

Science in its present mode may be said to have begun with the view of the universe put forward by Copernicus and can be dated exactly to the publication of his astronomical work, *De Revolutione Orbium Coelestium,* in 1543. Copernicus awoke philosophers and astronomers from the dogmatic slumber of the ancients by centring the universe not on the earth but the sun, and while it is hard for the modern person to understand how disturbing that was, it is easy to imagine how little progress science could have made until that transition had been made. The boundary of Copernicus's universe was left undefined, but vaguely assumed to be where our material world separated from the heaven of Judaeo-Christian mythology. The Copernican world view was to be critically modified by Johannes Kepler's "celestial physics", in his *Astronomia Nova* (1609) and perfected in Isaac Newton's *Principia* (1687), both works of scientific genius, and so things remained until Albert Einstein's published his theory of General Relativity in 1915. General Relativity (henceforward GR) may be regarded as a new paradigm not because it recentred the universe but because it was presented as an answer to Newton's previously unaddressed question, *what is the causal origin of gravity*? Einstein's revolutionary world view has been validated by certain predictions that it makes which have turned out to be accurate but it embodies several weaknesses and critical contradictions, which will be examined in the chapter, "The Importance of Einstein". Suffice to say here that while it broke new ground in proposing that gravity originates in the curvature of spacetime, it assumed that universe is a closed system. Indeed, in its original version, GR assumed that reality was limited to a single, non-developing galaxy, our own Milky Way. These and other weaknesses of the theory have been remedied by continual tweaking of the mathematical model, but this is very unsatisfactory, for it raises the question of whether a theory that is so flexible can be the basis for a genuine paradigm. However, criticism in general has been inhibited by the stature which Einstein achieved in his lifetime and since.

It is the greatest of ironies that while Einstein was working on GR a startling new paradigm was coming into existence, one might truthfully say "being forced into existence," by data from a new generation of very large reflecting telescopes. What they revealed was the existence of other galaxies, at first a dozen or so, but eventually billions of galaxies each with billions of stars. More critically, the new telescopes enabled Edwin Hubble and others to observe the galactic redshift, which was taken as evidence that the universe is expanding and hence that it originated at some distant point in the past, identified in Fred Hoyle's derisory term "the Big Bang". Stephen Hawking is on record as saying that proof of the Big Bang theory, gained from the data recorded by COBE satellite in 1992, was "the discovery of the century, if not of all time." With this judgement the present work agrees but goes further, for it argues that knowledge of an expanding universe not only ushered in a new scientific paradigm, but redefines science. How this is so, and why it is so important, are the book's twin themes. On a purely scientific level, Hubble's theory calls for explanation of the mechanisms at work in an evolving universe, but it also raises two questions that may prove to have paradigm-shaking answers. If the cosmos is now seen to be a three-dimensional space in process of expansion, the boundary between physics and philosophy blurs, for we need to know, or at least to ask, what it is expanding into, which cannot logically be an already existing 3-space. The second potentially explosive issue arises from the ambiguous significance, now coming into view, of red-shifted light in the expanding cosmos, for it could indicate either a light-emitting body accelerating away from us or a slowing down of the light as it travels towards us. Since Einstein's theorising, as well as the whole of physical science, rests on the axiomatic assumption that the velocity of light in a vacuum has a constant value, if this assumption turns out to be false, a revolution in science can hardly be avoided. This will be treated in the chapter "Cosmology: the Unscientific Science", the significance of the heading being that logic and observation are now taking cosmology, and science more generally, to a situation where both words need tighter definition, for cosmos is no longer co-extensive with universe. Furthermore, cosmology is morphing into cosmogony, a theory of origins which has religious implications and the balance between the Platonic and Aristotelian understanding of reality is tipping towards the former, after two thousand years of comparative neglect.[2]

A paradigm may be identified by the type of explanatory model through which it seeks to give understanding of the universe. Newton famously modelled the cosmos as a machine, predictable as clockwork, and although the model was a superb mathematical exposition of gravity at work, he specifically declined to hypothesize on the origin of the gravitational force. Einstein, taking his cue from Maxwell's field theory of electromagnetism, modelled it as a four-dimensioned field of energy (space time) in which gravity arose from the warping of space by massive bodies. The present work, builds on data from astrophysics, a science that was unavailable to either Newton or Einstein, and views the cosmos adiabatically, that is, as a system of energy in transformation. It could appropriately be titled "The Story of Energy", cooling and changing state as it expands from an initially immensely high temperature at the point of the Big Bang, but concurrently contracting and heating under the pressure of gravity. It is gravity which ultimately explains the heat of the sun and why the centre of the earth is molten. From this perspective the origin of the universal force of gravity is to be found in the force which brought the cosmos into existence at the moment of the Big Bang. In premising an expanding cosmos, what will doubtless prove to be most controversial is the logical corollary that it must have begun as a dimensionless point of unimaginable energy, that is to say, when time and space did not exist. There is disagreement about this among theorists, but it is probably true to say that the majority hold that the origin of the cosmos was very small - Planck size, 10^{-35} metres in diameter – but still finite. However, if we wind back an imaginary film of the expanding cosmos, there is no logical reason why it should stop there: reality is surely not to be defined for the convenience of mathematicians. Hubble's discovery of the galactic redshift, published in 1929, was a breakthrough in astronomy but it left many loose ends, and it is perhaps worth mentioning that Hubble himself was rather conservative in his conclusions and not completely convinced that the redshift was definitive proof that the universe was expanding. His hesitance may have arisen from a sensed need for more data, but doubtless also from the fact that the astronomer's job would be much more complicated if the cosmos were found to be a dynamic – i.e., evolving - structure. In the same breath, though, it must be said that it would be more challenging and exciting. When the psalmist marvelled at the "wonder of the heavens", he could never have dreamed of wonders like this, nor that they would be revealed mostly (but by no means entirely) by religiously agnostic scientists.

The word *adiabatic* used above will probably be unfamiliar to the general reader and calls for some explanation. It defines a system in which temperature, volume and pressure vary to bring about changes of state, in exactly the same way that H_2O changes state as it cools from gas to liquid to solid ice. The basic idea is quite simple: particles, elements and galaxies appear as the cosmos cools, much as fog, snowflakes, hail or rain appear as water vapour is cooled. Though we tend to think of water as somehow the natural state of H_2O, a true scientist today should not be so provincial. The cosmological theory to be proposed is remarkably simple in outline, quite easily explained to a ten year old, and is a fascinating story to boot, but the scientific justification for it is wide-ranging, deep and controversial and calls for evidence of a technical and mathematical nature. This creates a problem for both the author and the intended reader, since the book risks losing the general reader by putting in too much scientific detail, while, at the same time, it risks weakening scientific plausibility if the detail is minimized. The ideal reader would probably be someone with a high school level of science who enjoys reading popularized science, but the book would fail in its purpose if it did not give something worthwhile to the professional scientist. In an attempt to bridge the gap I have integrated sidebars into the text, which will function as extended footnotes. These will, hopefully, serve two quite opposite purposes, in providing some scientific background for the not-so-scientific reader and more detailed evidence for scientists and philosophers of science. The extra explanation can be skipped in order to keep the narrative flow, for it is a story and an adventure of ideas and personalities, albeit with a complex plot. It is surely a tragedy that science is rarely taught at school, and probably never at university, in such a way as to bring out its drama and excitement.

Various internal crises are taking science to a crossroads of decision, as evidenced by a growing number of books with titles like *The End of Science, The End of Physics, The End of Certainty*, etc. [3] and the present work owes much to them. What is rarely, if ever, mentioned is that the development of cosmology is opening up two issues which are at the heart of science and of this book. The first concerns the scientific method, for in theorizing about the origin and structure of an evolving universe, the experimental method is clearly irrelevant (or almost entirely so) and thus a new standard of proof is called for and, along with this, the role of the thought experiment, once a rather suspect footnote to the scientific method, becomes of critical importance. The second issue is that a world which came into existence at some time in the past, which is the theory now almost universally accepted, calls for some explanation of its cause and the mechanisms of its development. Of initial causality orthodox science has nothing to say, other than the mantra of "quantum fluctuation", and little more of the initial mechanisms of cosmic development, save an undetailed hypothesis about the coalescence of cosmic dust and debris, which leaves most of the celestial machinery to be explained. In engaging on these matters the book can only be a beginning and it is only to be expected that it will have many gaps and will raise questions that can only be answered in the future.

All depends on how reality is defined, for once it is consciously hypothesized that there exists a reality beyond the reach of our senses, but accessible to logic in some degree, scientists must decide whether or not the "world unseen" is a fit subject for a science founded squarely on "seeing is believing." As well as Descartes' exclusion of the un-measurable and the invisible from authentic science, the founders of science banned explanation through what Newton called "occult forces". It was an obvious and necessary step to rule out magic and superstition from science, but the exclusion of the "unseeable" was to bring on a crisis in physics in the 1930's, when a famous argument about the "*unanschaulich*" between Heisenberg and Bohr made headlines, the former insisting that since subatomic particles were too small to be seen, even with the most powerful microscopes, physics would have to make do with mathematical models and the information that could be drawn from them. The echoes of their debate have not died away, and indeed are stronger still today, for cosmologists are still coming to terms with the concept and reality of black holes, which are invisible by their very nature. The whole point about a black hole is that its gravitational pull is so strong that not even light can escape from it; so, strictly speaking, it can never be seen, only hypothesized. Yet a whole new theory of gravitation hangs upon belief in its reality and this will constitute an essential part of the present work. If, from this and other evidence and from systemic coherence, the reality of hyperspace comes to be accepted and other alternatives are ruled out, the word "universe" will call for tighter definition.

What we call science today actually started life as "natural philosophy", and in some ancient universities is still carried on in departments with that name. The word "scientist" was first used only in 1834, in a lecture by William Whewell, and later in his authoritative work, *The Philosophy of the Inductive Sciences.* [4] Whewell also gave us other now familiar terms such as "physicist", which were not welcomed at the time and seemed very awkward and artificial. The neologism "scientist" was regarded by many as pretentious, redundant and even misleading. If there was going to be a change from "natural philosopher", some expressed (with unconscious sexism) a preference for "men of science"; "virtuoso" had a brief currency, indicating a person with exceptional intelligence and experimental skill; Maxwell said that he would like to be called an "electrician" (and was so described in the *Encyclopaedia Britannica*) since he felt that electromagnetism, rather than Newtonian mechanics, had now become the frontier of scientific discovery. Whewell's shiny new term eventually won the day, for it was an explicit recognition that natural philosophy had undergone a significant change and called for a new name. Natural philosophy, largely carried forward in its first phase by well-to-do amateurs and through an informal network of correspondence had become a complex social enterprise, with university departments and research institutions, funding bodies, grant committees and industrial connections. International correspondence between the new philosophers was invariably in Latin and Newton's great work, the *Principia*, first published in 1687, appeared only in an English translation in 1729, three years after his death. As a matter of passing interest, a copy of the first edition recently sold at auction for almost half a million pounds. Once accepted, the word "scientist" brought with it a definite sense of belonging to a community of like-minded individuals and one which claimed a certain superiority over non-scientists.

In parallel with Whewell's innovation, the present work will propose a new term, *neoscience*, to recognize that science is now changing in a significant way. The outcome of this is as yet only partly visible, but it can be said that it will include a return to the original idea that science is an integral part of philosophy – the love of wisdom – only now the concept of "natural philosophy" needs to be enlarged to take in many facts that the different sciences have discovered. The Big Bang, for instance, is far from being natural in the old simple sense, nor are such vitally important things as antimatter, genes and protein folding, not to mention black holes, as already noted. It is not possible to give a tight definition of *neoscience* at this point: its meaning will only emerge as new questions are raised and answers provided that are both satisfactory in themselves and fit together to make sense of and unify an intellectual world which is becoming increasingly fragmented. Most of science, and especially physics, has gone beyond the understanding of the normally educated non-specialist. Indeed, individuals from one branch of science can rarely connect with one another except at a fairly superficial level. Physical science, once the study of bodies in motion, now ranges from solid state physics and quantum chemistry to astrophysics and, as specialisation grows, so too do the walls of non-communication and incomprehension. This may be the price we must pay for progress, but neoscience as here presented hopes to make science in its most essential sense more coherent and more accessible. It aims to do this by creating a unifying narrative which is comprehensible and intellectually satisfying at different levels, from the mathematical to simple story-telling. That said, a minimum level of education and intelligence will always be needed to think scientifically.

The greatest demand made on any novel scientific proposal is its ability to make unexpected predictions and answer questions that science in its current form cannot answer. There are several very big unanswered questions in physical science today, most notably perhaps the nature of "dark matter" and "dark energy"- which are really no more than labels for our ignorance - and the so-called self-energizing electron. If neoscience can throw light on these, it will be almost self-validating. If not, it will have little or no value. Karl Popper (1902-1994), widely considered among the greatest philosophers of science of the 20th century, is famous for defining a scientific statement as one which is capable of being disproved, in his words, "Every genuine test of a theory is an attempt to falsify it, or to refute it. Testability is falsifiability, but there are degrees of falsifiability; some theories take … as it were, greater risks."[5] This is one of those landmark statements which are subsequently shown to have weaknesses but play a critical role in stimulating debate on a theme of great importance. The ambiguous phrase "take greater risks" conceals the difference between theory in a limited sense and paradigmatic change, for when it comes to testability, there is clearly a critical difference between a fundamentally new theory of cosmic gravity and, say, a simple yes/no hypothesis that a particular chemical will kill bacteria. From this perspective, Einstein's theory of General Relativity is seen to be far more than just a theory: it is a world view, deliberately intended to supersede that of Newton and will in its turn only be superseded by a more convincing world view. It has often been remarked that Einstein himself did not do any laboratory experiments, but put great emphasis on the *Gedankenexperiment* or thought experiment. That was a novelty in its time, but it is doubtful that physics on either the micro or cosmic scale can make progress now without making more conscious use of it. The pioneers of the future into which science is entering will doubtless be those who, while having a sound technical background, are more than usually gifted with imagination.

Neoscience, as here introduced, is loosely modelled on Newton's great work, the *Principia* , which lays down three major axioms, usually referred to as Newton's laws, and goes on to justify them and discuss their consequences in a substantial appendix, the *Scholium*, which was added to the second edition. The *Scholium* is a relatively unstructured commentary on his axioms, circling around the problem which in the first edition he had left open and specifically declined to deal with, namely, the cause and origin of the gravitational force which he had described with such skill. The question remains unsolved today, for quantum gravity cannot be reconciled with Einstein's cosmic gravity, and neoscience approaches it from a new perspective. Two things in the *Scholium* surprise the modern reader, the first a theological argument which is unexpected because he had deliberately eschewed explanation by means of "occult forces" and also because it was illegal in England at the time (indeed, until as recently as 1813) to question the Christian doctrine of the Trinity. It is commonly believed that Newton was a Unitarian, but the *Scholium* reveals him as a panentheist with a surprisingly mystical bent. The second unexpected element is an enigmatic concluding comment on the existence of a new kind of force, a certain "spirit" (his term), which he identifies as electricity and which is, of course, quite absent from his mechanistic model of the heavens. His brief remarks are vague, but prescient, for a science of electromagnetism was to appear 150 years later. Science today is a god-free zone, as a matter of principle, which it was not in the time of Kepler and Newton, but as cosmology moves into cosmogony, questions about the origin of the universe come to the surface and hence questions about a first cause. Somewhat in parallel with Newton's hunch about the role of electrical energy in a mechanical universe, are speculations about consciousness as a form of energy, and this subject, taboo in orthodox science, will be introduced.

The argument for neoscience will be built upon five assumptions, which function as axioms (a term to be explained) and constitute a foundation on which the main argument will be built. They are in brief:

- the conventional 3D universe of science is taken to be a subspace of a higher dimensioned realm, viz., hyperspace
- our cosmos emerged as a dimensionless point of immense energy at an identifiable time in the past, when time itself came into existence
- a new taxonomy of elementary particles is needed to replace the Standard Model
- a new general law of energy is needed to critically modify the law of entropy
- a deeper understanding of what constitutes scientific proof is needed

The book will provide arguments to justify these claims. Their significance can hardly be communicated in a brief listing, but anyone with a modicum of scientific education will recognize that there are very big and controversial issues at stake. How big the issues and how plausible the solutions offered by neoscience are what the book is really about. The following brief explanations will give a little more shape and substance to the bare list.

The first assumption states that the 3-dimensional universe of common experience and of contemporary science alike is a subspace of a higher dimensioned and timeless reality, the hyperspace beloved of science fiction writers. This is a shift of perspective and a recentring of reality that cannot be validated by observation, only by its systemic consequences. The concept of higher dimensioned realities is not new to science and indeed has dominated particle physics in the form of string theory for the past thirty years or so, but seems now to be on the wane. There is also routine discussion about the reality of other universes than our own, sometimes of higher dimensions, all inaccessible in principle to observation and usually connected by convenient "wormholes".[6] Without notable exception, however, all these imagined multidimensional entities are assumed to be *within* our 3D universe and subject to the same laws of time. By contrast, neoscience starts from the orthodox position that our universe came into existence some 13.8 billion years ago, but makes the unorthodox assumption that it originated within hyperspace, and has evolved within it from a dimensionless point of energy to its present size and complexity. As a rough analogy of this process, it might be envisaged as a bubble appearing in water at a certain temperature and expanding. In the neoscientific view the surrounding "medium" is a hyperspace of infinite potential dimensions, our familiar three-dimensioned reality being one that has been actualised. The analogy, however, is no more than a heuristic first cut, potentially misleading, and must be treated with the greatest care.

Several questions arise from assuming the reality of hyperspace, the most obvious being how anything can be said to have a timeless existence. The notion of the cosmos originating as a pure geometrical point of energy does not present a scientific problem as such, since the dimensionless point charge of electricity is routinely accepted by physicists and practising electricians alike, as also is the point centre of gravity, both rather Platonic concepts. It does, however, bring up two quite distinct intellectual challenges, the first to our imagination, for to think on the scale now required tends easily to numb our imaginative faculty. Cosmological theory now accepts that all the energy in the cosmos, with its hundreds of billions of galaxies, must have initially been compressed into a point (finite or otherwise), after which came the originating event, the Big Bang, that brought our cosmos into being, but visualising such a situation requires a critical stretch of the imagination which many will resist. A very inadequate picture may be gained by thinking of Mount Everest sitting on a pin and imagining the kind of pressure generated at the point of the pin. The second difficulty is mathematical, since postulating a cosmos that came into being as a dimensionless point of energy creates severe, probably insuperable, obstacles to making a mathematical model of this first moment. The reason for this is that mathematics, which is at the heart of physics, abhors infinities and infinitesimals since the normal operators give nonsensical results. The product of infinity or zero multiplied by 2 is indistinguishable from the product when multiplied or divided by any other number. Inability to fit the maths to this unconventional kind of reality leads many theorists, with perverse logic, to rule out the possibility that the universe began as a dimensionless point because that would spoil the maths. The most prominent of them is probably Roger Penrose, whose 2005 blockbuster, *The Road to Reality: A Complete Guide to the Laws of the Universe,* puts the case at length. There must surely be suspicion, however, that reality cannot ultimately be limited to what is mathematisable, and this question will be opened up in the section "The Use and Abuse of Mathematics". Even when one starts from belief that the Big Bang began as a finite but very very small point of energy, another infinity intrudes, and must be dealt with. This is the widespread assumption that it was a point or particle of infinite energy density. By contrast, neoscience assumes that the energy at the point source of the Big Bang may have been unimaginably huge but it was finite, limited to that which will eventually be contained in a fully expanded universe.

Once the real existence of a timeless hyperspace is assumed, it raises the other great question, bequeathed to us from Hubble, namely, *What is our 3D universe expanding into?,* for it cannot logically be an already existing 3-space. It is probably fair to say that cosmology until now has sidestepped this question in order to keep intact the belief (conscious or otherwise) that reality is defined by its three-dimensionality. The commonly accepted explanation, promoted initially by Arthur Eddington (1882-1944) but resting largely on the authority of Stephen Hawking, is that our universe is finite but boundless, like the surface of a sphere and somewhat akin to the seemingly three-dimensional loop of a planar Moebius strip. The geometric analogy initially sounds plausible, but once put under scrutiny its inadequacy becomes apparent. The present work reopens the question, arguing for the existence of a domain of reality that may be beyond our senses but is not beyond our powers of logical imagination. It is very possible that satisfying answers may come from pure mathematics, from topology in particular, but this is territory into which the book will not enter, nor is the author qualified to speak about it. The essential point here is that questions of hyperspace cannot legitimately be asked by science under its present Cartesian constitution, since domains of anything other than 3D are unobservable and un-measurable in principle, though 2- and 1-dimensional entities can be visualised. If Popper's criterion of falsifiability is adopted, theories based on the real existence of hyperspace must be dismissed as no more than fruitless speculation dressed up in pseudoscientific categories. Hyperspace would indeed be no more than a superstition if it were not proposed as an axiom that can be proved by its systemic consequences, but a moment's reflection on that assertion brings awareness of a knottier question of a philosophical nature, *What constitutes proof?* Neoscience reopens this question and provides new answers, or rather, one should say, answers that have until now been overlooked or neglected.

Implicit in the first assumption is not only a new theory of gravitation but new definitions of mass and matter. Neoscience builds upon, but goes beyond Newton's law of universal gravity and offers a more general law, which merits the term *primordial gravity*. This states that just as all entities exert a mutual attraction – Newton's original and highly non-intuitive speculation - all matter in our 3D cosmos is attracted to a central point by a force which seeks to return it to its origin in hyperspace. From this perspective gravity is actually an inertial force resisting cosmic expansion, a concept that is equally non-intuitive. Newton declared in the famous phrase, *Hypotheses non fingo*, that he would not attempt to assign a cause to gravity, but neoscience not only sets out to do that but offers an explanation of what caused the cosmos to expand in the first place and keeps it in existence. From this unfamiliar new perspective of a potential 3D universe, which has been actualized from an infinitely dimensioned hyperspace, emerges the picture of a cosmos, material but made out of energy, in tension between the force which brought it into being and keeps it expanding volumetrically and a primordial gravity which seeks to return it to its original state. Initially the expansionary force is dominant, but as stars and then galaxies collapse to black holes by their inherent (Newtonian) gravity, the balance between the expansionary and inertial force changes: primordial gravity slowly starts to dominate in a process that will not be ended for many billions of years. The theory of primordial gravity predicts an accelerating coalescence of black holes which exert increased braking pressure on cosmic expansion until reversal sets in and, as this increases in power, the cosmos, which actually began as a white hole (or "cosmic gusher", as John Gribbin has called it) shrinks to a black hole of unimaginable attractive power and eventually to a dimensionless black hole.

Evidence for this novel vision of the dynamics of the universe on the grandest scale has been building up from many recent astronomical discoveries made possible by enormous strides in telescope technology, particularly from the Hubble, X-ray and very large array radio telescopes. Typical of the flood of new data that astronomers are now working to interpret are supernovas, neutron stars, pulsars, quasars, gamma ray bursts, galactic walls and an unseen and distant force which has been called "the Great Attractor"[7]. It is a time of great uncertainty, excitement and anticipation among the community of astronomers, more so even than a century ago when a new generation of powerful reflecting telescopes revealed the startling fact that the heavenly domain was structured hierarchically in stellar systems, galaxies, galaxy clusters, superclusters and supercluster complexes. From all this is emerging a picture of the cosmos not as a fixed structure but as an evolving system, following laws that are slowly being revealed. The cosmos does not give up its secrets without great intellectual and technological effort, but both the effort and the subsequent dispersion of our ignorance are sources of deep satisfaction and excitement.

It is still not widely realised that this unexpected information is seeding a new Copernican revolution, but even the ordinary individual in the street now knows what Einstein did not when he published his theory of General Relativity, that the Milky Way is only one of billions of galaxies, each containing billions of stars. If the logic of the first assumption of neoscience is followed through, a similar expansion of our cosmological vision seems now to be inevitable: what once was taken to be the whole of reality is now seen to be only a part. As this sinks in, a new definition of *universe* will become imperative, for it would no longer be appropriate to call the limited 3D domain of conventional science the universe: it should properly be termed the *cosmos* and the word *universe* should be applied to the hyperspace that is its matrix, as this is the whole of imaginable and logically consistent reality. From this viewpoint, our familiar world once existed *in potentia* along with untold others, and while orthodox science will doubtless jib at the idea of a potential cosmos, which goes against the reality of the here and now and the experimentally accessible, it may be well to remember it once had difficulty in accepting the concept of potential energy when first proposed by William Rankine in 1853. From a neoscientific perspective, the cosmos will reach a limit of expansion before contracting, to end its current existence, as it returns to hyperspace and is literally "de-actualised". Of course, if one is of a Platonic temperament, it will seem to be not *de-actualised* but *re-realised*, since it is the unseen realm that is now taken to be the real reality.

The second assumption about the point source of the universe, has been contested twice in recent times, first by proponents of the Steady State theory, which was eventually abandoned after the COBE satellite provided critical data about the cosmic background radiation in 1992. The second objection has come from so-called plasma cosmologists, who have revived the Steady State theory, following their different interpretation of the galactic redshift. Their argument rests on evidence for the primary structural role of electricity in galaxy formation, which in mainstream cosmology is regarded as secondary, if at all relevant, and while the case is argued in a good many technical works and a few semi-popular books,[8] it resists a summary explanation. What can be said is that, in general, plasma cosmologists do not take the galactic redshift as evidence for the Big Bang theory, while mainstream cosmologists tend to look the other way when it is pointed out that the redshift is quite clearly capable of two interpretations. It is evidence of galaxies (or other luminous bodies) accelerating away from us or of light decelerating as it travels towards us, or quite possibly of both. If the latter were to be the case, the present rather neat theory of the Big Bang would be thrown into disarray, and if light were to travel at different speeds, the whole of physics, would need to be reconstructed on a different foundation, for it would contradict Einstein's axiom, now universally accepted, that light travels at a constant speed and is indeed the fixed marker for measurement that physics and astronomy require. The data on the galactic redshift is still being mined and is posing questions for every cosmological theory, orthodox or otherwise, since the discovery by William Tifft in 1976 that the degree of redshift across the whole cosmos is not random, as one would expect, but is quantized.[9] That is to say, the whole range of velocities, taken from millions of observations, has been found to be multiples of a basic number. This totally unexpected discovery has huge significance for current theory, clearly suggesting that there have been phases of cosmic expansion, when some kind of replicative mechanism has been in play and giving support to Georges Lemaître's more or less abandoned conjecture that cosmogenesis all began with a "cosmic atom" which proceeded to divide and multiply. For lack of understanding of the actual mechanism, the initial conjecture has never been raised to the level of a testable hypothesis,[10] but that possibility is now made likely and, if it were found to be so, it would mark a milestone in science comparable to the discovery of the DNA helix.

The third assumption of neoscience is of a quite different kind from the others, being a proposed new classification of particles. The importance of this should need no explanation, for the taxonomy that we choose in every situation is not only a statement of our sense of significance but determines thereafter what we will see as a fact. Early Greek science classified states of matter as solid, liquid and gas, which was a very logical and commonsensical way of looking at things, but modern science has added more states, most notably plasmoid (superhot) and Bose-Einstein condensate (supercold), and future reclassification is by means out of the question if the state of electrical superconduction is considered to be of fundamental significance. What any culture considers significant is sometimes a matter of logic, sometimes of unreflexive feeling. It is interesting to note, for example, how many of the world's languages bear evidence of their emergence at a time when gender was of over-riding significance in the way our forebears classified their world. As a consequence they tried to squeeze newly invented words into male and female categories. This was not too difficult when one was inventing words for phallic trees and spears (clearly male) or for lakes, seas and caves (clearly female) and in similar fashion a strong sun and weaker moon were "just felt" to be male and female. But then problems set in, forcing the creation of a separate class of neuter, i.e., neither male-like or female-like. Thus we have *der*, *die* and *das* in German, though French is able to manage with only *le* and *la* and English has dispensed altogether with this fossilized taxonomy. Once the classification had been subconsciously set up, our forebears were faced with ongoing decisions: was a river, for example, to be classified as male, because it had force, or as female, because it had fluidity.

In a somewhat similar fashion, the classification of atomic and subatomic particles has undergone changes and adjustments over the last century, with particle colliders smashing atoms and subatomic particles into ever smaller pieces, resulting in what is commonly referred to as a "particle zoo", with hundreds of mostly unclassified and unrelated items, some accepted as genuine particles, others only as resonances. To add to this confusion, adoption of the field-and-particle model of explanation has resulted in the invention of imaginary particles which have never been seen but have been assigned a name and function and a purely mathematical form – e.g., gluons to stick matter together, gravitons to transmit gravitational force and even inflatons to explain why the cosmos may have gone through an anomalous period of inflation in its initial phase. The very concept of subatomic structure has been replaced with "clouds" of electrons and "quantum foam", a move which one may suspect reflects a fog of ignorance about what actually is going on at the very heart of the atom. The need for a convincing particle taxonomy using visual criteria as well as mathematics is now becoming critical and a classification in terms of dimensionality offers a promising start. To take one obvious example, the muon gives every indication of being a two-dimensional electron and the fact that it is so short-lived – slightly more than two millionths of a second - suggests that, being a 2D entity, it is a temporary alien in a 3D environment. The particle taxonomy to be offered here, in the section "The Particle Story", will resolve one anomaly of the Standard Model in suggesting a physical basis for half integer spin, until now treated as a mathematical property with only the haziest relation to actual motion.

The fourth assumption concerns a new approach to, and definition of, that elusive entity *energy* as a start on building a new science of energetics. The call for such a science, of which thermodynamics would be only a part, was made strongly in the late 19th century, most prominently by William Rankine (1820-1872) and the Nobel laureate chemist Wilhelm Ostwald (1853-1932), but has never been fulfilled and the reasons for this are of scientific interest. Science itself, which began as the study of bodies in motion and branched vigorously into chemistry, biology, particle physics and astrophysics, has shied away from energetics because the concept of energy is so poorly understood. Virtually every scientific dictionary and textbook defines it as work, but clearly energy as such is something quite different from work. There are no international units for energy in itself, only for the different forms in which it is manifested, such as heat, kinetic, gravitational and chemical energy, etc., and the very first invented unit, the rather quaint horsepower, is still in use. The reality which underlies these different forms has permanency, for it can neither be created or destroyed, but also a strange will-o-the-wisp existence, without form or location, which makes it about as close to magic as could be imagined. It would be a huge task to create a clearly defined science of energetics from scratch, but neoscience aims at least to make a start. The section of the book which deals with it will return to the theory of energy proposed by Sadi Carnot (1796-1832) in his pioneering monograph *Reflections on the Motive Power of Fire* and developed in the work of Rudolf Clausius (1822-1888).

Carnot is often credited with being the father of thermodynamics and his contribution came almost entirely in his attempt to find a comprehensive theory for the recently invented steam engine. In doing so he came up with two seemingly unrelated principles. The first of these is the irreversibility of any process in which work is performed by burning fuel. The second is the need of a cold sink as well as a hot source for an engine to function. Neither Carnot nor Clausius addressed the relationship between the energy of the chemical bond and thermal pressure, and neoscience will embark on harmonising these two apparently different kinds of energy by proposing a more general law than entropic decay, which no less an authority than Sir Arthur Eddington said "holds the supreme position among the laws of nature." The proposed new law will also throw light on the obscure notion of spontaneity, which is supposed to follow from the law of entropy, and which seems to break the first law of science, that there can be no effect without a cause. The notion of spontaneity is as magical as that of energy and neoscience will bring quite simple logic to bear to exorcise this "occult power" in both cases.

The fifth assumption is in some ways the most important but will be of more interest to philosophers and psychologists than practising scientists. It concerns the nature of proof and is thus a concern of metascience rather than of science proper. Broadly speaking, protoscience found proof in agreement on the meaning of words and in deductive logic, while science finds it in observation and inductive logic. This seemingly dry historical footnote has the most significant implications, for science originated in the quest for certain and public knowledge, from which it takes its nobility and its usefulness, and if it is to progress, a better understanding is required of the nature of proof. If agreement cannot be found on what constitutes proof, science itself is in danger of losing its pre-eminence as a form of understanding. One might expect that the criterion of certain knowledge would have become progressively tightened, but in fact physics has had to fall back increasingly on probability, and this for several reasons, which will be examined. Looking at science in general, the most obvious source of uncertainty is that inductive logic is based on generalisations made from a limited number of observed facts and there is thus always the possibility that the next observation will prove to be an exception to the rule. The classic example of this is the once apparent certainty that all swans are white, which was lost after black swans had been discovered in Australia. At the same time, once an observation has been translated into a mathematical model, a new criterion of certainty enters into the picture, effectively the consistency of the equation. The nub of the present argument is that certainty is at base a feeling, what John Henry Newman called "the illative sense", and when it comes to constructing neoscience, or even giving it a fair hearing, two new factors must be taken into account. The first may be called gestalt logic, when the certainty of pattern recognition appears for no obvious reason. In science, as in life more generally, one has to wait upon the "Aha, now I see" moment and there is no guarantee that another person will see the same thing in the same pattern of facts. The second, and related, sense of certainty arises from what might be called systemic logic, when an array of different arguments, not all fully understood, slowly or suddenly come together to make sense: they cohere as a system. This picture is complicated by the phenomenon of group certainty when the normal individual's logic and often even plain observation is overridden. This will be looked at more closely in the section "Science as Group Think". When it comes to big issues, inspired mavericks in science are hardly more welcome than simple eccentrics and yet progress ultimately depends on them.

Enough has been said here to indicate the scale of the problem and hence the difficulty of structuring any solution. The concept of "science" has morphed over time and has divided and subdivided into many different sciences and the only way to give coherence to such a mass of material, in which no one individual can claim expertise, has seemed to be organize it diachronically, showing historical development and examine the critical areas synchronically at critical periods to show the relationship between different scientific disciplines. Since the overall purpose is to project a future development, namely, neoscience, the different sections have been headed as Mark 1, Mark 2, Mark 3 science, with excursions and diversions along the way to make important points about philosophical and psychological principles, etc. that are always at issue.

It should be clear from this brief introduction to the assumptions underlying neoscience that it will be more than a tweaking of science as commonly understood, just as science was more than a tweaking of protoscience. Living habitually on a round earth sets one off from those who have never questioned that the earth is flat, and so too for those who have become convinced that reality is not bounded or defined by the three dimensions of common experience. Our species is half way now to that point of recognition, for in the last half century we have become accustomed to seeing the earth from the outside, and perhaps we shall never cease to wonder at photos of our blue and white planet set against the black immensity of space. Seeing the cosmos against the immensity of hyperspace is what this book is about, but it can only be done with what Wordsworth called the inward eye.

Neoscience offers hope for the human future, for while its development will call for the finest intellects, it will provide a new and solidly grounded great narrative to replace the formative myths of the past, most notably the biblical account of creation and the Adam and Eve story which have underpinned Western civilization for two thousand years, but now no longer. Such a scientifically grounded story could unite the human race, where existing myths divide and lead to endless, mindless wars. With such a unifying influence, it is not too much to hope that the empty phrase, "the human family", will eventually become a reality. But this is the distant horizon and the present work can be no more than a pushing out of the boat. Its inadequacies will without doubt be manifest but hopefully will prompt others to set them right and will not detract from the importance of its theme. G. K. Chesterton once quipped, if something is worth doing, it is worth doing badly, and there are surely few things more worth doing than taking science, so great an adventure of the human spirit, into a future that now beckons.

Endnotes

1. Heinz Pagels, *Perfect Symmetry: The Search for the Beginning of Time*. London: Penguin, 1992. p. 16.
2. "Platonic" only in the general sense of admitting into science "things unseen", as against what might be called hardcore Platonism, such as promoted by the theorist Julian Barbour in *The End of Time: The Next Revolution in our Understanding of the Universe*. (London: Weidenfeld & Nicholson, 2000, and other editions.) His invented realm of "Platonia" is, central to, in his words, an "argument that time does not exist."
3. A small selection would include: Ilya Prigogine, *The End of Certainty* (1997); John Horgan, *The End of Science*, (1996); David Lindley, *The End of Physics* (1994); Lee Smolin, *The Trouble with Physics* (2006); Peter Woit, *Not Even Wrong* (2006); Alexander Unzicker and Sheila Jones, *Bankrupting Physics* (2013).
4. William Whewell, *The Philosophy of the Inductive Sciences: Founded Upon their History*. 2 vols. Cambridge University Press, 1840. Reprinted 2010.
5. Karl Popper, *Conjectures and Refutations*. London: Routledge (1963), with subsequent reprints.
6. See, for example, B. Carr (ed.), *Universe or Multiverse*. Cambridge University Press, 2010, esp. Steven Weinberg, "Living in the multiverse".
7. See, for example, Alan Dressler, V*oyage to the Great Attractor: Exploring Intergalactic Space*. New York: Vintage Books. 1995.
8. Halton Arp, Seeing Red: *Redshift Cosmology and Academic Science* (Montreal: Apeiron,1997) is taken as the classic statement. Hilton Radcliffe, *The Static Universe: Exploding the Myth of Cosmic Expansion*. (Montreal: Apeiron, 2010) is a more popular treatment.
9. Tifft's findings, reported in "Discrete states of redshift and galaxy dynamics", *Astrophysical Journal*, 206; 38-56, were published with an unusual *caveat*, that while the editors could find no error in the data or the logic, they disassociated themselves from the author's conclusions. Such is the nervousness when existing paradigms might seem to be threatened.
10. One notable exception is Ernest J. Sternglass who attempted to unify Lemaître's prototheory and General Relativity in *Before the Big Bang: The Origins of the Universe*. (NY and London: Four Walls Eight Windows, 1997). This is somewhat ironical, as Einstein had

initially strongly rejected it, telling Lemaître rather bluntly that his mathematics was correct but his physics was “abominable”.