

SPACE and GRAVITATION

Reginald T. Cahill

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School of Chemistry, Physics and Earth Sciences
Flinders University
GPO Box 2100,
Adelaide 5001, Australia
Reg.Cahill@flinders.edu.au

1 Space and Gravitation

Space is that entity in which we find ourselves; we are located in space. But how should we categorise space? Is it a ‘thing’ or is it a ‘process’? From at least the early Greeks to the present day this question has been examined again and again, but has remained unanswered. However some recent discoveries have cast a new light on this essential core of existence, and the experimental evidence is strongly indicating that modern day physics has got it very wrong. Gravity is apparently an aspect of space which has gone through various possible explanations, from the force concept by Newton, as expressed in his famous inverse square law, to Einsteins curved spacetime formalism. However experiment and observations are indicating that both of these explanations are seriously flawed; they are both in strong disagreement with observation. Here we sketch the nature of a new modelling of reality, known as *Process Physics*, and reveal some of the startling predictions that it makes about space and gravitation, and how these have been confirmed by experiment and observations. In doing so the prevailing paradigms in current physics are being overturned.

2 Syntactical Information Formalism in Physics

How do current physical theories work as explanations of the various aspects of reality? Slowly over essentially the last 300 years the apparently successful theories all turn out to have the same character they are syntactical information systems. This means that they have the structure of a formalised system, with some abstract ill-defined or undefined symbols, and rules for manipulating these symbols. This procedure is essentially about the ‘formulae’ of conventional physics. Of course physicists usually attach some metaphysical interpretation to the symbols, such

as saying that a certain symbol stands for say an ‘electron’ or some aspect of an ‘electron’. But in the end it all comes down to doing mathematics. It was Euclid in 300 BCE who introduced the first such formal system when he axiomatised planar geometry. The success of such formalised systems have been impressive.

Physicists were quick to adopt Euclid’s system to model space. Properties of space were observed and used by the Babylonians and Egyptians, apparently in the latter case to enable the agricultural boundaries to be re-established after flooding of the Nile Valley. Eventually these properties of space were encoded and formalised in the mathematics of geometry with its abstract notions of a geometrical space, points, lines, etc. This was the first major modelling of a physical phenomena by a mathematical system, and gave us the mindset of syntactical formalism that prevails in physics to this day. Eventually the mathematical model became identified with the phenomenon itself, that is, physical space was understood to be a geometrical space. And so the distinction between physical space and geometrical space disappeared. This confusion of a phenomenon with its mathematical modelling is a re-occurring problem in physics. Given that now physical space was considered to be a Euclidean geometrical construct, and as such devoid of structure, thinkers like Descartes and Newton appreciated that such a modelling appeared to be deficient. To improve the modelling they embellished the old Aristotelian notion that space was occupied by an aether. This dualism with both space and aether became a major concept in physics. It does not appear to have occurred to the early investigators that something other than geometrical space could underpin the phenomenon of physical space. In the same era Galileo introduced the modelling of time by the geometrical one-dimensional space - the time line, and Newton made extensive use of this modelling in his development of dynamics. Like space the phenomenon of time eventually became synonymous with its geometrical model until today most physicists regard time as a geometry, which of course necessitates the denial of any aspects of time that the geometrical model cannot accommodate.

The bizarre idea that time is nothing more than a geometry has led to the notion that nothing actually ever happens, reality is frozen. Then why we experience a sense of change is totally inexplicable. Of course the weakness was merely revealing the ineffectiveness of the geometrical ‘explanation’ for time. Nevertheless this modelling has persisted for over 300 years since it was introduced by Galileo and Newton. Einstein in the last century then melded the geometrical model of time to the geometrical model of space, giving us a new ‘frozen’ entity known as spacetime. The curving of this geometrical construct was supposed to explain gravitation, according to Einstein, in what is known as General Relativity. However experimental and observational checks of this formalism have been very restricted, and it now turns out that the theory has been falsified by various experiments and observations. Despite that it will be ruthlessly defended by those for whom the experimental testing of physical theories is not required.

3 Goedel's Theorem

In the 1930's the German mathematician Goedel dealt a fatal blow to the notion that reality, at least at a fundamental level, could be modelled by a formal system. Goedel showed that any reasonably complex formal system, and even ordinary arithmetic is such a system, was actually very limited. Such a system is unable to demonstrate, by formal manipulation of the symbols, the truth or otherwise of many possible assertions. Such systems are much weaker than anyone until then had suspected. So such systems have indeed very limited explanatory capabilities. This discovery went essentially unnoticed in physics, although some saw the problem and suggested that science would never be capable of a deep and final explanation of reality. But such a pessimistic view turned out to be wrong. Rather if we are to ever understand 'deep reality', and not just make do with some superficial phenomenology, then a fundamentally new approach to comprehending and explaining the nature of reality was required. Over recent years just such a system was discovered.

4 Semantic Information in Physics

Research by the author into the very abstract mathematics of quantum field theory, the formal mathematical theory that deals with elementary 'particles', revealed that the formalism may be recast into something like a stochastic neural network, although the analogy was far from complete. But this did suggest that perhaps a stochastic neural network in which time is modelled as an iterative process and not by geometry, might be an interesting new starting point for modelling reality. Such a system has intrinsic randomness. This system then deals with self-forming networks of relations, and is remarkably analogous to the neural network structure of brains. Rather than having a priori undefined objects, it develops a fractal network of relationships. The ongoing flux of patterns have the form of a cellular network, of the form indicated in the picture, and amazingly the cellular network organises itself into a global pattern having an essentially growing three dimensional features, just like the spatial structure of our expanding universe. The self-organisation process uses the intrinsic randomness as a resource, and this randomness in some sense also expresses the limits of internal knowledge and is called self-referential noise. More than that there are special defects in this network that are preserved because of the way they are embedded in the spatial network, and these patterns have the properties we immediately recognise as that of matter. So both space and matter, at the quantum level, emerge. The semantic nature of the system is that the information is not about how we perceive reality, as in syntactical information systems, but rather the information or pattern structure is internal to the system, and in the main unavailable to us as observers.

This has a remarkable parallel with human consciousness: an external observer has no access to the consciousness of another individual, only the individual experi-

ences his or her consciousness - the information states of consciousness are strictly internal and experiential. Just as in process physics there is evidence that randomness in brains is also essential to their activity. The implications of these analogies is that semantic information systems are endemic in reality, that they alone are the only means by which systems can form and maintain ‘structures’ or ‘forms’, hence the descriptor *information*. And perhaps all these ‘structures’ are merely thoughts. The analogy is so close that one is tempted to assert that in some sense the universe as a whole has some notion of primitive consciousness, and that living systems, such as us, may actually derive our consciousness, in its much more developed form, from that underlying and intrinsic consciousness of the universe. This of course is an idea that has arisen in many cultures and philosophies. As we move away from the mechanical mindset associated with syntactical information systems, these far reaching implications begin to appear not only scientifically viable but philosophically very attractive. But I digress too much. Before we explore such exciting notions it is essential that the new *Process Physics* be tested against reality, by both experiment and observation.

5 Self-Organising Space and Quantum Matter

The stochastic neural network is a means of dealing with self-organising informational patterns; it generates a network of relationships, in a manner that reminds one of the ideas of the mathematician and philosopher Leibniz. But how is a relationship manifested and what is being related. This is actually an important and subtle issue. To implement such a semantic information system one must seed the process by beginning with a syntactical information system, in a manner known in science as a bootstrap process - a process that gets the system up and running, so to speak, after which it takes care of itself. Then in the seeding system one starts with nodes and links between the nodes which have a numerical value - large and small, together with a very primitive rule for changing these link strengths and at the same time feeding randomness into the system so that it is not deterministic. At the same time this randomness plays the role of limiting the precision of patterns within the system - it limits self-referencing because the system, as it evolves, cannot access all current information to infinite precision. The studies of such a system show that it generates extremely complex patterns which look like an emerging spatial network with a cellular structure, and appearing to mimic aspects of space at what we might consider to be a sub-geometrical level. The patterns are probably fractal in the sense that as we zoom out we see cellular patterns linking and forming larger cellular patterns. Indeed we see the emergence of geometry itself because this cellular network has, as we zoom out, the characteristics of three dimensionality, a feature of space known for thousands of years but until now never explained.

But as we zoom back in we of course see the nodes and links of the seeding syntactical system. Then the key insight arises: we interpret these primitive nodes

and links as representing nothing more than cellular structures themselves, so that as we zoom in further and further we see a never ending sequence of cellular patterns within cellular patterns. So we arrive at the notion that space is a fluctuating fractal network of informational relationships, and with nothing more than relationships: essentially relationships between relationships. The graphic by one of my PhD students, Christopher Klinger, attempts to suggest this by means of the magnifying glass effect. As well the spatial system of fractal patterns has special defects that once formed are essentially trapped forever, even though they, having a fractal structure also, are continually having their cellular components replaced as the randomness washes out old patterns and creates new patterns. Again this has a very familiar biological analogy: while our biological cells are, in the main, dying and being replaced, our bodies nevertheless remain remarkably stable. This of course raises a fascinating distinction between the semantic information system that is reality at its deepest level, and the information systems that constitute biological systems, and it is this: biological systems are those semantic information systems which ‘discovered’ how to encode useful patterns in a syntactical or symbol code, namely the DNA code. At a deep level reality does not have such a syntactical or symbol code, and so its stable systems tend to be very primitive, such as elementary particles.

Unlike biological systems the manner in which these special defects in the spatial network are preserved is by means of topological processes. A simple analogy should illustrate this. Suppose you have a loop of string with a knot in it. Suppose further that the segments of the string are continually wearing out and being replaced. Then after a while none of the original string will remain but the knot will still be present in an unchanged form. The information that represents the connectivity of the knot has been preserved. This is what in mathematics is known as a topological argument. So in Process Physics matter, by which we really mean stuff that does not disappear, is explained as topologically preserved informational patterns. It appears that the fractal character of the cellular network plays a key role here, for only then can we envisage the ongoing dissolution and replacement of the components not grossly affecting the integrity of the ‘topological defect’ - the knot if you will. However there is more to this, for there is also evidence that this system of a processing fractal cellular system is characterised by quantum behaviour, but of a very general and abstract form, namely what is technically known as a Quantum Homotopic Field Theory. The word ‘homotopic’ refers to the notion of cells within cells. This emergent quantum language applies to both the spatial cellular network and its embedded topological defects. So we see an natural common explanation for both space and quantum matter - at a deep level they are merely different modes of a incredibly complex and changing network of relationships. This network then reveals space to be a quantum foam. As I discuss later experimental evidence has just been found that substantiates this in a most dramatic manner.

6 Absolute Motion

One immediately sees that space is a very different category from time: space is that emergent growing (expanding) and continually processing network of relationships, while time is a more primitive notion and its iterative character was assumed from the beginning - it cannot be explained in terms of entities, it is a truly fundamental and irreducible process. Indeed this iterative process-time is the only way known for generating fractal structures, which are essential if we are to avoid being stuck with some primitive unexplainable set of a priori symbols and rules for their manipulation. But this manifest distinction between space and time is totally lacking in current physics, particularly following Einstein's success in urging the physicists to accept that the frozen geometrical spacetime construct was the fundamental underlying structure of reality. So how did the physicists get into this quagmire of a belief system?

In 1887 two American physicists, Michelson and Morley, performed what has turned out to be one of the most historic but misunderstood experiments in physics. In that era physicists believed that motion relative to space should be measurable - one should be able to say that I am moving through space at some specified and measurable speed. Michelson had conceived of an apparatus that he believed could carry out just such a measurement. It is called an interferometer, and works by splitting a beam of light into two orthogonal paths, and recombining the light, after reflections from mirrors, onto a screen, where through interference effects, fringes of light and dark are indeed seen. To detect translational motion the device is rotated, and if the speed of light is fixed relative to space, then the difference in travel times between the two arms as the device is rotated, caused by the absolute translational motion of the device relative to the space, should manifest as a shift back and forwards of the fringes. So what did they actually see? If you read their paper you will see that it reports fringe shifts exactly of the form expected. So absolute motion had been detected. This would have implied straight away that space had structure, and that this device was indicating its translational speed relative to that structure. But here physics took a wrong turn, a mistake of ghastly proportions, from which it has yet to recover. Using the old but prevailing Newtonian physics Michelson computed from the magnitude of the observed fringe shifts that the speed of the device through space was approximately 8 km/s - an enormous speed. But Michelson noted that this was less than the orbital speed of 30km/s of the earth about the sun, and he had expected to observe at least this amount of speed. Rather than concluding that absolute motion had been detected but, for reasons unknown, the calibration of the device using Newtonian physics was in error, Michelson came to a different and momentous decision: the fringe shifts were erroneous and absolute motion had not been detected.

It's a long story from here to the current belief system in physics. But briefly Einstein adopted this so called "null result" as an postulate in his modelling of reality.

To this day absolute motion is a banned concept in physics, editors of ‘mainstream’ physics journals will reject any paper claiming the reality and observability of absolute motion, internet archives censor their submissions and remove the offending papers, and conference bans are placed on any persons who report experimental evidence for absolute motion. But what about the experimental evidence? It was only in 2002 that the mystery of the operation of the Michelson interferometer was finally sorted out, and for the first time in over 100 years it was discovered how to calibrate the device as a ‘speedometer’ for measuring absolute motion speeds. There are two key physical effects that no one, until then, had taken account of in explaining the operation of the interferometer. The first effect is the Fitzgerald-Lorentz contraction effect; namely that, say, the arm parallel to the motion has its physical length shortened by the absolute motion. But by itself this would predict that no fringes should be seen. However there is a second effect, namely that when the interferometer is operated in a gas, the gas slows down the speed of light ever so slightly. The two effects together then result in fringe shifts much smaller than predicted by the older Newtonian physics. So finally in 2002 we knew why the Michelson-Morley fringe shifts had been small. Re-analysis of the data then revealed that this famous experiment had actually detected a speed of some 330 km/s, and from the small changes in this speed from data taken 6 hours apart, the direction of motion must be nearly in a North-South direction. It needs to be noted that the device can only detect the projection of the velocity onto the plane of the interferometer, so the true speed is probably larger than this speed. This is an enormous speed, something like 1/1000 the speed of light. So the most famous of all the Einstein postulates is simply wrong. But in science one experiment is not considered conclusive. However over the intervening years at least six other experiments have all detected absolute motion, and all agree that the absolute speed of the solar system through space is some 430km/s in a direction close to a North-South direction. The most impressive of these experiments was by the American physicist Dayton Miller who operated a massive interferometer and over many years took data from some 200,000 turns. Analysis of that data confirmed beyond any doubt that absolute motion was meaningful and measurable. Other absolute motion experiments were done by Illingworth and by Joos. These were operated in a helium gas, while the Michelson-Morley and Miller devices operated in air. An experiment by Jaseja and co-workers used a helium-neon gas mixture, and also detected evidence of absolute motion. The effect of the different gasses is apparent from comparisons of the data. Two other experiments that detected absolute motion were entirely different. They used atomic clocks to measure the travel time of radio waves through a coaxial cable. The most successful of these two experiments was carried out in 1991 by Roland DeWitte in the Belgacom laboratories in Brussels. Of course no physics journal ever permitted the publication of the results from this stunning experiment. Being inconsistent with the Einstein theories they had to be banned. As the earth rotated these times vary. Again the results from these experiments are completely

consistent with the interferometer results for both the speed and direction of the absolute motion.

So why is absolute motion still a banned concept in physics? The answer appears to be that Einstein's ideas resulted in essentially a cult following within the physics community, and that cult ruthlessly attacks any evidence that is not in agreement with their belief system. As a result of this progress in understanding space and gravitation has stalled for the last 100 years or so.

It should be emphasised that the experimental evidence is implying that absolute motion is the cause of effects such as the Fitzgerald-Lorentz contraction and the time-dilation effects. These so-called special relativistic effects should not be thought of as arising from the erroneous Einstein postulates, rather they are manifestations of the motion of physical systems through the complex structure that is space. This corresponds to the line of thought that had been formulated by Lorentz and others well before Einstein produced his postulates.

7 Gravity as Spatial In-Flow

The unified explanation for space and matter had suggested that gravitation was caused by the differential rate of replacement of the cellular components, resulting in a slight net relaxation of the spatial network towards matter. That gravity might be caused by some kind of in-flow dates back to at least Newton. However when the Miller interferometer data was analysed in 2003 with the full insight as to how it worked it was discovered that the data revealed not only the speed of the earth about the sun, and the absolute speed of the solar system through space, but also an in-flow of space with the appropriate speed past the earth towards the sun. So for the first time we saw experimental evidence of the true nature of gravitation. Gravity is an in-flow of the structure within space. This is not a flow of something through space, that is the aether concept, rather it is a ongoing re-structuring of the space itself, that manifests as an inhomogeneous flow of space towards matter. It is this inhomogeneity rather than the motion itself that actually is the phenomena we know as gravity. In general we would expect such a flow to exhibit turbulence, that is, it would display fluctuations in both the speed and direction of this in-flow over time. Amazingly such turbulence is manifest in nearly all the seven experiments that have detected absolute motion. This turbulence is a form of gravitational wave, so it turns out that gravitational waves have been present in experimental data for some time. Even the 1887 Michelson-Morley data appears to show signs of gravitational wave effects. The Einstein curved spacetime theory of gravity predicts a totally different form of gravitational waves. Searches for these over the last 40 years have failed to find any evidence for these waves, and in recent years the search for the Einstein gravitational waves has reached a momentous scale with experiments costing into the billions of dollars, and with even greater expenditure planned for the future.

8 The Failure of Newton's Inverse Square Law

Newton's theory of gravity was based on the motion of the planets around our massive sun. This explanation asserted that gravity was a force acting over a distance and the magnitude of that force being inversely proportional to the square of that distance - the famous inverse square law. Einstein's spacetime theory of gravity was constructed to agree with this law in appropriate limits. But is Newton's law of gravity correct? Again over the years numerous so called gravitational anomalies have been discovered. Anomalies are phenomena that are inexplicable by the prevailing theory. The most obvious of these is the spiral galaxy anomaly where the galaxy as a whole rotates far too quickly according to Newton's theory. Since the Newtonian-Einstein theories are sacrosanct, the explanation offered was that the galaxy was filled with a prodigious amount of unseen and undetected 'dark matter'. On earth laboratory experiments have been unsuccessfully looking for such 'dark matter' for decades.

However the in-flow theory of gravity has suggested that the Newtonian theory of gravity was based on too special a case. Development of the new theory of gravity has led to the prediction that gravity should display the observed form of gravitational waves, but also that in general the inverse square law is a very special case: in spiral galaxies, because of the presence of primordial quantum-foam black holes, the force of gravity should reduce very slowly, so that the inverse square law is totally wrong. There is no 'dark matter', merely an exotic self-interaction and annihilation process of the quantum cellular structure that is space. But can the existence of this quantum-foam process be confirmed by observation? Good science can only move forward by taking account of all experiments and observations, otherwise it degenerates into a belief system that ends up being defended by ruthless acts.

9 Quantum-Foam Space and the Fine Structure Constant

Analysis of a gravitational anomaly discovered by geophysicists in the 1980's revealed that the one parameter determining the strength of the spatial self-interaction was non other than the fine structure constant, known from the quantum theory of atoms, and having the value of $1/137$. Then In an amazing discovery in late December 2003 it was then shown that the new in-flow theory of gravity predicts the same generic form of the rotation velocities of spiral galaxies as that found by the Italian astrophysicists Persic, Salucci and Stel from analysing rotation velocities of some 1100 galaxies. It also correctly predicted the masses of the central black holes recently discovered at the centre of globular clusters.

In atoms the fine structure constant is a measure of intrinsic quantum randomness, namely the probability of a charged particle to emit or absorb a photon of light. So this discovery has revealed that the intrinsic randomness associated with

space itself is determined by the same measure. So the evidence implies space is also a quantum process, and both the Newtonian and Einstein theories of gravity are disproved by the observational data. There are numerous other gravitational anomalies that are finally being understood and they too point to the same conclusion.

So finally after being stalled for most of the last century our understanding of space and gravitation are now moving forward, and it is by examining the experimental evidence, and not by suppressing it, that this is happening. But behind all this we see exciting insights into the very nature of reality: it looks more and more like a thought rather than a collection of mechanical objects obeying prescribed laws.

Needless to say the paper¹ reporting the discovery of the spatial-dynamics explanation for the ‘dark matter’ effect, and thus of the rotation properties of spiral galaxies, and the involvement of the fine structure constant as a second gravitational constant, has been banned by the so-called ‘science’ journals. It is also banned from the Flinders University *Process Physics* website, which was frozen in March 2004.

The *Process Physics* papers are available at the websites:

<http://www.mountainman.com.au/process-physics/>

http://www.scieng.flinders.edu.au/cpes/people/cahill_r/processphysics.html
(Only papers prior to 2004 at this site.)

The book *Process Physics: From Information Theory to Quantum Space and Matter*, by Reginald T. Cahill, will be published by Nova Science Publishers, NY, during 2004.

¹R.T. Cahill, *Gravitation, the ‘Dark Matter’ Effect and the Fine Structure Constant*, physics/0401047.