A SCIENTIFIC APPROACH TO THE PROBLEM OF CONTINUED EXISTENCE AFTER PHYSICAL DEATH

Three consecutive papers

Alan Baldwin

A SCIENTIFIC APPROACH TO THE PROBLEM OF CONTINUED EXISTENCE AFTER PHYSICAL DEATH

I - FUNDAMENTAL RELATIONSHIPS BETWEEN GRAVITY, ELECTROMAGNETISM AND THE GEON

(First in a series of three papers)

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For the pleasure of …..

ABSTRACT

In this first paper of the series, the fundamental properties of geons are described in relation to quantum theory, gravity and electromagnetism.

Key Words: Geon, Quantum Gravity, Loop Quantum Gravity, General Relativity, Quantum Field Theory, Electromagnetism, Kaluza-Klein Theory, Deformed Special Relativity, Anthropic Principle, Bio-electromagnetism.

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INTRODUCTION

In General Relativity (GR), a geon is a hypothetical gravitational wave packet confined to a compact region by the gravitational attraction of its own field energy, first investigated in 1955 by J.A. Wheeler who used the name as a contraction for ‘gravitational electromagnetic entity.’ That means one can admit the possibility that the gravitational field coupled to the electromagnetic field can lead to a sourceless solution termed ‘geon’. Further studies gave birth to particular ideas such as ‘mass without mass’ and ‘charge without charge’, where fluctuations of the gravitational field were thought as responsible for the generation of elementary particles.

It is clear that, if such a possibility exists, it is encoded in Einstein’s field equations and because GR is a classical field theory, Wheeler’s work on geons does not treat them as quantum mechanical entities, but he speculated that there might be a relationship between very small geons and elementary particles. That was an attractive proposition. With no workable theory of quantum gravity (QG), the accuracy of such a speculation was not susceptible to any test but with the advent of Loop Quantum Gravity (LQG), some objects have been theoretically discovered very similar to Wheeler’s notions of a geon.

Wheeler did not derive explicit geon solutions to the GR vacuum field equations and that was partly done in 1964 by Brill and Hartle and the construct is known as the Brill-Hartle geon. Theirs is only an approximate solution that exhibits the geon features anticipated by Wheeler. Wheeler’s hope that geons are the basis of a classical model for elementary particles rests on the question of stability.

The essence of Wheeler’s arguments is that an electromagnetic disturbance is associated with a mass. The gravitational attraction of that mass is, under appropriate circumstances, capable of holding the disturbance together for a time long in comparison with the characteristic periods of the system. Therefore, geons provide a completely classical, divergence-free, self-consistent picture of the Newtonian concept of mass over a wide range.

From the outset, it was realised that the aspects for research would inevitably include, to name just a few, geons versus free waves, mass and radius, the energy action relation, estimates of leakage rates, the quantum limit and electron pair phenomena, idealized spherical geons, conditions required for symmetry, instability time scale, the wave equation for electromagnetic potential, evaluation of the stress-energy tensor, the gravitational field equations, transformations and interactions of electromagnetic geons, photon-photon collision processes, interaction between two geons, the

electrodynamics, corrections to the stress-energy tensor and corrections to the electromagnetic field equations.

SECTION 1 - ELECTROMAGNETISM AND GRAVITY

In classical Newton-Maxwell physics the e-m fields have no influence upon gravity which is generated by sources of mass. In GR, e-m fields alter the spacetime metric and induce a gravitational force through their energy-momentum tensor. In addition, the Maxwell equations are coupled to gravity. In [2], it was highlighted that the relationship, using the usual terminology, between e-m and gravity can be expressed as:

$$\nabla \bullet \mathrm{B} = \mathbf{0}$$

$$\nabla \times \mathrm{g} = -\frac{\partial}{\partial t}\mathrm{B}$$

$$\nabla \bullet \mathrm{g} = \frac{\rho}{\varepsilon_0}\frac{q^2}{m^2} - 4\pi\rho G$$

$$\nabla \times \mathrm{B} = \frac{1}{c^2}\frac{\partial}{\partial t}\mathrm{g} + \mathrm{j}\left(\mu_0 \frac{q^2}{m^2} - \frac{4\pi\rho G}{c^2}\right).$$

The Einstein-Maxwell equations show how the e-m-field leaves its imprint on the metric that has to satisfy the Rainich conditions. Additionally, and as a mention for now, the original work of Kaluza and Klein resulted in the unification of e-m and gravity in 5-space.

In [3], a remarkably close analogy between the Maxwell equations for the electric/magnetic fields and the Bianchi identities for the gravitoelectric/magnetic fields were found. Although that analogy has long been known in general terms, the approach taken revealed properties at a physically transparent level with a detailed accounting for each physical and geometric quantity. New interpretations of the role of the kinematic quantities – expansion, acceleration, vorticity and shear – in the source and coupling terms of gravito-electromagnetism were also found. The trace-free part of the Ricci identities reveal the role of the kinematic quantities as gravito-electric/magnetic potentials along with the exact nonlinear conservation equation that governs these quantities, and which involves a further natural invariant. That invariant is the anisotropic super-pressure and the analogy used shows that a covariant

spatial duality invariance exists in vacuum gravito-electromagnetism, precisely as in source-free electromagnetism.

The initial value constraints of GR minimally coupled to a scalar field, electromagnetism or Yang-Mills theory can be solved [4]. The results include both time-symmetric and asymmetric data with the time-asymmetric examples used to test Penrose's cosmic censorship inequality where it was found that the inequality can be violated if only the weak energy condition holds.

SECTION 2 –THE BASIS OF WHEELER'S GEON

Plane fronted waves with parallel rays (pp–waves) are exact solutions of the Einstein equations representing either pure gravitational waves or the gravitational field of e-m pulses. For those metrics, the Einstein field equations exhibit a linear property that allows one to superpose two pp-waves parallel propagating without apparent interaction and admit a solution of the same type. On the other hand, pp-waves propagating anti-parallel scatter and evolve into spacetime singularities or Cauchy horizons. One is compelled to ask why there is a difference. pp–Waves representing steady beams would be expected to behave in the same way irrespective of their direction of propagation, especially as the non–linearity of the Einstein equations cannot depend on the relative orientation of the sources in 3-space. That means a physical explanation is missing and that explanation is the subject of reference [5].

In 1934, Tolman, Ehrenfest and Podolsky (TEP) studied the gravitational field of light beams and the corresponding geodesics in the framework of linearized GR and discovered that null rays behave differently according to whether they propagate parallel or anti-parallel to a steady, long, straight beam of light. TEP did not provide a physical explanation of that fact. Wheeler adopted TEP's result as the basis of his e-m geon model, going further than TEP's findings by generalizing them to the case of two light beams Wheeler stated that "two nearly parallel pencils of light attract gravitationally with twice the strength one might have thought when their propagation vectors are oppositely directed, and when similarly directed attract not at all". Later, the geon idea was generalized to non-spherical topology and to other types of massless fields (neutrino, gravitational and mixed geons). Fairly recent interest in geon models have arisen from the study of the entropy of radiation, the analogy between e-m geons and quark stars and the basis for the gravitational geon construct.

The authors of [5] begin by studying the analogous problem for interacting light

beams in linearized general relativity, that is, pp–wave metrics with the non-vanishing Ricci tensor interpreted as the gravitational field of pulses or beams of light.

The TEP result is re-derived and then generalized to null rays of the gravito-electromagnetic Lorentz force of linearized gravity. The analysis is then extended to the realm of exact pp–wave solutions of the Einstein equations, and a physical explanation is given of the superposition property of parallel beams of light in the strong gravity regime. That analysis reconfirms well known physics and provides a further result. Theory and physical observation have shown photons are attracted by mass by twice the amount expected if they were instead massive particles, which is in consonance with the results obtained in [5].

It is known that massive particles are deflected by the gravitational field of light by a factor of 2, which the analysis in [5] supports as does the confirmation that parallel photons do not attract. However, in the case of two light beams interacting gravitationally in anti–parallel orientation (or when a test photon is deflected by the gravitational field of light), the authors of [5] found that each distribution of light contributes a factor of two, and in the new predictive results, an overall attraction factor of four appears. Wheeler's conjecture on the interaction of light beams is important for the confinement of electromagnetic radiation and therefore for classical models of particles and those authors firmly support that conjecture in their analysis.

SECTION 3 – GRAVITY ⇔ QUANTUM MECHANICS ??

The questions where gravity and where quantum mechanics come from are interesting. Here, we ask whether they arise from each other and that will have a direct bearing on the nature of the small geon. One should contemplate the possibility that quantum gravity might affect the nature of general symmetry or the theory of GR may not provide a complete description of gravitation. The foundations of GR and quantum mechanics allow modifications in each other at the region of their interface

In a very competent review [6], spin and statistics of topological geons regarded as particles in (3+1)-D quantum gravity can have half-odd integral spin and fermionic statistics. As the underlying gravitational field is tensorial and bosonic, that is an example of 'emergent' non-trivial spin and statistics as displayed by familiar non-gravitating objects such as skyrmions. The topological background was given and it was show that in a 'canonical'

quantization of gravity there is no spin-statistics correlation for topological geons although the reverse may be true if the topology of space is allowed to change. There exist a conjectured set of rules sufficient to give such a spin statistics correlation for all topological geons, but not for spinorial and fermionic geons.

Quantum mechanics and gravity may be intimately related. That comes from [7] involving the investigation of the quantum Hamilton–Jacobi equation in the case of two free particles where the quantum potential, which is attractive, may generate the gravitational potential. The investigation relates to the formulation of quantum mechanics based on the equivalence postulate and based on the analysis of the reduced action. A consequence of this approach is that the quantum potential is always non–trivial even in the case of the free particle. It plays the role of intrinsic energy and may in fact be at the origin of fundamental interactions such that gravity arises out of the quantum picture.

On the other hand, the logic of quantum mechanics can be derived from classical physics [8]. An orthomodular lattice of propositions, characteristic of quantum logic, is constructed for manifolds in GR. A particle is modeled by a topologically non-trivial 4-manifold with closed timelike curves, rather than as an evolving 3-manifold. It is then possible for both the state preparation and measurement apparatus to constrain the results of experiments. It is shown that the propositions about the results of measurements can satisfy a non-distributive logic rather than the Boolean logic of classical systems. Reasonable assumptions about the role of the measurement apparatus leads to an orthomodular lattice of propositions characteristic of quantum logic. In a previous paper [9], the same author stated that field and particle descriptions of nature are unified as Einstein had always hoped and expected. For the first time the origin of QM is explained in terms of existing theories. In doing so, GR and QM are reconciled, not with a quantum theory of gravitation, but with a gravitational explanation for QM. Thus there is no quantum theory of gravity, classical objects are possible, the 4-geon structures give rise to quantum effects, there is no graviton and gravitational waves are topologically simple solutions of Einstein’s equations without CTCs. Therefore they cannot exhibit quantum phenomena such as wave particle duality.

In a later paper, [10], the same author states “Einstein’s dream of describing elementary particles as solutions of a classical field theory is severely limited by our current understanding of nature. Quantum theory is inconsistent with any local realistic theory such as evolving topological structures in space. It is shown that allowing time reversal as an intrinsic part of the structure of elementary particles allows general relativity to explain quantum theory in principle. Such structures may also explain electric charge and spin-half.” He

goes on to say that a formal proof that acausal spacetimes lead to the logical structure of quantum theory is given in another of his papers and can be summarized by “acausal spacetime is context dependent”. This can been seen with CTCs or a failure of time orientability. In general, it is not possible to set up boundary conditions on an initial surface without some knowledge of future conditions. “There is a deep structural link between acausal spacetimes and quantum theory. As a consequence quantum theory may resolve some paradoxes of time travel. Conversely, non-time-orientable spacetimes naturally give rise to electric charges and spin-half. If an explanation of quantum theory is possible, then general relativity with time travel could be it” [11].

SECTION 4 – TOPOLOGY

Suppose that space has a topology at some fixed time. Could that topology alter at some later time? If that answer is in the affirmative, it is possible to view matter particles as kinks or knots in space and any non-trivial topological configurations of space will exhibit mass, half-integral spin as well as charge (geons). GR involves geometry, and if geometry changes, does also the topology change? If so, there lays an explanation for particle interactions.

Considerations as above have been beset by limitations imposed by Geroch and Tipler. Geroch has shown that topology change may be obtained in these cases only at the price of causality violations. Tipler has shown that Einstein’s equation cannot hold on such spacetimes if the spatial topology changes where the source has non-negative energy density. Such limitations have led to other research that follow those propositions, inevitably ‘closing off’ avenues and confining results to a narrow range so producing either no ‘picture’ of what was intended to be found or some ‘skewed’ picture of it. It is respectfully submitted that, and recently some have adopted this attitude, perhaps causality violations do occur in nature and perhaps Einstein’s equations are incomplete and need to take account of changes in topology. After all, the first major alteration to GR was carried out by Einstein himself.

Whenever anyone says “You cannot do that because…”, there inevitably follows a list of restrictions. Some of those in this context are that topology change is intrinsically incompatible with the Lorentzian metric; closed-universe topology change gives CTCs when the metric is time-orientable and some specific energy condition prevails, or a singularity is produced and, 2-D topology change is necessarily singular and topology change may be dynamically had only in closed universes only if the metric is allowed to be singular. There is some measure of refute of these in [12] that clarifies some

aspects of Lorentzian topology change and it extends to a wider class of spacetimes than that of Geroch and Tipler.

The scenarios studied are ones in which an initial spacelike surface is joined by a connected ‘interpolating spacetime’ to a final spacelike surface, possibly of different topology. The interpolating spacetime is required to obey a condition called causal compactness, a condition satisfied in a very wide range of situations. No assumption is made about the dimension of spacetime. It is stressed that topology change is kinematically possible; i.e., if a field equation is not imposed, it is possible to construct topology-changing spacetimes with non-singular Lorentz metrics and simple 2-D examples of this are shown.

In such an argument one must not forget that there exist the quantum aspects. From the spin statistics of geons, spatial topology in quantum gravity cannot be a time-invariant attribute, and its transmutations must be permitted in any eventual theory. Geons are solitonic excitations caused by twists in spatial topology. In the absence of topology change, a geon can neither annihilate nor be pair produced with a partner geon, so that no geon has an associated anti-geon. Spin-statistics theorems generally emerge in theories admitting creation/annihilation processes and can be expected to fail for geons in gravity theories with no topology change. Calculations on geon quantization confirm this.

The absence of a universal spin-statistics connection in these gravity theories is much like its absence for a conventional non-relativistic quantum particle that cannot be pair produced or annihilated. Such a particle can obey any sort of statistics including parastatistics regardless of its intrinsic spin. The standard spin-statistics connection can be enforced in non-relativistic dynamics by introducing suitable creation/annihilation processes. There is a general opinion that the spin-statistics theorem should extend to gravity as well. Just as this theorem emerges from even non-relativistic physics once it admits pair production and annihilation, quantum gravity can be expected to become compatible with this theorem after it allows suitable topology change.

In this matter, the desire for the usual spin-statistics connection leads us to look for quantum gravity with transmuting topology. Canonical quantum gravity in its elementary form is predicated on the hypothesis that spacetime topology has an eternal spatial topology. This fact has led to numerous suggestions that conventional canonical gravity is inadequate if not wrong, and must be circumvented by radical revisions of spacetime concepts or by improved approaches based either on functional integrals and cobordism or on alternative quantisation methods. We see here that topology change can be achieved in quantum physics by judicious introduction of new degrees of freedom. They

control the BC's of operators associated with the classical configuration space. When they change, the classical configuration space is changed and suffers topological transmutations [13].

Source free equations of e-m can display apparent charge in regions of spacetime with a non-trivial topology such as Wheeler's wormholes where one mouth has positive electric charge and the other mouth has the same amount of negative electric charge. These topological structures of spacetime are geons. It has been suggested that quantum mechanics could be explained by modeling elementary particles as 4-geons (geons with a non-trivial casual structure). If there exist topology changing interactions between geons with a reversal of the time orientation, spacetimes that are not time orientable result. Spacetimes that lack a time orientation were considered unphysical but now and from this perspective, they are not only physically relevant but important. If source-free Maxwell equations and the definition of electric and magnetic charge are applied to spacetimes that lack space or time orientations, various wormholes can be constructed with each type of orientability. In these examples net magnetic charge can appear when space is not orientable and electric charge when spacetime is not time orientable.

That leads to a new spacetime that lacks a time orientation, has spherical symmetry and the outward appearance of a point source of electric charge – an electric monopole. Topological obstructions prevent the construction of an analogous magnetic monopole. In that way, topological structures for spacetime are constructed that can exhibit an apparent net electric charge without any apparent source and spacetimes with non-orientable immersed surfaces were known to exhibit magnetic charge. The spaces with non-co-orientable immersed surfaces exhibit the opposite type of charge. These spacetimes are not time orientable. That may seem unphysical, but they are the type of classical structures that would be required to exhibit quantum mechanical effects so the classical gravitational model for quantum mechanics is also seen to lead naturally to the existence of electric charge and the absence of magnetic charge [14].

A blunt statement is: "The key feature of the models is the role of topology change. It is the breakdown of causal structure associated with topology change that leads to the apparently non-classical behaviour. For geons, topology change is required to describe the interaction of particles. It is therefore natural to regard topology change as an essential part of the measurement process. This leads to models in which the measurement imposes additional non-redundant boundary conditions. The initial state cannot be described independently of the measurement and there is a causal connection between the measurement and the

initial state"[15]. An even blunter statement is "There are no compelling reasons to exclude topology change from quantum gravity" [16].

It would now seem that one must bring into being a little common sense. We ask which is it to be, a GR universe or a QM universe? If we say that the equations of GR govern space, it follows that QM arises from those equations. We already know the shortfalls of GR alluded to in the literature and as just one example we point out infinite mass in zero volume vis à vis the Big Bang Theory. Can anything be more unphysical? If GR predominates, the shortfalls within GR would make QM exceedingly difficult and virtually unworkable. If we say that QM governs space, it follows that GR arises as a result, that being relegated to a very good attempt at describing the universe in some sort of classical manner and we emphasise that it is a very good attempt. Regarding GR in that way turns it not from some attitude that looks upon it as an 'all powerful' tool but as an approximation concerning how the real universe behaves, much the same as Newtonian gravity is an approximation within GR that is valid for practical purposes over very short distances. Consequently, we now rest on the proposition that the universe is quantum mechanical in its basic structure and operation as previously indicated in [2]. From that standpoint it is felt necessary to treat with caution any so-called 'established fact' or condition imposed that is expressed in a General Relativistic framework, including the use of the energy-momentum tensor unless that quantity is applied in a non-GR manner and is directly applicable to the quantum state under consideration.

As a consequence of the contents of the paragraph above, we refute all statements in the nature of:

"Because every three-manifold occurs as the spatial topology of a solution to the Einstein equations, one might ask why such topological structures are not part of our ordinary experience. A key part of the answer is a singularity theorem due to Gannon, showing that any asymptotically flat spacetime with a non-simply connected Cauchy surface has singular time evolution if it satisfies the weak energy condition. Only topological structures comparable in size to the visible universe or small enough that quantum effects play a crucial role in their dynamics can survive from the big bang to the present. According to the cosmic censorship conjecture, singularities forming to the future of a regular initial data surface are hidden by an event horizon. If correct, the conjecture suggests that any topological structures will ultimately collapse within the horizon of a set of black holes. This collapse is too rapid to allow observers to traverse the wormhole throat for known exact analytically extended black hole solutions. Consequently one is led to a related topological censorship conjecture that no observer remaining outside a black hole has time to probe the topology of spacetime" [17].

Unfortunately, GR is so entrenched in the thinking of workers it is difficult to divorce oneself from it. Being regarded as a powerful tool and a very seductive theory that has existed for more than a century, one is almost forced into its use. Therefore, we do not condemn those who use that tool but if a conflict arises between the GR result and the QM result, the reader is now acquainted with where we stand in that event. Further, it is easy to complicate matters by the combination of GR and QM in the simplest of concepts as set out below.

From the practical point of view, what do we measure? Everything reduces to a length, and that length is some multiple of $\hbar^2/me^2$. There is also a point of view that such a basic length may alter owing to the expansion of the universe. Be that as it may, complete accuracy is required. That can be obtained by the standard of a point defined by intersection of two world lines of two test particles, or one test particle and a light cone, or three light cones and we know that time and mass can be expressed as lengths. In GR, mass, length and even time are geometrical entities and can be measured because they produce spacetime curvature. Electromagnetic fields also produce that curvature and curvature is proportional to field squared that can be expressed in units of per centimeter. Likewise, a charge Q, measured in esu can be expressed as q in centimeters and **E** and **H** become e and h. Classical physics deals only with lengths, even though we may dress them up and give them other units.

As to the nature of matter, according to Wheeler, if we have an e-m field or a neutrino field or a mixed field of sufficient density, under the appropriate conditions, it can hold itself together by its own gravity. It will do that for a time much longer compared to the characteristic period of its field oscillations. As an opposite to that, a sufficiently strong gravitational field can guide an e-m or neutrino wave and confine the energy to a bounded region of space. But when the energy of the standing wave is sufficiently large, it needs no outside influence because it will have sufficient mass to provide its own guiding gravitational field. The wave will hold itself together. Therefore, GR and Maxwell equations admit a variety of self-consistent solutions describing a stable concentration of energy. This stable concentration of e-m energy has mass and can move through space like a Newtonian body only when it is subjected to fields in space and time that vary slowly. If the variation is rapid, the e-m concentration of energy will be subject to transmutation.

In his original work Wheeler attributed great mass and radius to his creation. The equations of motions derived from these field equations must, of necessity, assume that some massive object exists. The theory of a particular field equation should be a self-contained exposition of nature from that particular viewpoint. The introduction of some extraneous massive body remains to be justified if that theory is indeed self-consistent. If there is no self-consistency

there is no objection to include some arbitrary body into the theory. Even the introduction of a mass as a singularity in the metric is nevertheless the introduction of an extrinsic body. It seems natural that through desire, we wish to see success and to achieve this we may select not to introduce any singularity but to introduce an object that obeys the equations of a fluid. With the induced regularity of the metric, the body of fluid can show us its internal degrees of freedom and all that implies.

For such an entity as a geon, the acceleration needed to retain radiation in a circular orbit of radius r is in the order of c^2/r. The available acceleration arising from the gravitational attraction of a concentration of radiation is in the order of Gm/r^2. Then $r \approx GM/c^2$ showing that a geon is a classical object. Saying that, if no quantum effects are involved, means that the body has to be large. That geon from a distance appears to have mass, but it does not. It really has no mass because when one looks at it more closely, all one sees is a curvature of spacetime.

To end this section we take a 'story' from [18]: "Entertain the conjecture of a time, long, long ago, when there lived a quantum baby of cheerful semblance and sweet majesty. It was brought up by its doting parents on a nourishing diet of self-adjoint operators on a Hilbert space. All it could experience as it grew up were their mean values in quantum states. It did not have a clue when it was little that there is our classical world with its topology, dimensions and metric. It could not then tell a torus from a hole in the ground. Yet the baby learned all that as it grew up. And the wise philosopher is struck with wonder: How did the baby manage this amazing task?

For the problem is this. Even in a quantum theory emergent from a smooth classical configuration space Q, there is no need for a wave function ψ, or a probability density $\psi^*\psi$, to be continuous on Q. It is enough that the integral $\int\omega\psi^*\psi$ over Q for an appropriate volume form ω is finite. Probability interpretation requires no more.

But if the baby can observe all self-adjoint operators with equal ease, and thereby prepare all sorts of discontinuous quantum states, how then does it ever learn of Q, its topology and its differential attributes? The problem is even worse: We shall see [below] that any two (separable) Hilbert spaces are isometric so that there is only one abstract Hilbert space… We can explain the baby problem in yet another way. In quantum physics, observables come from bounded operators on a separable Hilbert space H. [We will deal only with separable Hilbert spaces]. The latter is generally infinite-dimensional. But all infinite-dimensional Hilbert spaces are isomorphic, in fact unitary so. If

$|n>^{(i)}$ ($n \in IN$) gives the orthonormal basis for the Hilbert space $H^{(i)}$ ($i = 1, 2$), we can achieve this equivalence by setting $|n>^{(2)} = V\ |n>^{(1)}$. That being so, any operator $A^{(1)}$ on $H^{(1)}$ has a corresponding operator $A^{(2)} = V\ A^{(1)} V^{-1}$ on $H^{(2)}$.

How then does a quantum baby tell a torus from a hole in the ground? Without further structure in quantum physics besides those to be found in standard text books, this task is in fact entirely beyond the baby."

SECTION 5 – GEONS

It is worth mentioning that there exist potentials that lead to theories that admit gravitational geon solutions in (1+1)-D and for a particular choice of $V(\varphi)$, φ can be eliminated from the action and the Lagrangian written in terms of the Ricci scalar is proportional to $R^{2/3}$ [19]. There are no (2+1)-D asymptotically flat solutions of the vacuum Einstein or Einstein-Maxwell equations containing geons. In contrast, (2+1)-D asymptotically AdS spacetimes can contain geons. However, those geons are always hidden behind a single black hole horizon [20].

Brill and Hartle developed a method for finding approximate solutions to Einstein's equations that correspond to high frequency gravitational waves propagating in a background geometry created by the average stress-energy of the waves themselves. That was applied by them to the case of a static spherically symmetric background geometry and found that gravitational waves can remain confined in a region for a time much longer than the region's light-crossing time. This gravitational geon is generated by a large number of high frequency, small amplitude gravitational waves such that the time average of the curvature due to these waves creates the background geometry of the geon. It is that background geometry that traps the waves for a long time in a region of space called the 'active region'. Here the solution of Brill and Hartle shows that the gravitational field both creates and responds to its own effective stress-energy.

In a more detailed study of the Brill-Hartle geon [21], a correct self-consistent set of equations for the gravitational geon was obtained. Those describe the gravitational waves and the background geometry. These equations are accurate in the high frequency, large angular momentum limit. In and near the active region they have been shown to be the same set of equations as those found by Wheeler for the electromagnetic geon. Thus, to leading order, the geometry both

inside and outside of the active region of the gravitational geon is identical to that of the electromagnetic geon.

Electromagnetic, neutrino and mixed type geons have been studied with suggestions that it should be possible to construct a geon from gravitational waves. After the Brill and Hartle paper, subsequent work assumed the correctness of that. In their approach, Brill and Hartle considered a strongly curved static or quasi–static background geometry on top of which a small ripple resided, satisfying a linear wave equation. The wave frequency was assumed to be so high as to create a sufficiently large effective energy density that served as the source of the background geometry and was taken to be spherically symmetric on a time average. For their analysis, they used the Regge–Wheeler decomposition of the small ripple in a spherical background in terms of waves characterized by the usual quantum numbers related to the angular momentum operators and the frequency. They claimed to have found a solution with a flat–space spherical interior, a Schwarzschild exterior and a thin shell separation meant to be created by high frequency gravitational waves. With the mass identified from the exterior metric, there would follow an unambiguous realization of the gravitational geon if two conditions were satisfied. One condition is that the gravitational geon must be a non–singular solution of the Einstein equations in vacuum because any singularities present would indicate the presence of non–gravitational sources.

As to that first condition, it fails. The junction conditions for regularity are not satisfied by the Brill-Hartle solution and cannot be singularity–free. With that condition violated it is pointless to examine the second.

If we said that whist the structure is inadequate as it stands, an expansion of the shell region into one of finite extent would reveal a desired geon solution with both regularity and consistency. The sufficiently general analysis in [22] does exactly that along with an examination whether geons ‘leak’ radiation to the exterior.

Geons can have quantum numbers like charge and can be tensorial or spinorial, having integer or half-odd integer spin. In fact, in classical GR, geons have the transformation properties of a spinor if the spacetime manifold is not time orientable. .A striking result is that geons can violate the canonical spin-statistics connection and such violation induces novel physical effects at low energies. Those effects are expected to be small since the geon mass is expected to be of the order of Planck mass. Nevertheless, these effects are very striking and include CPT and causality violations and distortion of the cosmic microwave spectrum [23].

SECTION 6 – WE MUST STOP GOING AROUND IN CIRCLES

Most of the above frustrates rather than informs for it is evident that workers switch between GR and QM at the drop of a hat. That is not to be unexpected as workers favour either GR or QM depending on their scientific 'upbringing', with a few quite comfortable in both. Nevertheless, nothing is simple, nothing is made simple and there are no simple answers, for everything is couched in terms of 'ifs' and 'buts'. There is much to be said for sorting the simple aspects from the multitude of complicated ones as well as the ones made complicated, and then using those simple aspects in the construction of a consistent theory.

Suppose we observe many types of interactions in nature. The natural tendency is to list those as being of different types. By doing that, we completely overlook the possibility that there is only one type of interaction that manifests itself in many different ways depending on environmental conditions.

Intuition gives rise to the notion that there should be some process in nature whereby a field transforms into a particle and vice versa depending upon the prevailing environment. For the field we use QM and for the particle we use GR in the full knowledge that using QM and GR is like trying to mix oil and water. Mixing oil with water has two possibilities. The first is that it should not be attempted so use the oil or the water and do not try to mix them. The second is to introduce a surfactant that will produce an emulsion. For the field to particle transition, GR will describe the gravitational field of the particle matter distribution via an action with a term for field and a term for matter. The term for the field is easy whereas the term for matter needs to be included ad hoc because the matter element is an external quantity with its own specific and not generalised properties, and that is not simple. Suppose that task is now complete, what do we have? A final equation representing a field to particle transition for one specific particle and not a generalized equation encompassing all particles and all fields.

SECTION 7 – SUMMARY

Matter and field are the basics of GR where the Einstein tensor is expressed in terms of the geometry of spacetime, the matter being represented by its momentum-energy density tensor. These two intrinsic concepts are connected by the Einstein field equation, according to which, a given distribution of matter determines the geometric properties of space-time. One can regard this as the creation of spacetime geometry by matter. Now read the field equation in the

opposite direction, and expect that matter will be created by geometry. In the famous paper by Einstein and Infeld, “Could we not reject the concept of matter and build a pure field physics? … We could regard matter as the region where the field is extremely strong.”

Wheeler introduced the concept of electromagnetic geons, massive entities created by spatially confined fields. Then Wheeler and Power introduced the thermal geon. Geons were included by Misner and Wheeler in their book ‘Geometrodynamics’, that described gravitation and e-m in terms of geometry.

In 1974 G. ‘t Hooft showed that in gauge theories in which the e-m group is a sub-group of a larger group, massive magnetic monopoles can be created as regular solutions of the field equations. Then, Gross and Perry found that in 5-space, there exist regular static and stable soliton solutions. On quantization, these correspond to particles. In the 1990s, Cooperstock et al. demonstrated that no gravitational geon can exist in GR based on Riemannian geometry. That meant, to have matter created by geometry one needed to turn away from 4-space Riemannian geometry.

Kaluza proposed and then Klein showed a unification of e-m and gravitation in the frame of a 4-D hypersurface embedded in a 5-D manifold, suggesting that the fifth dimension has a circular topology that others have removed. In 1938 Einstein and Bergmann presented a generalization of the Kaluza-Klein theory. In this work the condition of cylindricity (that is equivalent to the existence of a 5-D Killing vector) is replaced by the assumption that with regard to the fifth coordinate the space is periodically closed. In the Einstein - Bergmann version the fifth dimension has a physical meaning. Wesson’s theory is one where physical matter of the 4-D spacetime is created by the geometry of a 5-D bulk. This induced matter theory has culminated in the proof of the geometric origin of matter and an induced unified theory of gravitation and e-m.

When one compares Wesson’s theory with the Weyl-Dirac theory, the results are similar. Both theories allow matter from geometry and singularity-free cosmological models. In both theories dark matter and quintessence follow from geometry. Both theories provide a unified, geometrically based description of gravity and e-m. and both the Kaluza-Klein theory and the Weyl-Dirac theory attempt the construction of unified theories using classical fields. In fact, Weyl geometry describes the 5-D bulk.

REFERENCES

[1] Sorkin (1997) gr-qc 9706002v1.
[2] Baldwin (2009) Particles, Gravity and the Zero-Point Field. Section 2. http://www.angmalta.net/clients/alan/creationfivepapers/
[3] Maartens and Bassett (1998) gr-qc 9704059v3.
[4] Husain (1998) gr-qc 9805100v2.
[5] Faraoni and Dumse (1998) gr-qc 9811052v1.
[6] Dowker and Sorkin (2001) gr-qc 0101042v1.
[7] Matone (2002) hep-th 0005274v3.
[8] Hadley (1997) quant-ph 970601v1.
[9] Hadley (1996) quant-ph 9609021v1.
[10] Hadley (2006) physics. Gen-ph 0601032v1.
[11] Hadley (2006) gr-qc 0612015v1.
[12] Borde (1994) gr-qc 9406053v1.
[13] Balachandran, Bimonte, Marmo and Simoni (1995) gr- qc 9503046v3.
[14] Diemer and Hadley (1999) gr-qc 9905069v2.
[15] Hadley (1999) gr-qc 9905061v1.
[16] Dowker, Garcia and Surya (1999) gr-qc 9910034v1.
[17] Friedman (1995) gr-qc 9305017v2
[18] Balachandran (2000) quant-ph 0002055v2.
[19] Vollick (2008) gr-qc 0807.0611v3.
[20] Stevens, Schleich and Witt (2008) gr-qc 0809.3022v2
[21] Anderson and Brill (1997) gr-qc 9610074v2.
[22] Cooperstock, Faraoni and Perry (1996) gr-qc 9512025v2.
[23] Alexanian and Balachandran (2002) hep-th 0111039v3.

II - THE GEON AND ITS SPACE

(Second in a series of three papers)

(8th September 2009)

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For the pleasure of …..

ABSTRACT

In this second paper of the series, fundamental notions concerning geons are set out.

INTRODUCTION

Reference [2] in the previous paper is a theory concerning the creation of the universe that also involves the existence of a self-replicating solitonic lattice filling 4-D space. We already know that the original Kaluza-Klein theory unified e-m and gravity with a 'left over' scalar field having a solitonic solution. It is that clue we use in order to simplify matters here and contemplate the notion of scalar geons that are no more than gravitationally bound solitons. If indeed scalar fields exist in nature, solitonic configurations kept stable by their own self-generated gravity are possible. That proposition admits a classical analysis where any curving up of the background metric is accomplished by the stress-energy factor of matter.

The Lagrangian density of gravitational coupled Maxwell field in the form of a geon is

$$L = \frac{1}{16\pi\ G}\sqrt{|g|}\ \ R - \frac{1}{4}\sqrt{|g|}\ \ F_{\mu\nu}\ \ F^{\mu\nu}$$

and it assumed that the geon possesses a scalar self-interaction, $I(\phi)$, such that $\sqrt{I(\phi)}$ is identical to the fundamental non-linear spinor equation. However, if the coupled scalar fields are complex,

$$L_{\substack{coupled\\complex}} = \frac{\sqrt{|g|}}{16\pi\ G}\left(R + 8\pi\ G\ \left[g^{\mu\nu}(\partial_\mu\phi^*)(\partial_\nu\phi) - I\left[\ \ |g|^2\ \right]\ \right]\right)$$

with the Einstein-Klein-Gordon equations as,

$$G_{\mu\nu} : = R_{\mu\nu} - \frac{1}{2}g_{\mu\nu}R = -8\pi\ G\ T_{\mu\nu}(\phi) \qquad \text{and} \qquad \Box\,\phi + \frac{\phi\ dI}{d\ |\phi|^2} = 0$$

with these geons capable of resisting gravitational collapse [1]. Here, we use the generally covariant d'Alembertian. If the frequency of a spherically symmetric bound state of the scalar field is ω,

$$\phi(r,t) = S(r)e^{-i\ \omega\ t}$$

Such a geon is no more than a macroscopic quantum state but at the outset it seems prudent to ask if such a quantum state is in fermionic or bosonic form. If

fermionic, the Pauli Priciple will apply and a large collection of these geons will be forced into a state with high quantum numbers. If bosonic, a collection of them can all exist in their ground state, possibly as a Bose-Einstein condensate. However, the purpose here is not to explore the interaction of geons but to explore their individual properties. In fact, we prefer neither. Such coherent quantum states generate their own gravitational field via their energy-momentum tensor and in that respect are classical objects. The complex scalar fields of two or more geons can be treated as a Schrödinger wave function and those would be described as semi-classical.

If the complex scalar field is minimally coupled to local U(1) gauge field, the Lagrangian density is,

$$\underset{U(1)}{L_{coupled}} = \frac{1}{16\pi\ G}\sqrt{|g|}\ \ R - \frac{1}{2}\sqrt{|g|}\ \left[g^{\mu\nu}(D_\mu\phi^*)(D_\nu\phi) - I\left[\ \ |g|^2\right]\ \right] - \frac{1}{4}\sqrt{|g|}\ \ F_{\mu\nu}\ \ F^{\mu\nu}$$

The coupling between the scalar field and the U(1)-valued 1-form is

$$A = A_\mu dx^\mu$$

and is introduced via the gauge. For scalar fields the general covariant derivative is

$$D_\mu\phi = D_\mu\phi + ieA_\mu\phi\,,$$

where e denotes the U(1) coupling constant. Furthermore, the Maxwell type term for the two-form

$$F :\ = \frac{1}{2}F_{\mu\nu}dx^\mu \wedge dx^\nu$$

occurs when the Faraday field strength is

$$F_{\mu\nu} = \partial_\mu A_\nu - \partial_\nu A_\mu$$

Because a real scalar has no anti-particle states, the corresponding Klein-Gordon field in a spherically symmetric spacetime metric can be decomposed into positive and negative frequency field operators,

$$\phi = \phi^+ + \phi^-$$

and the energy-momentum tensor becomes an operator. Now, the right-hand side of the Einstein equation is the vacuum expectation value for the ground state and $T_{\mu\nu}$ denotes normal ordering of the operator products. The gravitational field is self-generated by the mean value of the energy-momentum tensor, but remains completely classical, whereas the real scalar is treated to some extent as an operator. In order to ensure stability, because there exist no conserved particle numbers for real scalars, a normalizing condition is required. If the scalars are complex, a constraint is imposed that the solutions are asymptotically flat at spatial infinity.

SECTION 1 - SPACETIME

The Melvin magnetic universe dates from 1964 being a regular, static, cylindrically symmetric solution to Einstein-Maxwell theory. It describes a bundle of magnetic flux lines in gravitational-magnetostatic equilibrium. This solution has features that provide the closest approximation in GR to a uniform magnetic field. The non-singular nature of the solution motivated Melvin to call it a ‘magnetic geon’. The Melvin universe has been generalised in several ways including rotating and time-dependent magnetic universes and gravitational waves traveling in a magnetic universe. The Melvin solution has been generalized also for a gravity theory minimally coupled to any non-linear e-m theory including that of Born-Infield

E. Ragu and R.J. Slagter [2] chose the Liouville potential for $V(\phi)$ in that $V = V_0 e^{2b\phi}$ so allowing explicit solutions. The scalar field equation takes a simple form in the (u, v)- metric parametrization

$$\phi'' = -\frac{1}{2}\left[av'' + bu''\right]$$

The exact solutions are not general but only for specific values of a and b. When a = 1/b = $\sqrt{3}$ the action of the theory corresponds to the Kaluza-Klein reduction of the 5-D gravity with a cosmological constant with a parametized 5-metric. The value of the cosmological constant fixes the value V_0 through $V_0 = -2\Lambda_5$. It is hoped that one may generate Melvin-like dilaton solutions starting with suitable vacuum (anti-)de Sitter 5-D configurations.

The notion of spacetime necessarily includes time. GR is beset by non-trivial geometries that generate closed timelike curves. A closed timelike curve allows time travel, in the sense that an observer who travels on a trajectory in spacetime along this curve, returns to an event that coincides with the departure. The arrow of time leads forward, as measured locally by the observer, but globally he may return to an event in the past. That apparently violates causality with those consequent paradoxes postulated by others. Causality has consistently been taken as valid and fundamental in the construction of physical theories. Consequently, time travel has been demoted to the status of the ridiculous. The alternative would require the total reconstruction of physics.

The paradoxes constructed to deny that part of GR that proves to be totally inconvenient fall into two groups. The consistency paradoxes involve altering events in the past. Those include the classical grandfather paradox involving X moving into his past to kill his own grandfather and so preventing the birth of his own father. Causal loop paradoxes involve information given by X to his younger self, such as how to make a time machine.

One thing is evident. If we say that GR is valid, time travel must be included in the form of CTCs. The above paradoxes have been used to remove the inconvenient but those do not prove that time travel is mathematically or physically impossible. Taking those paradoxes one step further, it is obvious that X did not kill his grandfather. He may have killed someone but that someone was not his grandfather. That and similar failures of X form the basis of Penrose's Cosmic Censorship Principle.

Novikov's Principle of Self-Consistency stipulates that events on a CTC are self-consistent, that is, events influence one another along the curve in a cyclic and self-consistent way. In the presence of CTCs the distinction between past and future events are ambiguous, and the definitions considered in the causal structure of well-behaved spacetimes break down. What is important to note is that events in the future can influence, but cannot change, events in the past. The Principle of Self-Consistency permits one to construct local solutions of the laws of physics, only if these can be prolonged to a unique global solution, defined throughout non-singular regions of spacetime. Therefore, according to this principle, the only solutions of the laws of physics that are allowed locally, reinforced by the consistency constraints, are those that are globally self-consistent.

Hawking's Chronology Protection Conjecture is a more conservative way of dealing with the paradoxes. Hawking notes strong experimental evidence in favour of the conjecture from the fact that "we have not been invaded by hordes of tourists from the future". An analysis reveals that the value of the

renormalized expectation quantum stress-energy tensor diverges in the imminence of the formation of CTCs. This aspect was dealt with in reference [2] in the previous paper. Visser still considers the possibility of two other conjectures. The first is the radical reformulation of physics conjecture, in which one abandons the causal structure of the laws of physics and allows, without restriction, time travel, reformulating physics from the ground up. The second is the boring physics conjecture, in which one simply ceases to consider solutions that are inconvenient.

SECTION 2 - FIELD ⇔ PARTICLE ??

When working in a gravitational field, the geon is already of a specific gravitational configuration and a topological geon as a gravitational field configuration is easy to construct. Difficulties arise when one tries to obtain a topological geon that reproduces the behavior of a particle. Using exact solutions to the Einstein-Maxwell equations runs into the difficulty that there is no way a topological geon can be constructed unless by trial and error in all possible spacetimes which is hardly appropriate. The way to tackle the problem is to find generic solutions with conditions satisfied by spacetimes that can represent a particle. Then, the analysis is confined to those solutions to the Einstein-Maxwell equations that satisfy those conditions.

The properties of a particle involve mass, charge, and spin and these are quantized. The parameters of a gravitational configuration can take values in a continuum. That means a configuration with continuous parameters needs to change into something with discrete parameters. Indeed, the same holds true vice versa when one thinks of how to transform a particle into a gravitational field notwithstanding that particles with mass will exhibit their own gravitational field.

That problem was addressed in [3] where the authors reviewed some of the main conceptual aspects of the field-to-particle transition problem with the aim to regard physical systems in which fields and matter are involved in a way where matter is not some external entity that enters the theory in an ad hoc manner. Instead, matter should be an additional field component that arises as a specific field configuration.

“We have described some introductory aspects of the holographic principle, and we have shown that it can conceptually be used to understand the intrinsic problems of the field-to-particle transition. In particular, the problem of zero-modes could be investigated by specifying an equivalent theory in a different

space such that the fluctuations of the field become described by fluctuations of an equivalent entity with a finite number of degrees of freedom. This would help to handle the divergences that appear in the zero-modes. As the mathematical tool to formulate correctly the field-to-particle transition and the inherent problem of zero-modes, we propose to use nonlinear sigma models. We have described how harmonic maps allow us to project a theory from a space to a different theory in a different space. Although this procedure is quite arbitrary in general, we see this as an advantage for the formulation of apparently different theories which can then be analyzed under additional restrictions in order to find out their physical equivalence.

As an explicit example for a field-to-particle transition, we have analyzed certain gravitational field configurations by using a phase-like object. It was proven that the physical parameters entering these configurations become discretizated when we demand that the phase-like object be equal on two non homotopic surfaces with a common boundary. Additionally, we saw that these configurations behave under rotations either as bosons or as fermions. No other options are allowed! It is interesting that classical field configurations show the fermionic behavior, a property which is usually associated with quantum systems. The proposals presented in this work are all very rough and have no deep physical explanations. A more detailed investigation will be necessary in order to formulate them in a more consistent manner from the physical and mathematical points of view. They should be interpreted more as a first attempt to formulate questions which bother the authors."

With the greatest respect, the topological gravitational geon showing particle-like properties (theoretically) exists, then so does the photon (in reality) that also has a field/particle duality. The question how to incorporate matter as a non-extrinsic feature is not really a worthwhile pursuit. From the standpoint of this paper, we do not favour any method to 'force' a gravitational configuration into a true particle. That may well provide a method for eventually producing a limitless fuel to power spaceships to the stars, especially if the particles so formed displayed some extraordinary properties, but that would require some manufacturing process in some sort of engine room. In the context of this paper, even though geons remain theoretical at present, one should not too readily depart on a voyage of discovery to find answers to questions that have little bearing on the main issue that topological gravitational fields may well exist, and may well exist freely and in the form of boson stars.

The concept of particle to be derived from quantum field theory is naïve because it possesses intrinsic contradictions. Particles are not required. Quantum field theory is perfectly adequate as a tool without the notion of particles that merely provide a 'nice' way of visualising what is going on, and

that applies equally to the so-called ‘fundamental particles’. Quantum field theory is adequate in itself by its own structure that describes processes and not processes that involve particles. Those lay outside of quantum field theory.

SECTION 3 - DO GEONS EXIST IN TYPES?

Solitons figured much in reference [2] mentioned in the last paper. There are a number of models describing particles as solitons, being stable self-bound concentrations of field energy with much literature. For example, Rosen obtained soliton solutions from the interaction of a complex scalar field and the e-m field. Cooperstock and Rosen obtained soliton solutions by coupling a complex scalar field to both e-m and gravity whilst Wheeler used a different approach for his soliton solutions (geons) and Moroz, Penrose and Tod obtained soliton solutions from the Schrödinger-Newton equations.

R.A. Sones [4] presented a mode similar to that of Cooperstock and Rosen. What differed was the treatment of boundary conditions and the introduction of certain constraints. Cooperstock and Rosen required all fields to be finite and continuous at the center of the particle and they integrated the field equations outwards. Their parameters were adjusted until the asymptotic wave function vanished. The resulting model contained several adjustable parameters. In contrast, Sones imposed asymptotic boundary conditions and integrated the field equations inwards, toward the center of the particle with the requirement that the asymptotically measured mass and charge should equal the mass and charge parameters of the action. Then, the resulting model contained no adjustable parameters. But after calculating the asymptotic behavior of the equations and then imposing asymptotic boundary conditions, a single adjustable parameter remained, being the system electric charge. By again appealing to the principle of stationary action, Somes found that the charge must vanish. Hence, he arrived at an eigensystem with no adjustable parameters. Using numerical methods he calculated the eigenmodes and found five massive particle species without charge or spin that he named ‘quantum geons’ and showed that the spacetime curvature diverges at the center of each geon.

At the Planck scale many physicists expect classical notions of spacetime to fail, a concept conveyed by the phrase (coined by Wheeler) “spacetime foam”. A successful quantum theory of gravity would flesh out the details of spacetime foam and erase the singularities associated with point particles. The geon model developed by Sones suggests a different perspective. Classical spacetime is assumed valid at the Planck scale and point particles are replaced by eigenmodes of a quantum field. Singularities reminiscent of point particles

remain, but they do not disturb the geodesic completeness of spacetime. Multi-particle systems would, presumably, correspond to multiple excitations of the geon field and all particle interactions (including those involving wave-packet reduction), would ultimately derive from the action. In short, the geon perspective replaces the search for a "quantum theory of gravity" with the search for a "gravitational theory of quanta". The geons described are far too massive to correspond to any known particle for they would interact gravitationally with ordinary matter so they appear to be candidates for 'dark matter' but it is not clear whether such models can be successfully incorporated into standard cosmology.

SECTION 4 - ROOT GRAVITY

There exists a long and remarkable paper by B.V. Ivanov [5] parts of which are well worth reproducing. It is argued that static electric or magnetic fields induce Weyl-Majumdar-Papapetrou solutions for the metric of spacetime. Their gravitational acceleration includes a term many orders of magnitude stronger than usual perturbative terms and gives rise to a number of effects that can be detected experimentally. Four electrostatic and four magneto-static examples of physical set-ups with simple symmetries are proposed and the different ways in which mass sources enter and complicate the pure e-m picture are described.

It is not our intention to reproduce this paper but merely to highlight certain points from it. In view of the quoted paragraph above, the following is set out.

In classical Newton-Maxwell physics the e-m fields have no influence upon gravity which is generated by sources of mass. In GR, e-m fields alter the metric of spacetime and induce a gravitational force through their energy-momentum tensor

$$T_\nu^\mu = \frac{1}{4\pi}\left[F^{\mu\alpha}F_{\nu\alpha} - \frac{1}{4}\delta_\nu^\mu F^{\alpha\beta}F_{\alpha\beta} \right] \qquad (1)$$

where $$F_{\mu\nu} = \partial_\mu A_\nu - \partial_\nu A_\mu \qquad (2)$$

is the electromagnetic tensor and A_μ is the four-potential. T_ν^μ enters the r.h.s. of the Einstein equations $R_\nu^\mu = \kappa T_\nu^\mu$ (3)

$$\kappa = \frac{8\pi\ G}{c^4} \qquad (4)$$

The coupled Maxwell equations are

$$F^{\mu\nu}{}_{;\nu} = \frac{1}{\sqrt{g}}\left[\sqrt{-g}F^{\mu\nu}\right]_{\nu} = -\frac{4\pi}{c}J_{\mu} \quad , \qquad J^{\mu} = \sigma\ c\ u^{\mu} \qquad (5)$$

Here g is the metric's determinant and usual derivatives are denoted by subscripts, J^{μ} is the four-current, $u^{\mu} = \frac{dx^{\mu}}{ds}$ is the 4-velocity of the charged particles with charge density σ.

In the paper the problem is investigated whether e-m fields can induce strong enough acceleration, rising above the gravimeter's threshold of 10^{-6}cm/s^2 or even comparable to the mean Earth acceleration g_e = 980.665cm/s^2. Eqs.(3,4) show that the metric will be very near to the flat one without any singularities and faraway from the metric of a black hole. The question is whether the 20 orders of magnitude supplied by $\frac{c^2}{2}$ in Eq.(7) are enough to lift the e-m-gravitational force to that of the Newtonian gravity of very massive bodies.

[Equation 6 omitted}

Mainly electro-vacuum solutions are studied with $\sigma \neq 0$ only on some surface specifying the boundary conditions. The Einstein-Maxwell equations (3,5) show how the e-m field leaves its imprint on the metric, which has to satisfy the Rainich conditions. The gravitational force acting on a test particle is represented by the 4-acceleration but at rest

$$g_{\mu} = \frac{c^2}{2}\left[\ln g_{00}\right]_{\mu} \qquad (7)$$

for an arbitrary metric $g_{\alpha\beta}$. It seems natural to use perturbation theory in the harmonic gauge where

$$g_{\mu\nu} = \eta_{\mu\nu} + h_{\mu\nu} \quad , \qquad \Delta h_{\mu\nu} = -2\kappa T_{\mu\nu} \qquad (8)$$

More concretely, one can ask what is the gravitational acceleration inside a solenoid, the most common device for the creation of magnetic fields. There is an exact global solution when the solenoid is infinitely long. It is comprised from the Melvin geon as an interior and the vacuum Levi-Civita cylindrical

solution as an exterior. The acceleration has only a radial component and when the metric's signature and the scale of the magnetic field is changed correspondingly inside the solenoid

$$g_{(r)} = \frac{c^2\kappa}{16\pi}\frac{rH_0^2}{A^2} \quad , \qquad A = 1 + \frac{\kappa}{32\pi} r^2 H_0^2 \qquad (9)$$

H_0 is the physical magnetic field at the central axis. The acceleration points inwards and reaches its maximum at the solenoid wall.

Let us assume that the metric and the e-m fields do not depend on time. In this stationary case let us further simplify the problem by setting $A_\mu = (\overline{\phi_\mu},\ 0,\ 0,\ 0)$. There is just an electric field

$$E_\mu = F_{0\mu} = -\overline{\phi} \qquad (10)$$

T_V^μ from Eq.(1) contains only quadratic terms in $\overline{\phi_\mu}$. This allows us to hide κ from Eq. (3) by normalizing the electric potential to a dimensionless quantity

$$\phi = \sqrt{\frac{\kappa}{8\pi}}\,\overline{\phi} \qquad (11)$$

The factor 8π is chosen for future convenience and this is a much more elegant way to get rid of the constants in the Einstein-Maxwell equations than the choice of relativistic units c = 1, G = 1.

Imagine now that in some exact solution g_μ is proportional to the electric field, contrary to the quadratic dependence in Eq.(9)

$$g_{(r)} = ac^2\phi_\mu = ac^2\sqrt{\frac{\kappa}{8\pi}}\,\overline{\phi_\mu} \qquad (12)$$

where a is some slowly changing function of order O(1). For example, when a = a (g_{00}) then Eqs.(7,12) lead to the functional dependence f ≡ g_{00} = F (φ). Let us further assume that the spacetime is static. Then the above functional dependence has the unique form

$$f \equiv 1 + B\phi + \phi^2 \qquad (13)$$

In the axially-symmetric case Eq.(13) was found by Weyl and such solutions are known as Weyl fields. The potential in Eq.(11) is very small everywhere and naturally goes to zero at infinity. Then asymptotic flatness fixes the first term

which is otherwise an arbitrary constant. It is also fixed by the requirement to go back to Minkowski spacetime when $\varphi = 0$ since e-m effect on gravity with no masses present is important here. Hence, no gauge transformations $\varphi \rightarrow \varphi + C$ should be made which can eliminate the arbitrary constant B and spoil the behaviour of the metric. If B is 2 and not zero, the linear term in Eq. (13) is really present.

Thus in Weyl-Majumdar-Papapetrou fields we have

$$g_\mu = c^2 f^{-1}\left[\frac{B}{2}\sqrt{\frac{\kappa}{8\pi}\overline{\phi_\mu}} + \frac{\kappa}{8\pi}\overline{\phi\phi_\mu}\right] \qquad (14)$$

The first term is of the type given in Eq.(12), the second resembles the expression in Eq.(9). Let us note that for the actual values of

$$\sqrt{G} = c^2\sqrt{\frac{\kappa}{8\pi}} \quad \text{and} \quad c^2\frac{\kappa}{8\pi} = \frac{G}{c^2}, \qquad (15)$$

due to the square root, the first coefficient is 1023 times bigger than the second. The gravitational fields that have acceleration terms $\sim \sqrt{\kappa}$ are called root gravity. The WMP fields are an example, but there are others too. Thus GR has a Newtonian limit in the case of mass sources, where $g_\mu \sim G$ and a Maxwellian limit in the case of e-m sources, where $g_\mu \sim \sqrt{G}$. Provided that $B \approx 2$ the search for a strong gravitational acceleration induced by e-m fields does not seem so doomed.

When the derivations, proofs and other technicalities are omitted, the summary of the results can be divided into 19 points but only eight of those are recounted here:

1) The gravitational acceleration at rest in Weyl-Majumdar-Papapetrou fields has a root gravity term which is 1023 times bigger than the usual perturbative coefficient It is linear in the e-m-fields while the perturbative term is quadratic. Sizeable gravitational force exists although the metric is very close to the flat Maxwellian limit.

2) In WMP fields the gravitational potential depends directly on the 4-potential of the e-m fields.

3) The energy-momentum tensor (in particular, its energy component) induces a change in the Ricci tensor according to the Einstein equations. This leads to changes in the metric and its acceleration which can be ~ $\sqrt{\kappa}$, and may contain no monopole term.

4) The gravitational force at rest induced by electric and magnetic fields is the same unlike the Lorentz force, acting upon charged particles. The surface sources determine the master potential and not A_μ.

5) There is a 'mass out of charge' mechanism that allows us to obtain solutions with mass and charge from the Weyl solutions. It clearly indicates the part of mass which is of e-m origin and root gravity term remains, but B is affected by the mass. Such solutions can incorporate the mass of the charged surface that is always present in practice.

6) The pure electric plane-symmetric effect on the metric is described by the McVittie solution, which is a Weyl solution of class B = 2. Solutions with mass and charge also contain a root gravity term. There is a coordinate transformation between them and a Weyl axi-symmetric field that changes the plane into a paraboloid.

7) The pure electric spherically-symmetric effect on the metric is described by the charged Curzon solution which is related by a simple transformation to the critically (extremely) charged RN solution. This is a Weyl solution with B = 2. The same is true for prolate and oblate spheroidal solutions. They are singular at the axis, so one can use them as exteriors to a charged spheroidal shell with Minkowski interior. Their gravity becomes repulsive in the whole outside region for one sign of the charge.

8) The pure electric cylindrically-symmetric effect on the metric is regular outside the shell. In non-regular form it was first given by Bonnor and is the electric counterpart of the limiting VanStockum stationary solution. Once again, B = 2. The 'mass out of charge' mechanism leads to the vacuum LC solution.

The discussion opens with "It is hardly believable that such an important property of WMP fields as root gravity has been overlooked in the past. If we consider the work of Reissner as implicitly pioneering, WMP solutions date back to 1916, the year of the Schwarzschild solution. In the past 88 years the subject has been explored pretty thoroughly as can be seen from the number of references. Only in the first half of the previous century root gravity could have been discovered 8 times: by Reissner, Weyl, Nordström, Kar, McVittie, Mukherji, Papapetrou, and Majumdar [references omitted]. There were plenty of opportunities later too. In the same time certain spherically-symmetric

perfect fluid solutions have been rediscovered up to 7 times." That author then goes on to give possible reasons for those oversights. Then, "We use, however, fields which are common and satisfy all energy conditions and not exotic matter or the Kasimir effect… we try to induce gravitational force without altering very much the metric. This is possible thanks to the 20 orders of magnitude collected… We have demonstrated that except the Newtonian limit, general relativity possesses also a Maxwellian limit."

SECTION 5 - THE 5-D BULK

Let us now obtain a comprehensive perspective of what has gone before. Matter and field are basic concepts of classical field theories and are central in GR where the Einstein field equation connects the geometry of spacetime and matter, such that a given distribution of matter sources determine the geometric properties of spacetime. That can be regarded as the creation of spacetime geometry by matter, and in the opposite direction, the creation of matter by geometry.

If that last proposition is true, either we can regard matter as a specific configuration of spacetime or we can regard spacetime as a specific configuration of matter. One is then forced to ask what of regions within the universe where matter density is so small as to be negligible or even vanishingly small? If we were to assume that every unit volume (such as one cubic kiloparsec) of such a region contains one hydrogen atom, we are forced into saying that this unit volume has only sufficient geometry to produce that hydrogen atom. If that geometry is expended on hydrogen production, can it be said that there is no 'remainder' to maintain spacetime within that volume? If so, such a volume may assume the characteristics of the 'Genesis Void' set out in reference [2] in the previous paper. If that were to occur, the differential pressure between that and surrounding volumes would fill the void. The consequence would be that there cannot exist parts of the universe devoid of spacetime and its associated matter.

The converse of the above is standard GR. In a unit volume of the universe with matter abundance, the matter dictates how spacetime curves and spacetime dictates how matter moves. Of course, for creation theories, the 'which came first' question takes on relevance. Of the many questions we could ask, it seems to us that two of the most important are these: for field to transform to matter or vice versa, is some 'trigger' required, either intrinsic or extrinsic? The second question is do workers assume that field and matter transform predominantly in one direction, so ignoring the equality in Einstein's field equation?

What brings matter into existence is a question worked upon for at least the last sixty years. Wheeler introduced the concept of electromagnetic geons. Wheeler and Power introduced the thermal geon. Geons were included by Misner and Wheeler in their 'Geometrodynamics'. G.'t Hooft showed that in gauge theories in which the e-m group is a subgroup of a larger group, massive magnetic monopoles can be created as regular solutions of the field equations. Gross and Perry found in 5-D Kaluza-Klein theory regular static and stable soliton solutions corresponded upon quantization to particles. In classical gauge theories, where the e-m or the Yang-Mills field arises from connections on U(1) or SU(2), the gravitational field arises on the GL(4) principal frame bundle over {M}.

One can adopt the standpoint that all non-gravitational fields should uniquely determine the gravitational field and its mass. H. Dehnen et al. produced a theory based on a unitary phase gauge invariance of the Lagrangian, where the gauge transformations are those of SU(2) x U(1) symmetry of the two spinors and recovered GR. C. S. Bohum and F. I. Cooperstock used the Lagrangian of quantum electrodynamics and obtained the stationary Dirac equation and the Poisson equation. These equations lead to a Dirac-Maxwell soliton with the mass and charge of the electron. Classical models of elementary particles were presented by O. Zaslavskii built up by gluing the Reissner-Nordstrøm metric (or the Kerr– Newman black hole) to a static (or rotating) Bertotti-Robinson core.

According to classical GR, the most attractive scenario would be creation of massive matter by geometry. However, it was shown by Cooperstock et al. that no gravitational geon can exist in GR based on Riemannian geometry and on that basis, to get matter creation by geometry, a more general framework than the 4-D Riemannian one is required.

Wesson's theory involves physical matter of the 4-D spacetime created by the geometry of a 5-D bulk. Basic concepts and approaches of this theory as well as applications to cosmology have been developed by Liko, Lim, Liu, Overduin, Ponce de Leon, Seahra and Wesson, involving the proof of the geometric origin of matter, involving successful cosmological models with a variable cosmological constant, dark matter and accelerated universes. Wesson's framework includes an induced unified theory of gravitation and e-m.

Comparing Wesson's IMT with the Weyl-Dirac theory, there exist similar results. Both theories allow matter from geometry as well as singularity-free cosmological models. In both theories, Wesson's IMT and the Integrable W-D theory; dark matter and quintessence follow from geometry. Both frameworks provide a unified, geometrically based description of gravity and e-m and the

Weyl-Dirac theory and Kaluza-Klein theory originate from attempts to build unified theories of classical fields.

As Riemannian geometry is inapplicable to maintain any gravitational geon, the 5-D bulk should be described by Weyl's geometry. M. Israelit [6] states "The foundations of Wesson's Induced Matter Theory are analyzed. It is shown that the empty, - without matter, - 5-dimensional bulk must be regarded as a Weylian space rather than as a Riemannian one. Revising the geometry of the bulk, we have assumed that a Weylian connection vector and a gauge function exist in addition to the metric tensor. The framework of a Weyl-Dirac version of Wesson's theory is elaborated and discussed. In the 4-dimensional hypersurface (brane), one obtains equations describing both fields, the gravitational and the electromagnetic. The result is a geometrically based unified theory of gravitation and electromagnetism with mass and current induced by the bulk. In special cases one obtains on the brane the equations of Einstein-Maxwell, or these of the original Induced Matter Theory."

SECTION 6 – LIVING IN A 5-D UNIVERSE

Our physical senses are incapable of visualising 5-D and therefore, we will not attempt to 'paint pictures' for such are more likely to confuse than clarify. Nevertheless, if a fifth dimension is accepted without asking 'where is it?', 'what does it look like?' and 'who lives there?', some progress can be made. Here, we express ourselves in terms that border on the naïve merely to add emphasis and add some sort of 'picture'.

The conventional approach envisages a 5-D bulk in which there is embedded a 4-D part that we are capable of appreciating. The variety of theories dealing with that do not matter here. If such were true, a theory such as the modified Kaluza-Klein and that of Wesson could run like this. Travel out to the interface of the 5-D bulk and the 4-D embedded part and just over the border you will find that e-m and gravity are unified with the induced creation of matter from 5-D spacetime. In this visualization, there is a 4-D/5-D interface that dictates that only in the radion of a theory such as that of Randall and Sundrum and the Ekpyrotic theory can everything work using 5-D. However, back in the 4-D universe, we poor mortals are confined to puzzling GR, mathematically twisting and turning to bring about on paper what would be easily achievable if we had the appropriate means of transport.

The alternative is to attempt to unify gravity and e-m and to say that the universe about us is 4-D embedded in a 5-D bulk. The difference now is that the

5-D bulk is not some volume extrinsic to our 4-D space but permeates our 4-D space at all energy levels. Yet another alternative is to deny the separate existence of 4-D space and say that we live in a 5-D spacetime continuum where we perceive only four of those coordinates. Whichever, there is little difference between them and we regard both propositions in this paragraph as having equal merit except when dealing with creation.

For convenience, the conventional terminology of '5-D bulk' and '4-D universe' will be used but in the context only of the last paragraph. Once we say that the bulk is part of our universe and is intimately related with it, can we identify e-m separate from gravity and separate from the scalar field? In other words, does Kaluza-Klein theory tell us merely how to identify these things from a 5-D bulk or does that theory tell us that if we to put a bucket on the kitchen table and pour in some e-m, some gravity and a scalar field and give them a good stir, we would then have a quantity of 5-space?

This has been answered (in the negative) in [7]. "The scalar field is also independent of the EM and gravitational fields, and exists in the bulk where the primary fields are absent. Its function could be to bind particles located on the 4-D matter brane with anti-particles located on the 4-D antimatter brane. A potentially important clarification of Kaluza's theory is the observation that the velocity c_5 is not the velocity of charged source particles, but rather a property of the 5-D bulk ("vacuum"), analogous to the velocity of light. As such, it characterizes the propagation of massless scalar bosons in the bulk. Unfortunately, the sectorial formulation presented here does not predict the value of c_5, nor that of the interbrane distance d_5. It seems likely that these two values are related. The velocity c_5 could be either subluminal or superluminal, since the manifestations of the scalar force are not directly perceptible to observers residing on the brane, provided the interbrane distance d_5 is small enough."

The answer to our naïve question is, one does not obtain the 5-D bulk from 4-D spacetime ingredients. If that is so, and we have no reason to doubt the mathematics used in [7], and the 5-D bulk is not extrinsic to our 4-D universe, one seems compelled to ask again whether we actually live in a 5-D universe without a separate 4-D continuum.

Spherically symmetric entities filled with matter and induced by the 5-D bulk may be built in empty 4-D space-time. The substance of the entity regarded as a fundamental particle, is characterized by a pre-matter equation of state. The particle is covered in a Schwarzschild-like envelope and from the outside it is characterized by mass and radius. One can regard these entities as neutral fundamental particles being constituents of quarks and leptons. The presented

classical models are developed in the framework of the Weyl-Dirac version of Wesson's Induced Matter Theory [8]. In reference [9], the same author goes on to consider the formation of charged particles.

SECTION 7 – WHAT COULD BE THE 5th?

From general considerations, energy can be treated as a dynamical variable. If a process is being considered, its behaviour will be characterized by its energy range and we require that behaviour to be known. The metric coefficients are the appropriate tools in that respect. Add water to sodium hydroxide and the reaction is at once exothermic. That energy release cannot be changed for given amounts of water and NaOH. Therefore, the energy there is a parameter for that reaction. Broadly, energy can be a parameter or a dynamical variable.

Let us retrace steps back to a very basic standpoint. Travel far out into the universe and then, from a very, very great distance observe a quantity of 4-space in its 'undisturbed' condition, 'A'. We then approach 'A' and throw a net around it and haul it aboard. The very act of introducing proximate matter changes the geometry of 'A' into 'B'. The process described results in the geometry of 'B' being fixed by the metric coefficients that correspond to the values of the energy involved in that capture and confinement process. That says any fixed amount of energy fixes the structure of spacetime ('B') in the region of the interaction process and for any other process at its specific energy level or content. From the point of view of geometry, if 'A' were 4-space, the introduction of extrinsic energy to produce 'B' means that 'B' is (4-space + energy), a 5-D space. The consequence is that energy is just a geometrical entity.

We do not have to travel far into space to encounter the real world for here energy is geometric and bound to the geometric structure of everything in the physical world. The 5-D metric tensor will be a function of energy and any methodology whereby 4-space as one entity is embedded into 5-space as another entity appears to be a misdirection, for the simple reason that in the physical universe there is no such thing as a quantity of undisturbed spacetime.

An alternative to the above is Wesson's proposal that rest mass is the 5^{th} dimension. Rest mass is an invariant whereas energy is a dynamical variable. When various types of interactions are considered, they occur locally and not globally. If rest mass were to be the 5^{th} coordinate, for specific particles the same interaction would occur in exactly the same way throughout the universe because their rest masses are invariant. Using energy as the 5^{th} coordinate

permits different interactions between particles in all parts of the universe depending upon the prevailing conditions. That is self evident when one considers, amongst a myriad of other examples, proton-proton reactions in the core of the Sun and what happens between two protons at room temperature. Therefore, whilst rest mass as the 5^{th} coordinate is a local proposition, energy as the same is a global one. Nevertheless, what clearly emerges is that every metric coefficient depends on the 5^{th} dimension, unlike in the original Kaluza-Klein theory.

The Puff Field Theory and the Deformed Special Relativity theories are fairly recent and deserve to be mentioned. The Melvin Universe is an exact solution of Einstein gravity coupled with gauge fields and describes a consistent gravitational back-reaction when one attempts to support a uniform magnetic field in the background. Melvin Universes are natural in the context of Kaluza-Klein theory in which an angular coordinate is twisted so that in the spacetime, a plane has the following form in cylindrical coordinates:

$$ds^2 = dx^2 + dr^2 + r^2(d\varphi + \eta dz)^2 + dz^2 - dt^2$$

Here $z \approx z + 2\pi R$ is periodic, and η therefore cannot be trivially eliminated by a change of coordinates because redefining $\varphi \to \varphi + \eta z$ would modify the periodicity conditions on z and φ. For η = 0, the space reduces to flat space in (4+1)-D along the z-coordinate and gives rise to a spacetime with a background magnetic field and some background scalar field configuration. In [10] it was shown that the PF theory is decoupled from gravity with finite entropy and therefore a discrete spectrum under appropriate conditions.

Cardone and Mignani developed Deformed Special Relativity being a generalization of Special Relativity. The theory is explained in [11] as a new Kaluza-Klein-like scheme based on a 5-D space in which the 4-D spacetime metric is deformed such that it depends on energy and energy plays the role of the fifth dimension. They review the solutions of the 5-D Einstein equations in vacuum and the geodetic equations in some cases of physical relevance. The Killing symmetries of the theory for the energy-dependent metrics corresponding to the four fundamental interactions (electromagnetic, weak, strong and gravitational).

REFERENCES

[1] Kaup (1968) Phys. Rev. 172. 1331.
[2] (2004) gr-qc 0311075v2.
[3] Cortez, Patiño and Quevedo (2005) gr-qc 0501036v1.
[4] (2005) gr-qc 0506011v1.
[5] (2004) gr-qc 0407048v1.
[6] (2007) gr-qc 0710.3690.
[7] Sewards (2008) hep-th 0809.1600.
[8] Israelit (2007) gr-qc 0710.3410.
[9] Israelit (2007) gr-qc 0710.3923.
[10] Ganor, Hashimoto, Jue, Kim and Ndirango (2007) hep-th 0702030v1
[11] Cardone, Marranic and Mignani (2005) hep-th 0505149v1.

III – BIO-ELECTROMAGNETISM

(Third in a series of three papers)

(10th September 2009)

Alan Baldwin

For the pleasure of …..

ABSTRACT

In this third paper of the series, fundamental notions concerning bio-electromagnetism are set out.

INTRODUCTION

Experiments have been conducted to explore the possibility of a quantum physics-biology interrelationship. The first utilised pairs of human subjects in Faraday cages where just one of the pair was subjected to photostimulation. Possible electroencephalographic (EEG) correlations between human brains were investigated (in 1994). Later experiments have been carried out by Standish, Richards et al, Standish et al. and Wackermann et al. Experiments have also been conducted that have revealed evidence of correlated functional magnetic resonance imaging (fMRI) signals between human brains by Standish et al. These correlations occurred whilst one subject was being photostimulated and the other subject was having an fMRI scan performed. Research utilizing pairs of 2 cm diameter. basins containing human neurons on printed circuit boards inside Faraday cages separated by 20 cm. have been conducted at Milan University. Laser stimulation of one of the basins revealed consistent wave-form autocorrelations between stimulated and non-stimulated basins. In addition, there are indications that biological quantum non-locality has been observed in the coherence of induced magnetic dipoles involved in muscle contraction in single actin filaments at the mesoscopic level, (Matsuno, Hatori et al) and that cell motility underlying muscle contractions is accompanied by a quantum mechanical coherence on a macroscopic scale (Matsuno). Collectively, these experiments point in the direction implying entanglement and non-locality [1].

In [1], it is pointed out that the research group at the University of Freiburg, dealing with the human subjects, stress that “while no biophysical mechanism is presently known that could be responsible for the observed correlations between EEGs of two separated subjects, nothing in our results substantiates the hypothesis…of a direct quantum physical origin of correlations between EEGs of separated subjects”. The researchers at the University of Milan state that, “Despite at this level of understanding, it is impossible to tell if the origin of this nonlocality is a genuine quantum effect, our experimental data seem to strongly suggest that biological systems present nonlocal properties not explainable by classical models”.

To end this scant introduction, we ask whether humans (and other animals?) are merely entities that are subject to known physics or as yet undiscovered physics. The alternative is to ask whether humans have been placed in some sort of privileged position and that will be dealt with in the Section 3. For now, we attempt to shed some light on the work set out above.

SECTION 2 – CAUSALITY AND MORE

An elegant paper by Oleinik [2] is worth considering in detail. Part of the abstract reads, "…Maxwell's equations for [an] electromagnetic field interacting with electric charges and currents in a vacuum, without resort to any additional hypothesis…[results in a transformation of]…a special physical medium…capable of…[instantaneous]…transfer…[of a signal]…about any changes…to arbitrary large distances." Oleinik points to many published works where group velocity was found to be superluminal (by experiment) and superluminal transfer of information can be induced in artificially created media with negative dielectric and magnetic susceptibilities (metamaterials).

Non-homogeneous wave equations that describe e-m fields show that the field has two components. One is the photon itself. The other is the field of electrically charged particles that cannot be separated from those particles (being a field of standing waves of matter), cannot be reduced to a stream of photons and has no wave-particle duality. It is that field that transforms the environment into a physical medium capable of instantaneously transferring signals, usually without energy and momentum transfer from the signal generator to the receiver. Instantaneous long-range communications and short-range interactions at light speed can simultaneously co-exist. Oleinik cites at least three other workers who have confirmed superluminal signals and action at a distance from astronomical observations. The mechanism for superluminal communication is due to non-local connection between scalar and vector potentials of E and B, not the fields. With a change in potentials there is a shift in the wave function phases of charged particles. The basis is the Aharanov-Bohm effect. Oleinik quotes Lochak, "this remarkable effect, which proves the existence of a fieldless magnetic potential on electron waves, is shocking for those who have been convinced for a century that electromagnetic potentials are only mathematical intermediate entities." Oleinik sets out his conclusions. These are:

"…superluminal signals and their physical carrier as a special physical medium are derived from the equations of [the] electromagnetic field…

…the field…plays the role of an information field…instantly endowed with information...

…there is no gauge of potentials which would allow one to get rid of superluminal signals…
…the occurrence of superluminal signals can be seen from the above to be associated with the spacetime symmetry breaking of a special sort…"

In showing that the field of potentials is an information field, calculations proceed from standard Maxwell equations with the usual solutions. Using the constraint that ε is a real parameter, with the usual notation,

$$\varepsilon \frac{\partial \varphi}{\partial t} + \nabla \mathrm{A} = 0.$$

When ε = 0, that is the Coulomb gauge and when ε = 1, that is the Lorentz gauge. Therefore, the equation is a generalized gauge that is the basis for ultimately establishing the relationship between e-m field potentials A and φ to **E** and **B** locally and non-locally, both in space and time. That defines the field of potentials at a point at an instant of time, $A^{(\varepsilon)}(x)$. Once a region reduces to the point x, information from the **E** and **B** fields is transferred at a velocity $\frac{c}{\sqrt{\varepsilon}}$ and even if the **E** and **B** fields are absent, $A^{(\varepsilon)}(x) \neq 0$. It then follows that under those circumstances the field of potentials $A^{(\varepsilon)}(x)$ (the information field) can transfer information from one point in 4-space to another without transferring any physical quantity determined by the **E** and **B** fields.

To determine the velocity of information propagation, one of the modified Maxwell equations are used, split into two independent equations to describe a potential component, $\mathrm{A}_{||}$, and a vortex component, $\mathrm{A}_{\perp}$ that can be dealt with by Maxwell's equations using the same components of **E** and **j** . The same is done for A and it was found that $\mathrm{A}_{\perp}{}^{(\varepsilon)}(x)$ is independent of ε. Then, the equations show that although **j**(x) for a point-like is localized at some point in space, its potential and vortex components are distributed over the whole space. "This means that it is impossible to attribute a finite velocity of propagation in space to the physical fields…" of the $\mathrm{A}_{\perp}(x)$ and $\mathrm{A}_{||}{}^{(\varepsilon)}(x)$ components. "Because of the fact that the current density components are distributed over all space, the latter are instantly endowed with information about any physical process in which the point-like particle participates. In the Lorentz gauge, the field of potentials and field strengths of **E** and **B** propagate at c. When information is propagated without transfer of energy and momentum, the velocity of propagation lays between 0 and ∞. Once real electromagnetic interactions are considered by taking into account the back action of a particle's own field, particles cease to be point-like and there is no gauge of potentials that can be used to eliminate superluminal signals.

The potential field, $E_{||}$, is found to be generated by electrically charged particles and cannot exist in their absence and so is not just a degree of freedom of the e-m field.

The equations for potentials are not relativistically invariant whereas Maxwell's equations for field strengths are Lorentz invariant. Nevertheless there is a breaking of spacetime symmetry of the fields of potentials that is masked by the Lorentz gauge and superluminal speeds are masked by the demand that everything be relativistically invariant. The use of electric charges treated as point particles also masks superluminality because in standard perturbation theory, contributions to the 4-potential from superluminal excitations mutually cancel out so that the evidence of superluminality is removed.

The main technical obstacles in modeling particles as topological structures of space are the theorems of Tipler and Geroch. From the viewpoint of classical GR, if that modeling is to be performed, the exceptions to Geroch's theorem need to be lack of time orientation, the existence of closed time-like curves and singularities. The singularity is inconsistent with 4-space being a manifold but Sorkin has suggested a reformulated GR in order to allow singularities and their topological aspects. Negative energy is required to circumvent Tipler's theorem and so allow closed time-like curves. As regards time orientation, there needs to be 'flexibility' in time lines.

We remark that Oleinik took no account of the zero-point field in his paper.

Hadley [3] has shown that quantum theory results from acausal spacetime and acausal spacetime is context dependent. Thus for closed time-like curves, no boundary can be ascribed to a surface without first knowing the future conditions.

Jennings [4] elegantly modified Kaluza-Klein theory to deduce particle dynamics. His abstract reads "…propagation at the speed of light…confined to a small volume, forming a particle with rest mass….[4-spacetime] coordinates locate the confinement volume…[and the]…fifth coordinate is replaced by an internal degree of freedom. Electromagnetism corresponds to a gauge field…Self-gravity might create the confinement…but the particle would have a Planck mass…[that could be]… made much closer to the masses of observed particles if gravity were allowed to increase in strength within the confinement volume."

Setting the KK 5-D spacetime interval to zero gives, with summation in operation

$$g_{\mu\nu}dx^{\nu}dx^{\mu} = \alpha^2\left(dx_0 + \beta A_{\mu}dx^{\mu}\right)^2 \ , \quad \mu,\nu = 0, 1, 2, 3.$$

The lhs is the 4-D invariant spacetime metric and the lightcone retains unification of gravity and electromagnetism. If x^{μ} locates a particle in 4-D, the rhs = ds^2 , being a scalar displacement that remains when the particle is at rest, so describing an extra part of the particle motion not observable in 3-D. The extra degree of freedom is x_0. Now, physical propagation can be viewed as being on a light cone in 5-D spacetime and dx_0 is the 4-D invariant ds as well as an internal spatial interval, not an extra dimension. In fact, for these purposes, an extra dimension is not needed. 4-D Relativity is then a theory of motion in which the total velocity is c but some portion of velocity is hidden and internally captured. When the internal speed is non-zero, the external 3-D speed of the particle is less than c and the particle has a rest mass. If the particle could be entirely at rest in 3-D space, its internal speed would be c. If the internal speed is zero, the particle moves at c in 3-D space. In the presence of fields, there is just one speed of propagation at each spacetime location.

Gravity seems to be the best candidate responsible for the internal confinement field because if strong enough, GR shows that it can curve the speed of light propagation of a sufficient amount of energy into a closed orbit – Wheeler's geon. Therefore, "internal propagation takes place in a volume of tightly curved spacetime formed gravitationally by the trapped energy itself." Such a quantum object has specific features.

For a Schwarzschild-like geon, orbital radius is $r = \dfrac{kGm}{c^2}$ and stability will be assured when $r = \dfrac{\hbar}{mc}$, hence m = 10^{-5} g when there is overall stability, k = 10 and r = 10^{-33} cm. More realistic particle properties can be achieved by making G larger by a factor of 10^{38} within the particle but retaining its usual value outside the particle. In effect, that would bring the internal gravity in line with the other three forces.

Geons are capable of violating canonical spin-statistics and even at low energies, new physical effects are expected, including CPT violations. The reason for that is in the proof of the CPT theorem, tensorial fields are commutative whereas fermionic fields are anti-commutative. In the presence of geons, those parameters do not hold and CPT is capable of failure.

If CPT is capable of failure, as has been well documented, spacetime cannot be 3-space merely with the addition of time and because spacetime is an active participant in interactions, time cannot be a 'passive bystander'. Such a notion

was investigated by Oleinik, Borimsky and Arepjev [5]. They showed that "…the course of time along the trajectory of motion of a particle in the inertial reference frames moving relative to each other depends on the state of motion of the particle under the influence of a force field…[this]… follows[s] from relativistic equations of motion." With a " …point particle… the change[s] in the course of time results in the appearance of an additional force acting on the particle…" and time has a dynamical nature.

Oleinik [6] further explains that the non-relativistic approximation for the motion of a particle in a uniform electric (gravitational) field is

$$\frac{dt_A}{dt_B} = 1 + \frac{\left(\frac{F}{m}\right)^2}{2c^2}\left(t_A^2 - t_B^2\right)$$

for the relative course of time between points A and B that lay on the trajectory of motion of the particle.

Turning from CPT failure to the energy conditions of scalar fields, Barceló and Visser [7] described the different possibilities whereby a simple, classical scalar field theory is capable of violating energy conditions. They demonstrated that "…a non-minimally coupled scalar field with a positive curvature coupling can easily violate all the standard energy conditions, up to and including the averaged null energy condition…suggesting the possible existence of traversable wormholes supported by these non-minimally coupled scalars…[with fields that must reach]… trans-Planckian values somewhere in the geometry…[and]… are compatible with all known experimental constraints from both particle physics and gravity".

Olum [8] defines superluminal travel as requiring "…the path to be traveled to a destination surface…[reaches that surface]…at an earlier time than any neighboring path". He gives an example of a metric that is just flat space but nevertheless allows superluminal travel in accordance with that definition. Olum proves that such travel requires a violation of the weak energy condition.

A simpler explanation for the experimental results found in [1] are to be found in Section 6 of this paper. It can be said that overlapping e-m fields could provide the answer.

SECTION 3 – THE ANTHROPIC PRINCIPLE

If a theory is adjusted to coincide with observations, that is done by fine-tuning the parameters. Ideally, the mechanism responsible for adjusting those parameters to take on appropriate specific values should be known. If no such mechanism is known, at best it indicates that part of the 'jig-saw puzzle' is missing and a natural solution should fill the gap until that mechanism is discovered.

The original anthropic principle was suggested as early as 1903 and evolved so that account should be taken of our presence in the universe when we observe it. Our own limitations as humans necessarily limits our perceptions and therefore the type of universe that we are able to observe. The anthropic principle has been extended to require that the universe be capable of supporting intelligent life. That extension involves fine-tuning the fundamental parameters in various theories for the universe and from those, select models in which intelligent life, usually human, can survive. It is then concluded that our universe is that one sufficiently fine-tuned to support life. The parameters that seem to be fine-tuned by nature are, inter alia, fundamental forces, the so-called fundamental constants and their inter-relationships.

The idea that our universe may not be the only one was expressed in the many-worlds interpretation of Everett in 1957 to attempt to explain dynamical evolution in accordance with Schrödinger's equation and the collapse of the wave packet that leads to a unique measurement when the quantum state is a superposition of the corresponding eigenstates. In the framework of Everett, Schrödinger evolution is the correct interpretation and every possible outcome of an experimental measurement is simultaneously realized in different parallel universes.

It has been said by Dicke [9] that if the universe were ten times younger or ten times older than it is, either nucleosynthesis of carbon would not have had time to build or, main sequence stars and planetary systems would no longer be stable. Also, the density of matter in the universe must be exactly that to stop the universe from collapsing.

Weinberg [10] noted that the cosmological constant is some 120 orders of magnitude smaller than theoretically predicted and if it were just ten times its present value, the universe would have undergone such inflation that no stars would have formed. Therefore, we live in a privileged era in a privileged location.

Earthly life depends on water but no water would have formed because in the early universe, free hydrogen would have converted to helium had there been a small increase in the strong nuclear force brought about by the fine structure constant having a different value from that familiar to us. In fact, the values of the four forces are critical for Earthly life to develop. Hoyle showed that for carbon based life forms, the carbon-12 nucleus has an excited resonance state at 7.6×10^6 eV without which carbon-12 could not exist [11].

Originally, the description 'anthropic principle' referred to two separate but connected ideas. The name was coined by Carter at the 1973 Kraków Symposium, explaining that the 'weak' principle refers to privileged spacetime locations in the universe and the 'strong' principle referring to the fundamental fine-tuned physical parameters.

At this point, the reader can be forgiven for asking 'why are we here?' We are here because the universe has parameters that are conducive to our form of life because of certain numerical relationships existing between them. If they were not so conducive, either we would not be here or, we would or would not be somewhere else now or at some other time. If we were not here, we would not be able to measure those parameters. Because we are here, we can measure them and conclude that our part of the universe is privileged and so are we.

That appears to be a circuitous argument. We are here because the universe allows us to be here and the universe allows us to be here because we can measure its reasons why it allows us to be here – and, there are plenty of places in the universe we could be if we were not here. But are there? Arguments run like that of Wallace [12]. We live on a planet distanced from a main-sequence star that has around four billion years of life left in it before it starts to change in its old age. That distance is so perfectly adjusted that this planet is neither too hot nor too cold and is perfect for us. We are carbon-12 based plus water that has been allowed to form by a perfect balance of the four forces. Gravity is just right for us, the atmospheric gas mixture perfectly supports respiration and our planet protects us from harmful radiation. Now consider another location.

We live on a free planet very far from the centre of the galaxy that does not orbit any star. We are blessed by a perfect temperature of one hundred degrees above that of space itself from the internal heat of our world. Our atmosphere has the perfect mixture of carbon disulphide and hydrogen to sustain us and the gravity of our world is responsible for our very attractive flat appearance.

If those hypothetical creatures are also in a privileged location at a privileged era, there are two such locations in the same era with widely differing conditions. Is one location preferred by the universe or both? In other words, if

life can form in the universe, it will come into existence no matter what. Why assume that only carbon-water based life is allowed and only in circumstances where the water neither freezes nor boils? The answer is that on one hand, if a local part of the universe allows only our type of life forms, if life exists elsewhere, it must be like us and the Drake equation provides an estimate for the probability of other intelligent life. On the other hand, if life will appear in whatever form it takes according to the local environment, we are in no privileged position. More so if we were to agree that the purpose of the universe is to create and sustain life to make observations.

Contemplate a time billions of years ago when the first (hypothetical) civilization was ‘sponsored’ by the universe to make observations. Those creatures became extinct (a fact pre-known to the universe) and so the universe had taken adequate precautions to ‘sponsor’ another civilisation of intelligent creatures, and so on until we are the present incumbents of the duty to make observations in order to preserve the existence of the universe. When we disappear, the universe will have already made plans for yet another civilization. Such a suggestion endows the universe with foresight and the ability to think.

Carter offered two possibilities. One universe with life-supporting parameters and because we exist we can make predictions based on those parameters. Alternatively, there is a large or infinite collection of universes (a multiverse) where those parameters are either like ours or not. The strong anthropic principle now becomes a selection procedure. Choose a universe where the physical parameters are exactly like ours and that is the one we live in.

The anthropic principle has since been extended by Barrow and Tipler [13] to cover ideas a little different from that of Carter. Here, the weak principle becomes the universe must be old enough for all those parameters to take values at suitable locations where carbon-water life forms can evolve. Those parameters include dimensionality, fundamental physical constants and the cosmological constant. Their strong principle is that the universe must have properties that must, at some time, allow life to develop. For these propositions, there are three possibilities:

1. observers are required as a physical necessity to bring our universe into being, a similar idea having been banded about in quantum theory for some time concerning a cat and a box,
2. there is only one possible universe whose function is to bring observers into existence and sustain them and,

3. for our particular universe to exist, there has to be a collection of other universes with different physics because of different parameters because of different initial conditions.

With respect to Barrow and Tipler, as we know, the universe is quite large. It is about true to say that the Earth is a smallish planet orbiting one average middle-aged star of at least four hundred thousand million stars, two-thirds from the centre of our particular galaxy. There are about as many other galaxies as there are stars in our galaxy, and that is just the observable universe. In comparison, we are less than a speck of unimportant dust. Why then should the function of the universe be to produce us or any other form of life? Any semantic argument designed to distinguish 'us' from 'intelligent observers' is a difference that makes no difference unless it is being said that the intelligent observers contemplated are not human. If that were the case, why should those non-humans be so privileged? Extend the argument. One totally inhabited galaxy does not alter the scale of things, there being at least four hundred thousand million other galaxies that are not colonised. Even if every planet of every star in every galaxy were inhabited, an almost infinite number of observers would be unable to sustain the existence of the universe at a time before galaxies formed.

Of course, the principle has appeal to those who say that the universe was designed for us by a designer and that takes us into the realms of philosophy and the scriptures. Nevertheless, the universe by design aspect directly conflicts with the alternative that contemplates fine tuning until we say that the 'fine-tuner' was, in fact, the 'designer'. Whilst much has been published supporting and criticising those first two alternatives, from the point of view of physics, we find them to be sterile semantic arguments, incapable of scientific proof with no means to distinguish a universe that just happens to be that way from a universe that was specifically made for the purpose or came into being with a specific function.

In any case, and tritely, a little thought shows that the universe is largely an environment hostile to our form of life and we do not hold it as a truism that life anywhere will adapt to physics, but do support the proposition that life will adapt to the physics of most environments on our planet.

Some workers talk of falsifiable theories. The 'scientific approach' requires trained experts to reconcile their disagreements concerning a theory by rational argument using agreed evidence. The scientific approach works only if the theory is falsifiable. Any theory is falsifiable if it yields predictions that can be checked by practical experiments and those experiments show that the theory applies to nature or it does not. If a theory predicts something and experiment

confirms that prediction, by itself, that does not validate the theory. If the prediction is not substantiated by experiment, that shows the theory to be false. Once a theory is not falsifiable, experts are unlikely to resolve their differences. Suffice to say that a falsifiable theory is good but a non-falsifiable theory is bad. Any theory should have falsifiable predictions, and therefore there can be no pre-specifications to make any universe agree with what we see. General laws should dictate some mechanism whereby universes evolve and two such mechanisms have been investigated for the production of a multiverse.

Inflation involves sub-Planck scale energy density being dominated by a large vacuum energy in the early universe. The vacuum energy causes the universe to expand exponentially with inflation ceasing when a local minimum vacuum potential is attained. At that minimum, vacuum energy is converted to thermal energy that could be responsible for the cosmic microwave background radiation. Whatever the probabilities of inflation happening, once inflationary conditions exist, some models show repetitive inflation because quantum fluctuations cause the scalar field to fluctuate up the potential. The result is inflation in one region ending but continuing in another region, called eternal inflation because there are always regions inflating. Once conditions alter and inflation stops, there is a large number or even an infinite number of regions resembling universes. Here, each universe has the same ancestor being the primordial vacuum and cannot produce any daughter universes. Unlike the next process to be considered, eternal inflation cannot be observed because it occurs outside of our past horizon. Additionally, inflationary models can be constructed where no eternal inflation can occur. Some predictions of early universe inflation have been observed but there is no a priori method to distinguish between models that do and do not produce eternal inflation. No experimental evidence exists because the energy involved is somewhere between GUT scale and Planck scale.

Theoretically, stellar collapse capable of forming a black hole results in infinite spacetime curvature but quantum effects can act to remove infinities by demanding that density and curvature terminate at Planck scale by the interaction of quantum gravity. Then, quantum gravity reverses the collapse so that the collapsing matter expands in a region of spacetime that forms a new universe. However, the original horizon of the black hole that nearly produced infinite curvature still exists. That means no light from the new expanding universe can reach us. Such a process is called a bounce and our universe could be a bounce from a black hole in another universe as well as massive stars in our universe collapsing and bouncing to form new universes. These propositions have been confirmed by semi-classical calculations, in string theory and in the attempted formulation of quantum gravity [14].

Practically, there is much observational evidence that galactic nuclei possess black holes and black holes are likely in supernova remnants from accretion disc X-ray radiation measurements. Importantly, the energy scale involved is that of ordinary physics If this description is accurate, our universe has a past in the sense of a 'before' the Big Bang. It would also mean that our universe is embedded in another which could be embedded in another, and so on. It is estimated that our universe had or still has about 10^{18} black holes, each of which can form a daughter universe.

It is asked whether what has been so described forms a genuine scientific hypothesis considering that there has been much written on the topic. If you were told that a new energy field has been discovered from a solution to General Relativity and confirmed by a deep analysis of Maxwell's equations, the probability is high that you would believe. Here, the information is that multiple universes are possible from two (and possibly other) theoretical mechanisms but those universes cannot be seen, touched or measured. Belief is acceptance without proof. General Relativity and Maxwell's equations are well-worn, tested and are very likely accurate. On the other hand, the two mechanisms are not. Consider what is accepted without proof.

The performance of any telescope is constrained by its aperture, even if placed above the atmosphere. The Hubble Telescope can detect very faint and very distant galaxies when it looks back in time. Further than those, the Hubble cannot probe. Are there galaxies beyond what the Hubble can detect even though they cannot be seen? Now construct a telescope with such a large aperture and placed so far from the solar system that it is constrained only by the particle horizon where objects there have infinite red-shifts. Are there galaxies beyond that horizon? Lastly, are there galaxies so far away that with an expanding universe, light from them will never ever reach us? Are they a myth?

If they are not a myth, and if galaxies presently beyond the particle horizon are not myths, they fall into the same class as universes that can never be seen and measured. If such universes are not myths, they fall within the realm of theoretic scientific investigation, at least to attempt an answer to the question whether the laws of physics are unique.

If those laws are unique, the anthropic principle in all of its forms can be discarded. The alternative view is whether it is justified to theoretically construct an infinite number of universes to reconcile opposing views in quantum or any other theory. Even if parallel universes exist, they are inaccessible to us and attempting to predict their creation and properties is more difficult than arguing about different interpretations of the anthropic principle in all of its forms.

SECTION 5 - BIO-ELECTROMAGNETISM

Without us expressing any opinion whatsoever concerning the work of Reich, what immediately follows is a brief account thought to be pure rubbish by conventional science.

Wilhelm Reich claimed to have discovered orgone energy first in the human body and then by observations. Reich said he discovered that the energy existed freely in the atmosphere and in the cosmos. According to Reich, the properties of orgone energy are: it is massless, all pervading throughout the universe, is the medium for e-m and gravitational fields, is in constant motion, contradicts entropy in that orgone energy flows from lower concentrations to higher concentrations of it, forms units that are alive or not alive, creates matter, is responsible for life and is self-attractive.

Mesmer is attributed with the construction of the first device that manipulated orgone energy, being in the nature of an accumulator. Reich also constructed such devices being enclosed layered metallic and non-metallic materials that stored the energy and constructed antennae to withdraw orgone energy from the atmosphere. Of the documented experiments, one will be mentioned. Reich introduced a small amount of radioactive material into strong amounts of orgone energy. The reported results were widespread atmospheric disturbances that lasted months and an increase in the radioactive background over an area thousands of time greater than the locality where the experiment was conducted. Experimental animals housed far away from any possible effects from the radioactive material used all died and autopsies revealed radiation poisoning. People in the locality became ill and one physician is said to have nearly died.

Saxton-Burr was Hunt professor of Anatomy at Yale University School of Medicine, being a member of the faculty for over forty three years and published around ninety three papers from 1916 to the late 1950s.

Saxton-Burr is most well known for his claim that all living things are controlled by electro-dynamic fields that can be measured and mapped with ordinary voltmeters. These fields he called ‘life fields’. In the 1930s, he set up experiments that were later repeated by others. These showed that all living organisms are surrounded by their own energy fields and in the case of humans, that field completely surrounds the individual and is egg-shaped. Changes in the field leads to changes in health. An early experiment linked detectors to trees on the campus for decades. Saxton-Burr showed conclusively that changes in the environmental e-m fields such as sunspot activity, phases of the Moon, thunderstorms and such like, affect the life field. He detected a specific energy

in frog spawn and that the frog's nervous system developed precisely within that field. That suggested to him the life field is a controlling matrix.

With humans, he charted and predicted ovulation cycles in women, located internal scar tissue and performed accurate diagnoses, all by reading changes in the life fields. Leonard Ravitz carried on that work and showed that the human field is influenced by the lunar cycle, reading peak at Full Moon. Mental states and mental diseases were found to influence the life field and those could be diagnosed. Stimuli showed the same energy measurements as emotional activity. Ravitz also demonstrated that the entire human life field disappears before physical death.

We do not propose to continue with accounts of workers in the same and similar fields, but the assumption that the life field acts as a controlling something should not pass without comment.

If it is a fact that the life field originates before actual fertilization of the ovum and disappears prior to death, then one must agree that the life field exerts the control claimed and the physical state of being alive rests on the presence of the field. Natural questions follow that assumption. From where does the life field originate, how does it travel, how does it know its 'target', how does it know when to dissipate and to where does it go and how? Answers to those questions are very satisfactorily answered from a religious standpoint because instead of a scientific account, we can use the 'God of Gaps'. Alternatively, the life field is a result of electro-chemical activity in living things and at the moment of fertilization there arises a different life field from that of the host. Further, physical or mental illness will then produce an alteration in the life field rather than the reverse.

Bio-electromagnetic fields can be detected and measured by the use of non-invasive methods such as the use of transducers, simple electrodes and the magnetometer. These detect bio-electric and bio-magnetic evidence in real time from fields throughout and around the volume conductor (the body). Sources of B-EM fields are neurophysiological arising from all tissues and organs within the body. Theory states the cell membrane bears ionic channels for the passage of sodium ions, these being macromolecular pores through which Na^{+}, K^{+} and Cl^{-} ions flow. The membrane potential markedly and very quickly alters when these pass and their flow is one source of bio-electric phenomena. For example, the Nernst equation for equilibrium voltages for a cat motoneuron give V_{Na+} = + 61 mV, V_{K+} = -88 mV and V_{Cl-} = -70 mV which is the resting voltage of the cell.

Konstantin Korotkov is a medical doctor practising in Russia. By 1993 he showed using Kirlian photography that uses a charged plate and film, that e-m

phenomena within a dead body can persist for up to six days following death. Additionally, he used that photographic method to photograph the ‘aura’ of body extremities and was able to diagnose various diseases and abnormalities in living subjects by comparing the ‘aura’ photographed to a ‘standard aura’ of healthy subjects. The only paper by Korotkov of the many he cites was found on the internet and paraphrasing, states:

“…Serious debates on the efficiency of the given “non-chemical” methods of the influence on the organism are gradually coming down due to the statistically valid clinical data, conceptual approaches and practical applications of acupuncture, homeopathy, Systematic Medicine and low-energy treatments.

The GDV camera is presently the state-of-the-art in bioelectrography. It utilizes a high frequency (1024 Hz), high-voltage (10 kV) input to the finger (or other object to be measured), which is placed on the electrified glass lens of the GDV camera. Because the electrical current applied to the body is very low, most human subjects do not experience any sensation when exposing their fingertip to the camera. In practice, the applied electric field is pulsed on and off every 10 microseconds, and the fingertip is exposed for only 0.5 seconds. This causes a corona discharge of light-emitting plasma to stream outward from the fingertip. The light emitted from the finger is detected directly by a CCD (charge-coupled detector), which is the state-of-the-art in scientific instruments such as telescopes to measure extremely low-level light. The signal from the CCD is sent directly to a computer, and software analysis is done to calculate a variety of parameters that characterize the pattern of light emitted, including brightness, total area, fractality, and density. The software can also provide color enhancement to enable subtle features such as intensity variations of the image to be perceived. The underlying principle of camera operation is similar to well-known Kirlian effect but modern technology allows to have reproducible stable data with quantitative computer analysis. Purposeful investigations allowed to find the parameters, optimal from the point of obtaining the information on the biological object state with the minimum of invasivity.

These findings are described in more than 200 research works in the international scientific literature…This biophysical concept of the principles of GDV measurements is based on the ideas of quantum biophysics. This is further development of well-known ideas of A. Szent-Györgyi about the transfer of electron-excited states along the chains of molecular protein complexes. This transfer is provided by feeding mitochondria with electrons. Mitochondria, in turn, convert energy conserved by electrons into ATP energy. In this form, energy may be utilized by organisms to perform work. Therefore this is a concept of the biophysical mechanism of energy storage and transfer in the

biological organisms. This idea of energy transfer is the basis of traditional oriental medicine, but still is not accepted by the western scientific paradigm.

Electron-excited states may be stored in any group of albumin molecules, i.e. in any system and organ of our body, and in an appropriate moment may be transported to the particular place needed to generate energy and perform work. The most probable transport path is through connective tissues and bone marrow, but this theory needs additional exploration. Therefore, the GDV technique is measuring the level of functional energy stored by the particular systems of an organism. This level is defined by the power of the electron-excited states and the character of their transport along the chains of albumin molecules. The level of functional energy is correlated with health status, but is only one many of the components that define health. It works together with genetic predisposition, psycho-emotional states, environmental loading (food, water, air, ecology) and other factors.

This approach may be associated with the oriental notion of the energy transfer along meridians…All 10 BEO-grams from the fingers then undergo analysis via another software program creating the model of Energy Field around the body and the diagrams showing the energy distribution in the various organ systems … This is based on the map correlating the human fingers with different systems and organs of the body in accordance with Traditional Chinese Medicine (TCM) approach. This map was first proposed by Peter Mandel in Germany and then further developed by Korotkov. Another software analysis computes the relative energy flow in the 7 chakras...

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This is a breakthrough beyond Kirlian photography for direct, real-time viewing of the human energy fields. This new technology allows one to capture by a special camera the physical, emotional, mental and spiritual energy emanating to and from an individual, plants, liquids, powders, inanimate objects and translate this into a computerized model. This allows researcher and client to see imbalances that may be influencing an individual’s well-being greatly facilitating the diagnosis of the CAUSE of any existing imbalances showing the area of the body and the organ systems involved. One of the greatest benefits to date is the ability to do “real-time” measurements of a variety of CAM treatments for such conditions as cancer to determine which is the most appropriate for the client. The GDV technique is accepted by Russian Ministry of Health as a Medical technology, more than 1000 doctors, practitioners and researchers benefit from using this technology worldwide. The incredible implications for the diagnosis and treatment of physical, emotional, mental and spiritual conditions with applications in medicine, psychology, sound therapy, biophysics, genetics, forensic science, agriculture, ecology etc. have only just begun.”

SECTION 6 – AURA

Let us take a simplistic approach and recount what is known. We all live on a planet having a magnetic field and that planet is located at one Astronomical Unit from a star having a magnetic field that is located in a galaxy having a magnetic field. On the surface of the Earth, we are all immersed in e-m radiation either natural or artificially produced. The question is one of symmetry and its consequences. In living organisms, tissues are formed by chiral molecules. These exist in one of two mirror forms. Averaging, the numbers of the right and left molecules in nature are usually equal. In animals, they are not.

Consider the Faraday effect. The right-handed and left-handed components of light with plane polarization interact with matter in different ways when a magnetic field is present, depending on the direction of that magnetic field with respect to the direction of propagation. That says magnetic fields change the structure of electron transitions and cause asymmetry.

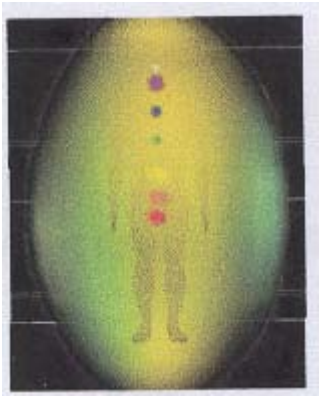
The energy of a particle does not depend on its orientation in space and spatial rotation is determined by the angular momentum. When the direction of the magnetic field becomes a controlling factor, it alters the initial symmetry with respect to arbitrary rotations around any direction in space and angular momentum is no longer conserved. If the angular momentum is I, the initial energy level was (2I+1)-fold degenerated. The alteration in the field in the presence of the magnetic field eradicates the degeneration as Zeeman splitting. The constant magnetic field of the Earth has the same effect and determines the direction in space, and that includes all biochemical processes. Only magnetic resonance determines the direction of biochemical reactions depending on orientation with respect to the geomagnetic field and its value.

Combining magnetic field with e-m., place an object with characteristic constants in a magnetic field and saturate it with an e-m field with suitable frequency. The particles of the object that possess magnetic moment resonantly absorb the energy of the e-m field. That is magnetic resonance of which there is nuclear magnetic resonance and electron spin resonance. However, that object may be some biological entity and we must ask to where is the magnetic resonance channeled, especially when biological evolution at the Earth's surface has produced a biological conduit for the absorption and radiation of e-m energy?

The human body comprises 70% water. At room temperature, water would be gaseous if it were not for the hydrogen-bonding present that displaces the

boiling point to some ‘extraordinary’ value. The H-bond is weak and participates in the bond between two DNA links and is intimately bound with the structure of polypeptide chains. Water possesses a magnetic moment and is susceptible to changes under nuclear magnetic resonance. The other necessary elements (oxygen, carbon, phosphorus, nitrogen and so on) also possess magnetic moments, and all are subject to an external magnetic field and e-m radiation containing resonant frequencies. The result is that each of us exchanges energy with our environment at a frequency determined by the environment.

One does not obtain information and research on human auras from arXiv, Physical Review or other scientific publications. Therefore, we are forced to the internet where it is described as the e-m field that surrounds the human body and every organism and object in the Universe. It is a collection of e-m energies of varying densities that permeate through and emit or exit from the physical body of a living person. These particles of energy are suspended around the healthy human body in an oval shaped field called the ‘auric egg’. The ‘egg’ emits out from the body approximately one metre on average on all sides, extending above the head and below the feet into the ground. The photograph below is said to have been taken with an advanced form of Kirlian photography with Chakra points superimposed.



An excellent and well-balanced fourteen minutes film titled ‘Auras on SciFi Network’s “Proof Positive” is available on youtube.com. Whilst that film highlights the interpretation of auras in terms of the personality of the subject, the Kirlian aspects are interesting.

Let us take it as true that the aura is an e-m field generated by electro-chemical processes taking place within the body. A fundamental question is to ask why the aura is outside of the body and does part of it reside within. Jumping to a conclusion, one might say because the skin conducts electricity, whatever is within is irrelevant because the skin acts as a Faraday cage. That is not so

because that conclusion is based upon there being no charge within a conductor that is hollow. For the human body, the question is not an easy one. The obvious is that skin has sweat glands that end as skin pores that are no more than small holes.

Model the human body as an electromagnetic source placed on one side of a perfect electrical conductor of finite thickness, h, possessing circular holes of radius a in vacuo.

Using an overline to denote a vector, the e-m field can be represented in plane components by saying that the projection of a given Dirac vector onto the position vector, $\left|\overline{r_t}\right\rangle$ [$\overline{r_t} = (x, y)$], will give us the value of the Dirac vector in that position coordinate dependent field in the coordinate space used. Then generally, $\overline{r_t}\left|\overline{E}\right\rangle = \overline{E_t}(x, y)$, and if we project one vector onto another, using * for complex conjugation, $\langle\alpha|\beta\rangle = \int d\overline{r_t}\langle\alpha|\overline{r_t}\rangle\langle\overline{r_t}|\beta\rangle^*$.

What we are looking for is an equation that links the field modal amplitude at z = 0 with the field modal amplitude at z = h in the plane of the skin. As the hole acts as a waveguide, we also need to describe the coupling between those values of z. The easiest approach seems to be a consideration of the field tangential components expanded over the entire plane waves. Let the wave vector component in the plane of the skin be $\overline{K} = (K_x, K_y)$ and to take account of the polarization, θ, $\varepsilon = (\overline{K}, \theta)$. When z = 0 and z = h, there needs to be integration over ε and θ.

In the z = 0 case,

$$\left|\overline{E}(z)\right\rangle_{z=0} = \sum_{\varepsilon} t_\varepsilon e^{i\varepsilon_z (z-h)}\left|\varepsilon\right\rangle \quad .$$

When z = h,

$$\left|\overline{E}(z)\right\rangle_{z=h} = e^{i\varepsilon_z i}\left|\varepsilon_i\right\rangle + \sum_{\varepsilon} r_t e^{-i\varepsilon_z z}\left|\varepsilon\right\rangle \quad .$$

The hole acts as a waveguide so inside the hole, we must introduce the waveguide modes, $\left|d\right\rangle$. The amplitudes of the waveguide modes are A_d and B_d. The propagation constant for a waveguide mode is D in the z-coordinate for just one mode bearing a label, d,

$$\left|\overline{E}(z)\right\rangle = \sum_{d}\left[A_d e^{iDz} + B_d e^{-iDz}\right]\left|d\right\rangle \quad .$$

Restricting the skin and its pores to a 3-D case, we require equations that apply to the skin which is taken to be an homogeneous medium. The dyadic of the Green's function in-plane e-m wave applies to that model of the skin and in turn, links to those coupling matrices of the waveguide equations. At the skin pore interfaces, match the e-m fields with orthogonal modes. That will produce the required connection between the modal amplitudes at z = 0 and z = h by way of the term C, the coupling between the e-m input and e-m output sides of the pore with any reflection at those openings taken care of by the term R.

For convenience, let $\left[A_d e^{iDh} + B_d e^{-iDh}\right]$ = S and $(A_d + B_d)$ = U.

$$(C_{dd} - R_d)U_d + \sum_{d \neq f} C_{df} E_f - C(-S_d) = V_d$$

$$(C_{gg} - E_g)E'_g + \sum_{g \neq n} C_{gn} E'_n - CE_g = 0 .$$

Then,

$$C = \frac{D\lambda}{2\pi}\frac{2ie^{iDh}}{e^{2iDh} - 1} \text{ for TE waveguide modes,}$$

$$C = \frac{2\pi}{\lambda D}\frac{2ie^{iDh}}{e^{2iDh} - 1} \text{ for TM waveguide modes and}$$

$$U_d = \frac{iD\lambda}{2\pi}\frac{e^{2Dh} + 1}{e^{2Dh} - 1} \quad .$$

In fact, C_{df} is a tensor that depends on the wavelength, λ, and is related to the other tensors used, but that relationship will not be explored. The above components of the electric field in the plane of the skin can be gleaned from differentiating Maxwell's equation and the expression for the far-field can be derived by associating the Green's function for scalar-free space to the Helmholtz equation and this too will not be explored. Remember that the model is an idealized one in vacuo. One could also write a solution for those last equations and normalize to attain the area transmission coefficient but for practical purposes, that would not mean very much. Suffice to say that the

above demonstrates a method that, inter alia shows when h tends to zero, the solution converges only if d is large. Once h tends away from zero, the solution still converges but with the use of a decreasing number of d such that there is an inverse proportionality between h and d. Nevertheless, the approach is sufficient to justify what we wished to justify, viz. that there is adequate standard physics to maintain that under non-idealised conditions an electromagnetic field generated within a human body can appear exterior to the skin. We would go further and say that the same is true for animals as well as plants, although the e-m field distributions may vary in shape.

As to the experimental findings in [1], it is evident that the e-m fields of the test subjects overlapped and e-m field interaction is well documented.

The last and most difficult question is one concerning the fate of the e-m field once the subject expires.

SECTION 7 – EXPIRY

It is tempting to review spiritualism, sightings, visitations, extraordinary manifestations, the scriptures and pagan beliefs but those offer no way forward. Even so, as in the case of UFOs, there will always exist a very small percentage of such that defy rational explanation. One wonders how the task can be attempted when eventually for all of us there may be nothing or something but whichever, that lays beyond the horizon of our perception much the same as the existence of galaxies that possess an infinite redshift, assuming those exist. Of course, we could resort to guesswork and may well need to introduce an element of that.

As a start, let us resort to basics. The physical body dies and undergoes decay. The e-m field that body generated has energy that is subject to the conservation law. Consequently, that e-m field cannot just disappear and using loose language, has to go somewhere or remain where it is.

Whilst an organism is alive, the e-m field is coupled to its source. When that source expires, the field remains as a field in its own right, as found by Korotkov. That Korotkov reported the field disappeared some time after its source expired provides possibilities.

Dissipation with total involvement of objects could be examined using standard equipment of high sensitivity in the vicinity of the ex-source but we are not aware of any such results undertaken by Korotkov or any other worker. Dissipation with partial involvement of objects attracts the comment above

together with the question about the remaining charge and potential that does not couple with objects. If part of the field couples to objects and part 'falls apart', that violates conservation unless part remains in its own right. The e-m field remaining intact without any dissipation involves three possibilities.

The first possibility is that the intact field becomes free within our spacetime (for want of a better description). The question is now whether a free field has sufficient cohesive properties to remain intact and not be corrupted by strong air currents, mobile telephone microwaves, high-tension overhead power lines, equipment that produces magnetic and electromagnetic fields, solar radiation pressure, the Earth's magnetic field and similar sources that we ignore and are part of our every day existence.

The second possibility is that the field dissipates. Again, conservation is a consideration. The third possibility is the field interacts with some thing. If the field were to be ordinary e-m, it is unlikely that any interaction process could involve tunneling because e-m waves possess no probability amplitude. However, if the field could be permitted to possess soliton-geon-like properties, self-cohesion would be more likely as well as the possibility of quantum tunneling. Using standard physics laced with an element of guesswork, we exclude the fate of the e-m field that involves a violation of conservation and say that the only alternative remaining is one of a 'free' condition and that will be explored.

The aspect of e-m energy is the easiest since $E = hf$, $c = f\lambda$ and so $E = \frac{hc}{\lambda}$. From the youtube.com film and the work of Korotkov referred to in the last section, it appears that 'auric colours' can be recorded on film and CCD devices but are not usually within the visual in their frequencies. For the sake of argument, we place the relevant wavelengths at $10^{15.5}$ and $10^{14.3}$Hz. Nevertheless the energy will still be in the order of 2eV. It is now inferred that since cameras of all types record light in much the same way as does the human eye (if not, what would be the point?), the 'auric colours' provide an exception to that and one should ask the reason. We may say that the relevant imaging devices work in a non-visible frequency range. If that were so, the frequencies of the reds, blues, greens, yellows and whites seen in the youtube.com film would need to originate in a non-visible range of wavelengths and somehow be converted within the camera itself so as to be recorded in the visible range to be appreciated from a photographic print-out. Conventional camcorders and digital cameras do not do that. Further, the Kirlian method is so simple that there exists no facility within that equipment to achieve the same.

A possibility that requires to be mentioned is that auras do not exist. ‘Auric colours’ in photographic print-outs are produced before the subject has the photograph taken and are stored within the circuitry of the printer. The colours are then superimposed over the photographic record at the touch of a button so that the final print-out is the face of the subject overlaid by the coloured ‘aura’. If so, the whole affair is no more than a money making confidence trick perpetrated on the gullible. That the internal working of the body is electro-chemical is beyond dispute and we have shown a mechanism that under ideal circumstances, may allow an e-m field so produced to the exterior. Whilst the treatment of the mathematics of that method provides no rigorous proof of ‘aura’, it points to its distinct possibility.

Turning away from specially constructed circuitry and taking it that ‘aura’ exists for each of us, what is its ultimate fate? Here, it is not discussed whether that e-m field has within it all of our memories and characteristics, nor will we dub it ‘soul’. If there is a fate, it is intimately bound up with the nature of the universe as regards a specific space or spacetime. The first question should be whether the e-m field detaches from the physical body or not. If not, the physical body along with its e-m field together go to the grave. That would not be the same in the case of cremation where conservation still applies.

E-m dictates that magnetic fields are sustained by charged particle currents. Once the physical body expires the e-m source disappears except where the brain continues to function for a while. The body nevertheless remains conductive but there can be no recombination between that and the e-m field, and what remains within the body is still endowed with a source of very slight magnetic curvature and virtually no electron activity from within the non-functioning cells. That lack of activity should, theoretically, mean that particle currents cease and displacement currents should be in evidence with the eventual decoupling of magnetic structures. In turn, that induces an electric field that accelerates remaining charged particles. Perhaps that is why the temperature of a corpse first decreases, then rises and then falls to the ambient temperature.

Suppose that a typical magnetic field **B** pervades a physical body and that the particle current that sustained it disappears. How does the system of body and aura evolve? Once the particle currents cease, the system reacts with an induced electric field that attempts to oppose the change. The size of that induced electric field is related to the timescale over which the magnetic flux alters. The situation is governed by the relevant Maxwell equations and assuming that the current density, **j**, becomes very small because of decoupling, $\nabla \times \mathbf{B}$ is determined by $\mathbf{E}/c^2$. Thus the changes in the magnetic field propagate at the speed of light as would be expected. The effect of that induced current is to

repel the external e-m field via its own electric field. Again, the proof is not rigorous but infers that the external field becomes decoupled from its once source after death depending upon the 'e-m state' of the physical body.

Some theories concerning spacetime have already been discussed, notably those that regard the 5th coordinate in terms of energy. In addition, there exist theories of creation resting on the proposition that our universe is a 4-D manifold embedded in a 5-D bulk. In order to take a more simplistic view of the Kaluza-Klein Theory, let the K-K spacetime interval in 5-D equal zero, so following Jennings [4]. The relationship so obtained with $dx_a = g_{ab}dx^b$ (a,b = 0, 1, 2, 3) is, with the summation convention in operation,

$$dx_a dx^a = a^2\left[dx_5 + bA_a dx^a\right]^2,$$

where A_a is the e-m field that gauge couples to the 5th dimension, x_5. Here, the position of any particle is dictated by x^a and the square root of the right-hand side of the equation is its scalar displacement in 5-D when at rest in 3-D. If the external speed of the particle is v and its internal displacement speed is u, it will always be true that u + v = c, so following Special Relativity and therefore a uniformly dense zero-point field. If u is confined to the vicinity of the particle, there exists a confined field that is very likely governed by the self-gravity of the particle, which is the Wheeler geon concept. Since the speed of light is decreased by a gravitational field, the particle is free to move at v under the influence of external gravitational sources.

Like Wheeler's original proposals and work since then, such a quantum mechanical particle has Planck mass and at present, the notion of geons cannot escape having that mass. Let us suppose that quantum field theory is correct and geons have that mass. If the free e-m 'aura' were to become geonic with Planck mass, the only place in which it could exist would be with other 'particles' having the same mass. In conventional theory, that would be in the zero-point field all around and pervading us and the universe.

It is true to say that with the multitude of theories and various aspects of them concerning the nature of the universe, cosmologists do not know how the universe was created nor do they know the true structure of space. Those theories answer the 'could it be like this?' question but none can say 'this is it for sure'. Neither is the nature of gravity known for sure nor the dimensionality in which it operates and at this point in time, there exist no definite answers.

REFERENCES

[1] Thaheld (2006) physics 0601060.
[2] Oleinik (2003) gen-phy 0306073v1.
[3] Hadley (1997) Found. Phy. Lett. 10.
[4] Jennings (2000) hep-th 0004156v1.
[5] Oleinik, Borimsky and Arepjev (2000) quant-ph 0010027.
[6] Oleinik (2003) gen-phy 03060074v1
[7] Barceló and Visser (2000) gr-qc 0003025v2
[8] Olum (1998) gr-qc 9805003v2
[9] Dicke (1961) Nature 192
[10] Weinberg (1987) Phys. Rev. Lett. 59
[11] Hoyle (1957) Rev. Mod. Phys. 29
[12] Wallace (1904) Man's place in the universe etc. Bell & Sons
[13] Barrow and Tipler (1986) The Anthropic Cosmological Principle. Oxford Univ. Press
[14] Frolov et al (1989) Phys. Lett B216
Lawrence and Martinec (1996) hep-th 9509149
Bojowald gr-qc 0104072
[15] Korotkov Monitoring Energy Levels During CAM Treatment with GDV Technique (The Internet)