COMPARING THE INHOMOGENEOUS PHYSICAL VACUUM AND THE ZERO-POINT FIELD

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Abstract*:* Differences are discussed between the zero-point field (ZPF) and the Physical Vacuum theory used to describe the void of outer space. The physical vacuum is a dense medium of dipoles and quadrapoles that link electric and magnetic fields as well as gravitic and spin fields; it is an inhomogeneous polarized medium. This notion can treat anomalous behavior of self-luminous bodies, and provide mechanisms for predicting weather phenomena. Experiments are warranted to detect these properties or their differences within the electromagnetic, gravitational and spin fields with the objective of developing a simplified approach toward Unification. Experiments to validate these relationships between these fields should potentially result in a collaborative U.S./Russian satellite effort.

Introduction

In order for mankind's destiny to survive, we must reach out and focus upon the stars exploiting the need for exploration with long-range space travel [1-3]. The vacuum is no longer an empty nothingness but, according to western views, is teeming with quantum mechanical life and energy. If true, and some experiments point in this direction, do we fully understand the properties of this medium and can we extract useful energy from this void to propel an intra- or inter-galactic starship?

There are separate and distinct views concerning the constituents of the void; foremost amongst these are the zero-point field or ZPF, and the physical vacuum or PV. The ZPF is similar to a bouillon tossed about in boiling soup of quantum activity based upon a cycle of instantaneous random creation and annihilation of virtual elementary particles and their subsequent fields. The second view treats the physical vacuum as a very dense medium consisting of dipoles and quadripoles. Dyatlov's views on physical vacuum theory and the different variants will be discussed. Physical vacuum theory is an outgrowth of many scientific investigations to explain anomalous phenomenon and behavior of a wide class of events observed within the atmosphere and in the near space.

It is intriguing that proponents for both the PV and the ZPF claim that their theories, to some degree, are based upon ideas surfaced by Sakharov in the

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mid 1960s. Despite these commonalties, developments in the West and in Russia proceeded along different paths. This could be due to translation errors or different scientific cultures. It is extremely important to identify these differences in order to create improvements or the genesis of a newer viewpoint that better characterizes the truth, as we know it. In this discussion, the PV is a polarized media. It is also interesting that in an unpublished work by Puthoff, he too takes a contemporary view at examining a polarized vacuum.

Discussion

This section discusses both the zero point field and the physical vacuum.

A. The Zero-Point Field

Haisch [4] recently developed and tested a published theory that Newton's equations of motion can be derived by Maxwell's equations of electrodynamics as applied to the zero-point field (ZPF) of the quantum vacuum. In the ZPF-inertia theory, inertia and to some degree mass is postulated as not being an intrinsic property of matter but rather an electromagnetic drag force that proves to be an acceleration dependent upon the spectral characteristics of the ZPF. The theory proposes that interactions between the ZPF and matter takes place at the level of quarks and electrons, hence could account for the mass of a composite neutral particle such as a neutron. Moreover, Haisch suggests the principle of equivalence implies that gravitation would also be an effect originating in the quantum vacuum along the same lines proposed by Sakharov in 1968. Concerning exotic propulsion, one speculative hypothesis of matter possessing negative inertial mass, a concept originated by Bondi in 1957, is considered logically impractical. The linked ZPF-inertia and ZPF-gravity concepts, however, open the conceptual possibility that manipulation of inertia and gravitation can occur within the vacuum phenomena. An essential concern is whether the proposed ZPF-matter interactions generating the right mass might involve more than one resonance.

One may initially feel that the physical vacuum concept is akin to the zero point field (ZPF) or zero point energy concepts discussed and adopted in the west. There are, however, very distinct differences. The ZPF advocates essentially have examined a slow moving charged particle and concluded that its inertia is a Lorentz force acting against the ZPF. This is in agreement with late nineteenth century efforts which implied that electromagnetic fields acting on a charged particle tend to increase the particle's mass. Further assessments suggest that the ZPF may act equally against sub-particles that constitute atomic particles. If true, then to take advantage of the ZPF as a propulsive medium, these effects imply that our starship must therefore have an electric or magnetic charge or, as a bare minimum, act as a charged dipole.

Forward [5] in 1996 offers some criticism of the ZPF, and if we allow for an extrapolation, the same may be said about the physical vacuum. Forward states that although the vacuum is the hottest topic in contemporary physics, it is the source of numerous effects: force fields emerge from nowhere, particles popping in and out of existence, and energetic jitterings occur with no apparent power source. Forward examines the Haisch, Rueda, and Puthoff [4] conjecture that mass and inertia of a body are induced effects brought about by changes in the quantum-fluctuation energy of the vacuum. Although it is not possible to identify a specific or unique experiment, Forward suggests some experiments may be defined to prove or disprove how mass can be altered by changing the effects of the vacuum surrounding the body.

Forward claims that one may extract energy from the vacuum which has an energy density of 10^{108} J/cc and a mass density of 10^{94} g/cc which is much higher than values associated with nuclear energy. Although this is an esoteric and little understood field, it does have potential as an energy source and changing the mass of an object. The objective is to develop a *vacuum propulsor drive* that could push against the *vacuum* itself.

Forward goes on to indicate that the uncertainty principle predicts that the vacuum is teeming with pairs of charged particles called electron-positron pairs. This means that the supposedly empty vacuum is not only full of photons but also a tenuous plasma of charged electron-positron pairs. This plasma makes the vacuum have an index of refraction slightly different from unity and makes it respond non-linearly to strong electromagnetic fields.

In 1998, Haisch et al [6] presented an analysis proposing that the most fundamental property of matter- inertia- could be explained as an electro-magnetic force traceable to the ZPF. This exploratory investigation admittedly had two weaknesses: (1) the mathematical development was complex, and (2) the calculations were dependent upon a simplified model to represent the interactions between material objects and the ZPF. Despite this, the remarkable results imply that Newton's law was based upon Maxwell's laws of electrodynamics as applied to the ZPF. Thus, matter was not an inane property but an electromagnetically driven force. If true, the potential exists for future technologies to manipulate the electromagnetic phenomena to alter mass or gravitation.

These efforts indicate that the principle of equivalence of gravitational mass will need to undergo an analogous reinterpretation from the foundation laid down by Sakharov 30 years ago. It is postulated that the concept of energy being proportional to mass should be viewed as a statement regarding the kinetic energy of the ZPF fluctuations induced by the quarks or electrons constituting matter. It also has been shown that extracting energy from the vacuum does not violate the laws of thermodynamics. The ZPF advocates also propose that inertia too is a Casimir-like acceleration-dependent drag force.

Haisch states there are four types of matter:

- inertial mass- this is the resistance of mass to acceleration more commonly called inertia;
- active gravitational mass: the ability of matter to attract other matter by Newtonian gravitation;
- passive gravitational mass: the property of matter to respond to gravitational force; and

- relativistic rest mass: the mass of the body to be converted to energy during total annihilation.

In using Newton's third law about equal and opposing forces, results now include an electro-magnetically derived force for inertia.

There are two views on the origin of the electromagnetic ZPF embodied by the perspectives for quantum electrodynamics (QED) and Stochastic Electrodynamics (SED). The QED approach is currently regarded as the 'standard' physics. Here it implies that ZPF radiation is comparable to black-body radiation because of applying quantum laws. SED is just the opposite where it is assumed that the ZPF is as real as any other electromagnetic field. Regarding its origin, for some reason zero-point radiation came into the universe. SED and QED are not on an equal footing since SED has been successful in providing satisfactory alternatives to some quantum phenomena.

An important discovery in the mid seventies showed the ZPF acquired special characteristics when viewed from an accelerating coordinate system. In conjunction with radiation from evaporating black holes as proposed by Hawking in 1974, and Davies in 1975, and Unruh in 1976 determined that a Planck-like component of the ZPF will occur in a uniformly-accelerated coordinate system having constant proper acceleration can be characterized as a temperature. This 'temperature' does not originate in emissions from particles undergoing thermal motion. Basically, in an accelerating system, an observer will see a bath of particles from the direction of the velocity vector while an observer that is in an inertial frame will see nothing (the Unruh effect). The 'heat bath' is a quantum phenomenon. The temperature is negligible in most accelerations. Only in the vicinity of large gravitational fields of black holes or in high-energy particle collisions, can this become significant.

Regarding the origin of inertia, Haisch et al consider a relativistic transformation of the ZPF itself into an accelerating frame. They found that a non-zero stochastically-averaged Poynting vector immediately leads to a non-zero electromagnetic ZPF momentum flux as viewed by an accelerating object. Regarding altering inertial mass, a naïve argument is presented that when components of matter are added up, the total is not the sum of the parts. This is more frustrating because a quark does not exist as a separate particle. Similarly, the resonance of a mechanical system bears no resemblance to the resonances of its component parts. Thus, it is easy to see how three quarks can add up to totally different masses than individually. The same may be said about mass defect. This logic implies that mass is not converted into energy and vice-versa. Quarks are basically unchanged entities but the resonance characterizing the interaction amongst the quark ensemble and the ZPF vacuum cause these variations. Thus, even neutral particles will experience the ZPF because of its constituents.

Finally, Puthoff et al also claim that the ZPF is evenly distributed and a consequence of the background noise created by the *big bang* theory. There is a view that, based upon a recently discovered dipole or quadrapole in the background noise based upon recent COBI satellite data, the background noise and, hence, the ZPF is thus not evenly distributed. By an even distribution, the implication is that a spacecraft that uniformly extracts energy from the ZPF can travel between galaxies with a constant thrust potential. Moreover, more recent work by Reuda, Haisch and Shanamoto[7] suggest that the ultra-high energies associated with cosmic rays could support a ZPF continuum outside of the galaxy. If it is not evenly distributed, then the ZPF is only an artifact and a consequence of our galaxy representing a specific domain. Furthermore, one may speculate that the ZPF may be subdivided entities that are unique to each galaxy. If this is so, the thrust potential is not constant but its strength varies by some yet to be defined variable based upon some field or spatial dimension. This suggests that travel between galaxies may require a different approach instead of extracting energy from the ZPF as currently dreamed. These facts support the partial view that the Physical Vacuum may also have such an expanse.

B. Anomalous Phenomenon

The motivation for the physical vacuum theory was to explain some unusual physical phenomenon. What are these anomalous events? Nachalov [8] discusses spin and angular momentum. Some experiments were performed during the nineteenth century to detect unusual effects associated with torsion by N. P. Myshkin and later reproduced during the 1960s by Kozyrev and Nasonov and later by others. During the 1940s, the Soviet astrophysicists N. A. Kozyrev [9] proposed that the rotation of stars is connected with their energy output; time and rotation also appeared to be closely interconnected. Kozyrev conducted a series of experiments to measure the forces acting upon a spinning gyroscope and detected that the weight changes depending upon angular velocity and the rotation direction. These observed effects were considered the manifestation of some physical properties of time. In 1989, H. Hayasaka and S. Takeuchi [10] conducted a series of experiments to measure the fall-time of a spinning gyroscope. They found that the fall-time also depended on angular momentum and direction of rotation. They have attempted to explain the effects of antigravitation as a manifestation of the torsion fields generated by a spinning gyroscope. A. I. Veinik made tens of different types of generators using rotating masses. These generators when operating were found to very slightly change their weight.

In the mid fifties to the late seventies, Kozyrev with Nasonov conducted astronomical observations using an unusual receiver mounted on a telescope. When the telescope was directed toward a particular star, the detector positioned in the telescope registered a signal from the star before the main mirror of the telescope that was shielded by metal screens. This implied that electromagnetic waves or light had some component that could not be shielded by metal screens. When the telescope was redirected not at the visible but the true position of the star, the detector was able to register a stronger signal. This was interpreted that the star emitted some form of electromagnetic radiation that had velocities billions of times faster than the speed of light. Kozyrev further detected a signal when the telescope was directed at a symmetrical location from the visible and true position of the star. This was interpreted as a detection of the future position of the star.

During the last 50 years, there have been numerous reports of anomalous behavior due to spin-polarized particles. Baryshevsky and Podgoretsky [11] experimentally determined that when neutrons are passed through spin polarized targets, a precession of neutrons occurs. The magnitude of the precession is thousands of times greater than that achieved by the magnetic field of the nuclei of the target. Krisch [12] in the U.S. observed similar anomalies produced by spin-polarized protons and the French noted that the heat conduction capability for helium depended upon the nuclear spin.

C. A Historical Perspective of the Vacuum

Russian theoretical physicists have long ago known that the physical vacuum was not a void based upon limitations imposed by the microscopic quantum field and quark theoretical viewpoints. The accepted belief is that the physical vacuum or PV acts as a dipole medium. On a microscopic scale, the PV based upon experimental evidence was found to accelerate elementary particles.

Einstein's general theory of relativity operates with four translational coordinates x, y, z, and ct. His theory does not take into account that an accelerating system can possess angular momentum. Thus, Einstein's mechanics does not consider the existence of torsional interactions or the torsion principle of inertia. G. I. Shipov [13-14] used the geometry of absolute parallelism with an additional six rotational coordinates and showed that 10 equations and not 4 as prescribed by Einstein's General Theory of Relativity should describe the movement of any body. These vacuum equations were able to be generalized to describe very fundamental equations by Einstein, Young-Mills, and Heisenberg. Shipov was able to identify, in addition to the two long-range fields of electromagnetism and gravitation, that a third long-range field existed. This latter field was the torsion field and the speed of torsion waves is assumed significantly higher than the speed of light. Second, torsion fields are able to propagate in regions not limited by a light cone. Third, torsional fields are able to transmit information without transmitting energy. Fourth and final, torsion waves are not expected to follow the superposition principle.

In 1986, M. Carmeli [15] attempted to create a special theory of rotational relativity as a compliment to Einstein's translational relativity. Carmeli did not take into account certain problems with inertia forces and could not achieve this effort. The program of rotational relativity can be realized within Shipov's so-called theory of the physical vacuum.

Spin and angular momentum generate torsion fields. There are two types of torsion fields depending upon spin orientation. Superposition of these fields determines the intensity and spatial configuration of the fields. If electric or magnetic fields exist in some region of space, then there always will exist a torsion field in the same region. Strong torsion fields are generated by high electric potentials and by devices using circular or spiral electromagnetic waves. Finally, torsion fields can be created as the result of a distortion in the geometry of the physical vacuum.

Dyatlov states that several Russian scientists brought forward the view of microscopic and macroscopic concepts. The work of Akimov and Shipov, for example, is in torsion fields representing a macroscopic point of view. Akimov and Shipov noticed the presence of a fourth field, that of torsion due to the mechanical rotation of particles that they proposed may explain some anomalous phenomena but this is as of yet to be explained. Torsion fields, however, are viewed as a very small field although it contains strong macroscopic elements of electric, magnetic, and gravitational fields. In their discussion on torsion fields they make very little or no reference to the inhomogeneous physical vacuum.

There is a continuous need for brand new ideas. The concept of an inhomogeneous physical vacuum as a macroscopic medium goes back before Einstein. Unfortunately, Einstein exploded the early development of electrodynamics and gravidynamics with his invaluable Theory of Relativity. Nevertheless, the theory's effect is comparable to those of Karl Marx where creating great ideas may still not adequately represent the truth. The need here is to find the truth. Thoughts regarding a inhomogeneous physical vacuum are based upon many concepts. The logic that developed the physical vacuum theory is as follows: Maxwell's equations can describe the PV as a polarized medium. There is an induction effect that is represented by the sum of the polarization within the PV and the substance polarized.

Electrodynamics essentially ignores magnetic induction because of the unavailability of a solitary magnetic source or monopole. Existence of a magnetic monopole and its sustainability is yet to be demonstrated, however, these terms should be included for completeness. If magnetic induction is considered, magnetic polarization allows everything to fall into place and the magnetic induction is the sum of the PV polarization and the substance polarization. All the comments regarding Maxwell's equations are also true about gravitation which further implies there is a gravitational component that allows for polarization within the PV due to the different electric, magnetic, gravitational, and spin field effects. Maxwell's E-M and Heaviside's gravitational equations are covariant regarding a Lorentz transformation; they must therefore agree with Einstein's Theory of Relativity. For this covariance, it follows that gravitational waves may move at the speed of light as a possible solution. Differences in the speed of photons and gravitons may also exist as another admissible solution which will be further discussed.

Akimov's "geomagnetic relation" connects magnetization and spin polarization within the PV. This implies that there has to be connectivity between electric, magnetic, and gravitational polarization by virtue of Maxwell's ideas regarding the symmetry of electric and magnetic displacement currents. These ideas, however, do not explain E-M faint or ghostly self-luminous emissions that could range the spectrum from ball lightning, UFOs with the clear emphasis on the word "unidentified", or the creation of tornadoes and other naturally occurring phenomenon. A majority of these different types of manifestations occur near geological earth fault lines. These emissions have several properties that are in common, foremost of these is that they are spherical in nature and may glow with different colors. The quest to resolve these issues initially started with Shipov's lectures followed by Akimov's experimental work. These ideas in Russia were not very easily accepted.

The transition to a model, that explains natural self-luminous formations (NSF) based on polarized properties of the inhomogeneous physical vacuum, was realized by Dmitriev and Dyatlov in 1995. According to Dmitriev [16], the study of a large amount of anomalous natural formations that developed within the atmosphere and in the near space, allows one to build a model, depending upon the physical nature of a variety of NSF. This basis considers the real natural bodies with the properties of the polarized inhomogeneous physical vacuum. A space-time combination of these physical properties in an NSF phenomenon according to Dmitriev and Dyatlov [17] is needed to advance and define a new subject for physical investigations– *the VACUUM DOMAIN*.

Dyatlov introduced several notions to compliment Akimov and Shipov suggesting that gravity waves within a vacuum domain (VD) can be transformed into electromagnetic waves or the reverse process is also feasible. Such transformations results in self-luminescence. Thus, gravitons are periodically transformed into photons and vice versa in these interactions. If, for example, stars radiate photons, then they must attract gravitons and this prevents contradicting the principals defined by the equations of Maxwell and Heaviside. Kozyrev initially proposed that stars attract gravitons and gravity waves may radiate away from stars. Hence, the stars act as energy transformers.

Ball lightning represents a small VD region where the ball acts as a dipole physical vacuum placed within a quadrapolar physical vacuum medium. Thus, the dipole's nature allows penetration through the absolute PV domain. Ball lightning or BL also has strong self-luminescence which is why the Apollo astronauts saw this during their flight to the moon. Moreover, BL may conserve its structure for a long time. One may look at the time derivative of the spin polarization to define the tangential stress tensor components to look at the mechanical moment acting upon the BL. The spin polarization linearly depends upon the magnetic and spin fields.

Regarding the model of tornadoes, the VD of ball lightning changes its form as it falls from the cosmos to the earth. It may act similar to a sail as the ball falls lower in the atmosphere toward the ground. If the wind direction leads to a strong change in the magnetic field, the spin polarization changes in time to create a mechanical moment that generates rotation of the entrapped air. If there is no spin polarization, there is no rotation. Tornadoes in the U.S., for example, move from a southerly to a northerly direction along a constant latitude aligned with the magnetic field of the earth. The wind gives the tornado its energy where the tornado cloud acts as a giant sail; the tornado itself is a very narrow needle or filament. Thus, wind energy is concentrated within the tornado's cross-section and the rotational velocity depends upon the tangential stress which is very large. The BL in a VD has an electrogravitational nature. Self-luminescence is the main physical property of a VD and is the result of transforming a gravispin wave into an E-M wave with circulation of material, energy, waves, and particles.

Analysis

The following section presents views regarding the PV, anomalous phenomena, and a hypothesis about stars. Additionally, an argument concerning natural or physical evidence that suggests faster than light phenomenon may exist is provided by qualitatively examining black holes. This is followed by a discussion on gravitation models and introduces Jefimenko's gravity/cogravity model; the cogravity field is sometimes referred to as the spin field or field of rotation. The possibility of changes in this model will also be discussed. Finally, an approach leading to a pseudo-unification theory is presented to show that certain gravitational terms are interrelated with electromagnetic field quantities.

A. Theory on the Inhomogeneous Physical Vacuum

Dyatlov states that the PV can exists in small domains that demonstrate amazing physical phenomenon. The physical vacuum is a consequence of Maxwell's equations and acts similar to a polarized medium with electrical and magnetic charges in the form of dipoles. Additionally, the medium is influenced by gravitation and spin dipoles to such a degree that the equations of Heaviside as well as Einstein are needed to characterize these effects. Thus, the PV is a collection of electrical and magnetic dipoles that obeys Maxwell's equations, and interact with gravitation and spin dipoles, which satisfies Heaviside's equations. It should be emphasized that a given direction of analytical studies directly results from the concrete characteristics of separately taken classes of NSFs. The point is that a number of observations unambiguously indicate the simultaneous creation of luminescence, levitation and vortex motion near a body under observation (to also include ball lightning with a diameter $\geq$ 1m). It is not clear how Einstein's equations can characterize a polarization medium consisting of gravitational and spin dipoles. Based upon known concepts about the connectivity of magnetic and spin polarization considering nuclear and paramagnetic resonances or the Einstein-de-Haas effects, one can connect electrical and gravitational polarizations. This results in a linear system of equations describing electrogravidynamics. This yields, however, an incorrect description of the physical vacuum unless one partitions the PV according to Dyatlov such that it is treated as a quadrapole that consists of two minor dipoles that each treat matter and anti-matter.

The physical vacuum is both homogeneous from an overall global perspective, as well as inhomogeneous to treat smaller distinct regions. This latter phenomenon includes ball lightning as a subset. Moreover, there are describable and distinct boundaries about each of these domains and they can interact with each other especially when these regions overlap. These interactions will create effects due to differences within the separate domains. An example of a distinct domain is again demonstrated by ball lightning. Ball lightning has been observed in outer space and associated with naturally occurring geological events appearing near the Earth's fault lines. Ball lightning can affect weather. For example, Merkulov [18] claims that if one was able to detect ball lighting in space from an overhead satellite, one could predict within a level of accuracy where a tornado would form on the Earth's surface. Here the ball lightning has a bipolar gravimetric nature and falls through the atmosphere elongating into an electromagnetic filament, which is a ray from the initial spherical physical vacuum domain. The vortices form due to the spin polarization within the original domain. As it descends, the filament entraps air eventually touching the ground as either a tornado or a waterspout over water. These filaments are very sensitive to the magnetic field of the earth which implies that the original ball lightning precursor may also have some magnetic properties.

In these theories, there is a question about negative mass. Negative mass is needed to introduce the concept of a dipole's gravitation as well as the polarization of gravity. This is based upon Shipov and Terletskiy. Negative mass is also needed to explain the thermal dearth of thermodynamics which is the increase of the entropy of the universe. Thermal dearth is not explained by an inverse flow of energy described by the equations of Heaviside. Terletskiy in his book: "Paradoxes of Relativity Theory", in 1966 found an explanation for energy circulation through the introduction of negative mass. Here, the universe's perpetual motion is within a homogeneous space. An inhomogeneous vacuum domain allows for the treatment of smaller domains. Furthermore, if a physical vacuum by virtue of its gravitational capabilities attracts matter, then its weight must increase over time if negative mass did not exist. This does not happen.

Flicker is a well-known property of physical vacuums. A pulse generator can create a storm cloud or a tornado. This involves a relaxation process within the vacuum domain when it captures large masses of substances as well as losses similar amounts almost simultaneously; this mass could be in the form of earth rocks, water, water vapor, etc. When the optical properties of water change, a flicker can occur. Thus, the vacuum domain acts as a resonator of electromagnetic waves with gravity-spin waves that simultaneously interact. In the Dyatlov ball lightning model, gravity-spin waves in the physical vacuum move at the speed of light. The Ymov-Poynting vector plays an important role in this model because it unites E-M theory with gravitational theory. This leads to the conclusion that photons and gravitons are the same.

In this theory, gravitons move toward an object whereas gravity waves move away from the object. There is a conversion process in the star where gravitons are turned into photons. In contrast to these views, the first author's earlier works cites that Black Holes are an example where gravity waves may move away from an object as gravitons but do so at greater than the speed of light. Moreover, Murad cites that black holes may provide the first indication of naturally occurring hyper-light phenomenon.

A. Black Holes and Feasibility of Hyper-Light Phenomenon

Is there evidence of naturally occurring hyper-light effects and what insights can be gained from black holes? Black holes are remnants of a collapsed star where mass is so condensed that the large gravitational attraction prevents light from leaving the star. The issue about charge and light not escaping a black hole deserves attention. If the initial star was not an electron or proton star before collapse, then how did the black hole obtain its charge? How does one measure the charge on a black hole? By charge, we are also including a magnetic charge. Maxwell's equations indicate a characteristic speed for a field created by a charge is the speed of light. If light cannot leave a black hole, one must then ask how does an electromagnetic emission moving at the same speed leave the black hole? Thus if a black hole does have an electric or magnetic charge, one should not be able to detect the charge due to the awesome first-order gravitational attraction.

Figure 1. Although this anomalous event occurred regionally, the event resembles a "solar pillar" usually seen in latitudes much further north.

Charge may reside, however, in the accretion disk outside of the black hole's event horizon. Moreover, charges and mass within the disk are eventually consumed by the black hole. Hawking [12] claims that black holes may rotate about a principle axis and are unstable. If a collapsing star initially rotates, the resultant black hole should also rotate based upon angular momentum considerations. If a black hole does rotate, the event horizon also rotates and mass with the right rotational velocity may develop enough centrifugal force not to be drawn in. If there is no rotation, the surrounding mass is eventually swallowed by the black hole. To do this, black holes must expend energy.

If one enters the event horizon, the gravity gradient supposedly pulls you apart and the image of falling into the black hole is forever frozen on the event horizon. If the escape velocity is equal to the speed of light, the event horizon is indeed a visual history of whatever entered the black hole. Images on the event horizon should eventually disappear since the speed of light is indeed *not* the escape velocity but must be some higher value, say between the speed of light or a larger value, the speed of gravity waves. This may be resolved from focused imagery scans of the event horizon to be acquired by the Hubble telescope.

A gravitational pulse is supposedly released whenever an object falls into a black hole. What can be said about gravity or gravity waves? Let us assume gravity waves radiate outward and gravity is represented by a field equation:

$$\nabla^{2}\mathbf{g} - \frac{1}{\mathbf{c}_{\mathbf{s}}^{2}}\frac{\partial^{2}\mathbf{g}}{\partial\mathbf{t}^{2}} = -\,\omega\&.$$

where g represents a gravitational field as a function of spatial variables and time, t, c_s is a propagation velocity, and the rhs is a gravity source term. The speed of propagation is in the denominator of a very small transient term. We need a reasonably valid gravity model that supports gravity wave phenomena.

If gravity moves at or less than the speed of light, then no gravity waves should leave the black hole; it should not exert any gravitational pull on any nearby gases. If gravity waves move at infinite velocity, the transient term disappears and gravity is not a transient function but acts like a steady-state response. Without the transient term, the canonical equation is elliptical and does not support wave–like effects which implies gravity waves do not have infinite velocity. Gravity creates causality upon the its surrounding environment. Thus, gravity waves must escape a black hole with a characteristic velocity that is greater than the speed of light but less than infinity. If manipulating the gravity field allows speeds near this velocity, a gravity gradient propulsor is an attractive option to exceed light speed.

If light cannot escape, is it feasible ejecta may leave and not fall back into the black hole? Hawking concludes black holes evaporate and become unstable. Evaporation implies mass is converted into energy to sustain the gravitational field. There is inefficiency in this process and mass or energy may be ejected. Mass, in the form of relativistic particles or anti-matter, ejected from a black hole will have an initial radial velocity. If this velocity is insufficient to overcome gravity, it should fall back into the black hole. To observe ejecta, it must leave the collapsed star at an escape velocity greater than light speed. If traces of particles or E-M waves are emitted from a black hole, they could come from one of three sources; either from the surrounding region influenced by the black hole, the black hole itself, or a combination of both. If from the black hole, this mass must move at hyper-light speed.

The previous logic raises questions regarding a model for a black hole. There are two solutions to the wave equations; that is incoming and outgoing waves. If outgoing, the prior argument about the speed of gravity waves being faster than light is logically sound. The fallacy of this logic is evident, however, for incoming waves. Thus, we need to formulate an experiment to ascertain this distinction and, if incoming, devise a better argument to explain the light-trapping capabilities of black holes. The fact that a gravitational pulse is released when an object falls into a black hole favors the argument with outgoing waves.

Harmon, a NASA astronomer, suggests there are as many [19-21] as three possible super-luminal events detected to date. These include a stream of particles emanating from two galactic black holes and a neutron star. These particles, believed to be electrons and positrons, are ejected along an axis and the uncertainty in establishing the velocity is to correctly predict the particle axis alignment with the earth. Nevertheless, these findings are encouraging. These notions could explain the *missing mass* or *dark matter* in the cosmos. Black mass could be mass that does not reflect or block light from reaching an observer depending upon surface emissivity and absorptivity. It is also possible that objects travelling at or faster than light produce no visible signature. If some mass falls in this category, the cosmic mass imbalance is easily corrected.

B. Questions Regarding Gravity Models

Gravity plays a crucial role at these conditions and this should be of concern to the propulsion dynamicist. Gravity is not as simplistic as one would presuppose in defining the trajectory of a near- or hyper-light vehicle. Several different gravity models need to be considered. The simplest is Newtonian gravitation [22] where the gravity vector satisfies:

$$\nabla \times \bar{\mathbf{g}} = 0. \ \ \textbf{and}: \ \nabla \cdot \bar{\mathbf{g}} = -4\pi \mathbf{G}\rho.$$

These equations lead to:

$$\bar{\mathbf{g}} = -\nabla\phi \ \ \textbf{and:} \ \nabla^2\phi = 4\pi\mathbf{G}\rho; \ \textbf{where:} \ \mathbf{g} \approx 1/\mathbf{r}^2.$$

Where G is a constant, ρ is gravitational density, r is radial distance, and ϕ is a potential function. Boundary conditions for Newtonian gravity vanish at infinity and asymptotically go to zero due to the inverse radius function. Although suitable for predicting satellite motion at conditions where the satellite velocity is far lower than light speed, it does not support gravity wave phenomena.

In his initial Relativity paper, Einstein created a model for gravity that modifies Newtonian theory:

$$\nabla^2\phi - \lambda\phi = 4\pi\kappa\rho\,.$$

Where both λ and κ are constants. Although an improvement, this equation supports gravity waves. Einstein was concerned about the instantaneous effects created by stars at infinity which he felt was wrong. This formulation also implies that the gravitational field is sustained by itself. The potential ϕ tends toward a fixed limiting value and the density of matter becomes zero at infinity. Einstein went on to develop a model where curvature of space-time geometry takes into account gravitational effects. Misner [23] provides an example of this theory in deriving a photon world line that results in predicting bending of light by gravitational forces.

Petkov [24] suggests, in deference to Einstein's space-time theory, that it is the anisotropy of space-time that causes the phenomenon traditionally called inertia and gravitation. Moreover, the concept of space-time curvature is in direct contradiction with experiments. The gravitational red-shift demonstrates that general relativity cannot be interpreted in terms of space-time curvature and that gravity is entirely electromagnetic in origin. Haisch and Rueda [25] suggest that the propagation of gravity waves is not rigorously consistent with space-time curvature. They ask if gravity waves will vanish in a properly chosen coordinate system? The discovery of apparent gravitational energy loss by the Hulse-Taylor pulsar provides indirect evidence for gravity waves.

Jefimenko [26-27] provides very interesting insights into this problem. He introduces a gravitation field as well as a cogravitation field which may be referred to as the spin field or field of rotation defined by the equation:

$$\overline{\mathbf{F}} = \mathbf{m}\left[\,\overline{\mathbf{g}} + \overline{\mathbf{u}} \times \overline{\mathbf{K}}\,\right].$$

Where F represents force, m is mass, u is the velocity vector and K is the cogravity vector. This equation resembles the Lorentz force acting on an electromagnetic particle. This is a crucial analytical finding based upon Heaviside's 1893 paper where equations are shown similar to Maxwell's equations, to describe gravity. Jefimenko also introduces cogravity to account for relativistic effects acting upon a rest mass. Both of these fields satisfy:

$$\nabla \times \overline{\mathbf{g}} = -\frac{\partial \overline{\mathbf{K}}}{\partial \mathbf{t}} \ \ \textbf{and:}\ \nabla \cdot \overline{\mathbf{g}} = -4\pi\,\mathbf{G}\rho;\ \nabla \cdot \overline{\mathbf{K}} = 0.$$

$$\textbf{and:}\ \nabla \times \overline{\mathbf{K}} = -\frac{4\pi\,\mathbf{G}}{\mathbf{c}_{\mathbf{g}}^{2}}\overline{\mathbf{J}}_{\mathbf{g}} + \frac{1}{\mathbf{c}_{\mathbf{g}}^{2}}\frac{\partial \overline{\mathbf{g}}}{\partial \mathbf{t}}.$$

The propagation velocity c_g, per Jefimenko, is assumed less than light speed; we shall modify this approach by assuming this velocity, c_g, which is the speed of gravity waves is actually greater than light speed. Moreover, these expressions for steady-state revert to Newtonian gravity. Interestingly these equations include all pseudo-analytical relations necessary to define unique vectors. If **K** is constant, the transient term disappears and this reduces to Newtonian gravitation. Jefimenko introduces matter currents, and these wave equations, ignoring the $4\,\pi$ term, are:

$$\frac{1}{\mathbf{c}_{\mathbf{g}}^{2}}\frac{\partial^{2}\overline{\mathbf{g}}}{\partial \mathbf{t}^{2}} - \nabla^{2}\overline{\mathbf{g}} = \mathbf{G}\left[\nabla\cdot\rho_{\mathbf{g}} + \frac{1}{\mathbf{c}_{\mathbf{g}}^{2}}\frac{\partial \overline{\mathbf{J}}_{\mathbf{g}}}{\partial \mathbf{t}}\right],$$

$$\frac{1}{\mathbf{c}_{\mathbf{g}}^{2}}\frac{\partial^{2}\overline{\mathbf{K}}}{\partial \mathbf{t}^{2}} - \nabla^{2}\overline{\mathbf{K}} = -\frac{\mathbf{G}}{\mathbf{c}_{\mathbf{g}}^{2}}\nabla\times\overline{\mathbf{J}}_{\mathbf{g}}\ .$$

For relativistic effects, he carries the terms one step further and defines gravity as:

$$\bar{\mathbf{g}} = -\mathbf{G}\frac{\mathbf{m}}{\mathbf{r}^3\left(1-\bar{\mathbf{r}}\cdot\bar{\mathbf{v}}/\mathbf{rc}\right)^3}\left[\left(\bar{\mathbf{r}}-\frac{\mathbf{r}\bar{\mathbf{v}}}{\mathbf{c}}\right)\left(1-\frac{\mathbf{v}^2}{\mathbf{c}^2}\right)+\bar{\mathbf{r}}\times\left[\left(\bar{\mathbf{r}}-\frac{\mathbf{r}\bar{\mathbf{v}}}{\mathbf{c}}\right)\times\frac{\dot{\bar{\mathbf{v}}}}{\mathbf{c}^2}\right]\right]$$

The leading coefficient adjusts for Newtonian gravity while the first term in the parenthesis is a light speed correction as a function of distance. The second or new component of this gravitational field depends upon velocity and is essentially a torque. Such a gravitational torque in a field involving planets causes planetary rotation in the direction of the orbital velocity of an adjacent planet. This term explains why the same side of the moon always faces the earth and reduces to:

$$\bar{\mathbf{g}} = -\mathbf{G}\frac{\mathbf{m}}{\mathbf{r}^3}\left[\left(1-\frac{\mathbf{v}^2}{2\mathbf{c}^2}\right)\bar{\mathbf{r}}_{\mathbf{o}} - \frac{2\mathbf{r}\mathbf{v}^2}{3\mathbf{c}^3}\bar{\mathbf{v}}_{\mathbf{o}}\right].$$

C. Unification

The term *unification* is ambiguous. It should explain the interactions between different types of forces and how they relate to each other. The main concern involves relating electric, magnetic, and gravitic forces. An approach would be to rely upon an undiscovered physical principle to achieve this. If this is not possible, what is the alternative?

Cravens [28] typifies such an alternative. He uses Einstein's tensor notation in four dimensions considering time and three spatial dimensions and assumes that additional admissible phenomenon may exist that are related by another process. The impact of these undiscovered laws is to add an additional dimension so that the action matrix grows from 4x4 to 5x5. This causes changes to the conservation laws by the appearance of additional terms. Cravens describes experiments to confirm or deny these terms and this warrants further investigation.

The major issue in these discussions is that there is clearly an interaction between electromagnetic and gravitic forces. For example, the hydrodynamic equations admit solutions that allow for the existence of vortices. Maxwell's equations possess mathematical terms that also allow for vortices. Murad has derived the electric and magnetic intensity equations indicating that the only coupling between steady-state electric and magnetic fields is through the curl of the opposing force's current. This is not obvious using Lorentz conditions or the traditional vector and scalar potentials. If the curl of the electric current is zero, the magnetic field exists independent of the electric field and vice versa. This suggests that magnetic or electric vortices can exist as a separate and pure entity. For the transient terms, because of the coefficient of the magnetic current term, the electric currents will have a more dominant role on the magnetic field than the magnetic current will have on the electric field. For this reason, it is easier to find an electric current than it is to experimentally isolate a magnetic current. Moreover, all of these equations have similar terms and this behavior should not be accepted in a cavalier fashion. There are claims of theoretically generating pure electric and magnetic vortices due to these terms. If one uses the Jefimenko gravitation model, the same may be said about creating a gravity and/or cogravity vortex. Gravispin waves may convert gravity into electromagnetic radiation and vice versa. This has clear implications concerning unification.

D. Unified Field Theory

It is our premise that strong electric and magnetic fields may produce a gravity well as part of the propulsion milieu. Unfortunately, we can not give any details about how to achieve this without far more research. Similarly, Cassenti and Ringmacher [29] looked at Einstein's theory of gravitation for general relativity where strong magnetic fields counter-balance the effects of a planet's attraction. Here, the fields are very strong and conditions are sublight.

Another approach assumes that a relation exists directly between the different forces. A reason for selecting the Jefimenko gravitation/cogravitation model is the form of the partial differential equations. The E-M equations are:

$$\frac{1}{\mathbf{c}^2}\frac{\partial^2 \overline{\mathbf{E}}}{\partial \mathbf{t}^2} - \nabla^2 \overline{\mathbf{E}} = -\mu \frac{\partial \overline{\mathbf{J}}_\mathbf{c}}{\partial \mathbf{t}} - \frac{1}{\varepsilon}\nabla \rho_\mathbf{c} + \nabla \times \overline{\mathbf{J}}_\mathbf{m},$$

$$\frac{1}{\mathbf{c}^2}\frac{\partial^2 \overline{\mathbf{B}}}{\partial \mathbf{t}^2} - \nabla^2 \overline{\mathbf{B}} = \frac{1}{\mathbf{c}^2}\frac{\partial \overline{\mathbf{J}}_\mathbf{m}}{\partial \mathbf{t}} - \nabla \rho_\mathbf{m} + \mu \nabla \times \overline{\mathbf{J}}_\mathbf{c}.$$

Where E is the electric field intensity, B is the magnetic field intensity, μ is permeability, ε is permitivity, ρ is the charge, J_m is magnetic currents, and J_c is electric currents. And gravity/cogravity fields are defined by:

$$\frac{1}{\mathbf{c}_\mathbf{g}^2}\frac{\partial^2 \overline{\mathbf{g}}}{\partial \mathbf{t}^2} - \nabla^2 \overline{\mathbf{g}} = \mathbf{G}\left[\nabla \cdot \rho_\mathbf{g} + \frac{1}{\mathbf{c}_\mathbf{g}^2}\frac{\partial \overline{\mathbf{J}}_\mathbf{g}}{\partial \mathbf{t}}\right],$$

$$\frac{1}{\mathbf{c}_\mathbf{g}^2}\frac{\partial^2 \overline{\mathbf{K}}}{\partial \mathbf{t}^2} - \nabla^2 \overline{\mathbf{K}} = -\frac{\mathbf{G}}{\mathbf{c}_\mathbf{g}^2}\nabla \times \overline{\mathbf{J}}_\mathbf{g}.$$

In these equations, ρ is the gravitational charge and J_g is the gravitational current. Great simplifications occur in these equations if one allows the speed of gravity waves to be equal to the speed of light. Additional similarities exist if the transient and source terms are also numerically similar. There is no reason to assume that this occurs although there appear to be similarities between the electric and magnetic field intensity equations and, with a leap of faith, some similarities between the gravitic and cogravitic fields. Legitimate coupling exists between the E-M fields due to the curl of the currents. Moreover, unification should relate coefficients in these equations to each other to find additional coupling. Jefimenko uses an argument that the gravitation field is proportional to the electric field by a factor. He presupposes an analogy between the gravity and E-M fields surrounding a body. However, this analogy is not obvious because there are many differences within these equations to include: propagation velocity, time rate of change of currents and source terms. Such differences influence each of these fields.

Looking at Jefimenko's equations reveals the same types of terms for both gravity and cogravity. Dyatlov introduces what he calls a *gravispin* field which should not be confused with a gravitational vortex. The difficulty is to provide realistic physical evidence that such phenomena exists and is easily reproduced in a measurable way for a propulsor. If Jefimenko's model is correct and the gravity and cogravity equations resemble E-M equations, several similarities should exist. What is the meaning of amplitude, frequency, phase shift, and polarization of a gravity wave? What does a gravitational vortex, dipole, or quadrapole mean? Are there physical representations that provide answers to these questions?

Consider a relativistic particle with inertia moving near a larger body's gravitational field. The equation of motion for a particle in these fields becomes:

$$\frac{\mathbf{d}}{\mathbf{dt}}\left(\gamma \mathbf{m_o}\bar{\mathbf{v}}\right)=\mathbf{q}\left[\bar{\mathbf{E}}+\bar{\mathbf{v}}\times\bar{\mathbf{B}}\right]+\mathbf{m_o}\left[\bar{\mathbf{g}}+\bar{\mathbf{v}}\times\bar{\mathbf{K}}\right].$$

Here γ is the relativity factor and q is electric charge. Separating this yields:

$$\frac{\mathbf{d}}{\mathbf{dt}}\left(\gamma\ \mathbf{m_o}\ \bar{\mathbf{v}}\right)=\mathbf{q}\ \bar{\mathbf{E}}+\mathbf{m_o}\ \bar{\mathbf{g}};\ \ \mathbf{and:}\ \bar{\mathbf{v}}\times\left[\mathbf{q}\,\bar{\mathbf{B}}+\mathbf{m_o}\ \bar{\mathbf{K}}\right]=0.$$

Under certain circumstances, a coupling may exist between inertia, electricity and the gravity fields as well as a secondary coupling between the magnetic and cogravity fields. Consider the second relation and look at ways where the cross-product term goes to zero. One obvious solution is if the rest mass and the cogravity field satisfy the identity:

$$\mathbf{q}\bar{\mathbf{B}}=-\ \mathbf{m_o}\bar{\mathbf{K}}.$$

This implies that the magnetic field is directly proportional to the cogravitation field. If one uses solutions to the wave equations proposed by Jefimenko for magnetic and cogravity currents, this becomes:

$$\frac{\mathbf{q}}{\mathbf{m_o}}=\frac{\mathbf{G}}{\mu_{\mathbf{o}}\mathbf{c}_{\mathbf{g}}^{2}}\left[\frac{\int\left[\frac{1}{\mathbf{r}}\nabla\times\bar{\mathbf{J}}_{\mathbf{g}}\right]\mathbf{dV}}{\int\frac{1}{\mathbf{r}}\left[\nabla\rho_{\mathbf{m}}-\mu\nabla\times\bar{\mathbf{J}}_{\mathbf{c}}-\frac{1}{\mathbf{c}^{2}}\frac{\partial\mathbf{J}_{\mathbf{m}}}{\partial\mathbf{t}}\right]\mathbf{dV}}\right].$$

The LHS is the electric charge to mass ratio while the RHS is a function of gravity, magnetic, and electric currents as well as magnetic charge. If these currents exist, then cogravity currents exist and vice versa. If magnetic currents are altered or reversed, how does this influences the gravity currents within a propulsor?

Let us consider the remaining force equation:

$$\frac{\mathbf{d}}{\mathbf{dt}}\left(\gamma\ \mathbf{m_o}\ \bar{\mathbf{v}}\right)=\mathbf{q}\ \bar{\mathbf{E}}+\mathbf{m_o}\ \bar{\mathbf{g}}.$$

If we consider special relativity, a similar expression exists for the charge to mass ratio as previously derived since the LHS vanishes. For the steady-state situation, this becomes:

$$\frac{\mathbf{q}}{\mathbf{m_o}}=-\ \frac{\bar{\mathbf{g}}}{\bar{\mathbf{E}}},$$

Alternatively, the charge to mass ratio is now a function of gravity and electrical currents. We could use the same solution as in the previous example. However, to create an identity for both of these expressions, we need to simplify the equations using:

$$\frac{\partial \bar{\mathbf{J}}_{\mathbf{g}}}{\partial \mathbf{t}} - \nabla \times \bar{\mathbf{J}}_{\mathbf{g}} = -\mathbf{c}_{\mathbf{g}}^{2} \nabla \rho_{\mathbf{g}} \text{ , and}$$

$$\frac{\partial}{\partial \mathbf{t}}\left[\mu \bar{\mathbf{J}}_{\mathbf{c}} - \frac{1}{\mathbf{c}^{2}} \bar{\mathbf{J}}_{\mathbf{m}}\right] - \nabla \times \left[\mu \bar{\mathbf{J}}_{\mathbf{c}} - \frac{\beta}{\mathbf{c}^{2}} \bar{\mathbf{J}}_{\mathbf{m}}\right] = \nabla \left[\frac{\rho_{\mathbf{e}}}{\varepsilon} - \rho_{\mathbf{m}}\right].$$

The first equation resembles a conservation of matter currents driven by a gravity source ρ_g, while the second is a pseudo-conservation equation for electric and magnetic currents J_c and J_m, and charges ρ_c and ρ_m.

The transient situation that considers the particle's inertia is far more interesting. The equations are greatly simplified if the assumption is made that gravitons move at the speed of light; however, this implies more restrictive assumptions concerning the magnitude and transient behavior of various currents. If the following terms were simplified, these terms would greatly reduce the complexity of these expressions:

$$\frac{\partial}{\partial t}\left[\frac{m_0 \mathbf{G}}{\mathbf{c}_{\mathbf{g}}^{2}} \bar{\mathbf{J}}_{\mathbf{g}} - \mu \mathbf{q} \bar{\mathbf{J}}_{\mathbf{c}}\right] + \nabla \cdot \left[m_o \mathbf{G} \rho_{\mathbf{g}} - \frac{1}{\varepsilon} \rho_{\mathbf{c}}\right] + \mathbf{q} \nabla \times \bar{J}_m, \text{ and}$$

$$q\left[\frac{1}{c^{2}} \frac{\partial \bar{\mathbf{J}}_{\mathbf{m}}}{\partial \mathbf{t}} - \nabla \rho_{\mathbf{m}}\right] + \nabla \times \left[\mu \mathbf{q} \bar{\mathbf{J}}_{\mathbf{c}} - \frac{\mathbf{m}_{\mathbf{o}} \mathbf{G}}{\mathbf{c}_{\mathbf{g}}^{2}} \bar{\mathbf{J}}_{\mathbf{g}}\right].$$

Again, these terms suggest a correspondence exists between electric, gravitic, and magnetic field currents.

There are other desired outputs from such an analysis. In addition to generating identities, it would be beneficial if relations could be defined amongst the constants that appear in this problem such as mass, the various currents and charges and ultimately an understanding of the speed of gravity waves with respect to the speed of light. For example, if the transient terms are equal, we could deduce Dyatlov's commentary [30] that gravitons have the same speed as photons. This would assume, in contrast to the argument previously presented about black holes, that gravity waves and assuming gravitons are the same, do not move away from a body but toward that body. We could also adopt the view that gravitons move at the speed of light but that subsequent gravity waves are a disturbance that moves faster than the speed of light amongst gravitons.

Results

The essence of these effects needs to be examined in terms of influencing a space propulsive drive. If the ZPF as well as the Physical Vacuum is not uniformly distributed, a tentative global model for the physical vacuum or the M-D-D (Murad-Dyatlov-Dmitriev) equation can be used as a crude first step:

$$\frac{1}{\mathbf{c}_{\mathbf{p}}^{2}} \frac{\partial^{2} \bar{\Gamma}}{\partial \mathbf{t}^{2}} + \alpha \nabla^{2} \bar{\Gamma} = +\mu \bar{\mathbf{R}} - \bar{\mathbf{I}}, \textbf{ where: } \nabla^{2} \bar{\Gamma} = \frac{1}{\mathbf{r}^{2}} \frac{\partial}{\partial \mathbf{r}}\left[\mathbf{r}^{2} \frac{\partial \bar{\Gamma}}{\partial \mathbf{r}}\right] + \ldots\ldots$$

The probability of the physical vacuum intensity (Γ) depends upon a propagation speed (c_p) as well as terms that allow for 'flicker' or quantum mechanical 'pulse generation' concerning the creation term (R) and/or annihilation term (I) of quantum level particles. If one does not wish to accept the flicker notion from the

ZPF perspective, one may also use these terms to characterize creating or annihilating dipoles and quadrapoles which will influence the vacuum domain's mass, electric, magnetic, and spin fields. The terms α and μ are used to allow for the inclusion of other effects regarding homogeneity and polarization as well as a simple means of matching experimental data, if such information was available. The Laplacian term is not meant to be firm but is shown in spherical coordinates only as a simplification. This equation is very geometry dependent and needs to consider the several (5) spiral arms for our galaxy. Angular terms should be added to accurately model our galaxy. If this correctly models the physical vacuum, the door is open to examining mathematical effects and establishing more meaningful experiments regarding the physical vacuum.

A. Potential Experiments

Since the physical vacuum consists of electric, magnetic, gravitic and spin fields, an experiment may be identified. The experiment is based upon a detector for each of these separate quantities and goes along the premise that the PV is random in location, size, and appearance. The place of the experiment must be such that the effects of each of these fields are eliminated or reduced as much as conceivably possible. There are several choices for us to consider.

Since we are discussing the inhomogeneous physical vacuum, this implies the domain may have various sizes and is not continuously distributed. The objective is to identify in a repeatable fashion an anomalous phenomenon and attempt to understand it by either duplicating the effects experimentally or analytically. Ball lightning and faint electromagnetic emissions at geological fault lines are one specific location for these investigations. These requirements should be relatively easy with devices set in place to detect long-term effects.

One may ask about the types of sensors to be used. Some observations suggest biological life forms such as human beings may sense vacuum domains and their radiation. Although this is an option, there is controversy regarding the types of metrics to isolate this capability or provide reliable predictions and obviously more work is required within this discipline.

Other experiments are more complex and would possibly be a bridge for a collaborative venture between the U.S. and Russia. To minimize the influence of magnetic fields, one may have to go to a location where there is little or no magnetic field. The only place where such a location exists is the moon. To eliminate gravitational effects, our experiment should be in orbit around the moon. To minimize electric effects, the Russians revealed in '89 that each of their satellites incorporate an ionic thruster for two purposes. The primary purpose was station-keeping and the secondary purpose would use the ion exhaust from the thruster to sweep over the spacecraft to deionize it. This would reduce areas of a specific charge and make our spacecraft electrically neutral. The only influence left is that of spin fields. Here, during different segments of our experiments, the satellite could take measurements and repeat the process after spinning the satellite about different rotational axes.

A physical vacuum would be detected with sudden changes in the field strength of an electric, magnetic, gravitic, or spin nature. This needs highly sensitize instruments to reduce the probability of false alarm rate but even here, a false alarm may be real and actually provide evidence of a physical vacuum. Other instrumentation may include using radiometers and quartz resonators. Experiments show that if quartz resonators are placed apart, differences may be measured within their oscillation frequency. This approach was previously used at the Institute of Clinical and Experimental Medicine (ICEM).

Kittel [31] says each crystal has a spectrum of frequencies. These can be altered by an electric field if the crystal is electrostictive and with a magnetic field if the material is magnetostictive [32]. Such crystals would be mounted on two different spacecraft that would be directed toward diametrically opposite ends of the solar system or, as in the case here, different orbits around the moon. If no effects occur, the separate spacecraft should provide identical readings. If one provides changes in the data stream, it may be due to the PV, experimental or instrumentation error or some other events such as a micrometeorite impact.

The physical make-up of the experiment deserves discussion. These crystals are aligned along the x, y, and z-axis using a gimbal arrangement. The alignment in both spacecraft should theoretically be identical to minimize errors. This would discern electric, magnetic, or gravitic effects. Likewise, electric, magnetic, and gravitational fields influence moving charged particles. Along three axes, one may use a cathode tube in lieu of crystals to measure beam deflection to ascertain magnitudes of these fields. The question remains to accurately measure the spin field. Here, a super-conducting magnet will measure a change in the internal electric current that would reveal the spin field through a direct proportionality. This may be a suitable approach to resolve this issue. Obviously, the merits of such approaches need to be assessed and there are probably more suitable methods for identifying the sudden appearance or changes within the vacuum fields. These are only provided as a first-order possibility.

Conclusions

Our emphasis is to characterize the physics of what exists and does not exist for both the inhomogeneous physical vacuum and the ZPF theories. Differences from the Russian perspective of the physical vacuum are also addressed considering the effects of either a homogeneous or inhomogeneous description. The former is in closer agreement with ZPF concepts whereas the latter has more utility to resolve anomalous phenomenon to include unusual weather or faint electromagnetic emissions near geological fault. Once differences are understood, the problem remains to find the means to extract energy from the void for use within a space drive.

Several simple experiments are identified which may have usefulness from the perspective of noting change detection within the electric, magnetic, gravitic, or cogravitic (spin) fields. Some of these experiments require spacecraft and may be ideal for a collaborative effort between Russia and the U.S.

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