THE "CHEMISTRY" OF FUNDAMENTAL PARTICLES AND GRAVITATION

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ABSTRACT

From one generalized field equation all observable force fields in nature can be derived. This generalized field equation describes the universal "force field" which is composed of pilot wave bundles on "UrMaterie". All relativistic fields, including the gravitational field, can be quantized and shown to be interrelated to one another. Utilizing various energy channeling configurations, bundles of energy as carried by neutrinos result in matter formation. Experimental investigation is proposed for photon-photon, neutrino and other couplings. Methods for measuring time-dependent stresses as related to the Fourier transform of the Riemann tensor are given.

Introduction

An energy field, through which, for example, electromagnetic and gravitational disturbances are transmitted, is postulated as a uniform medium throughout the material vacuum of space. This energy field contains bundles of energy or wave packets corresponding to Heisenberg's "Urmaterie", which are responsible for the formation of matter described by a universal field equation (Ref.1). Also, these energy bundles are postulated to be responsible for many of the fundamental processes in the universe. For example, it is suggested that the gravitational field can be quantized into discrete quanta or gravitons similar to the electromagnetic field being quantized into photons and the nuclear field being quantized into π-mesons. An equation must be derived which can apply to all particles and fields including the gravitational field.

Since Einstein's theory of the gravitational field has many common elements with Maxwell's theory of the electromagnetic field, it can be expected that an oscillating mass should give rise to gravitational waves just as an oscillating electric charge produces electromagnetic waves. Einstein's solutions to the basic equation of general relativity represent such gravitational disturbances propagating through space with the velocity of light.

Generalized Field Equation

To find the basic field equation which describes the universal "force field" containing energy bundles or wave packets corresponding to the "Urmaterie", the following approach is taken. Heisenberg's "Urmaterie" is characterized by a pilot wave bundle which acts as a "carrier" or transport vehicle which isn't limited to any particular mass. The particle which fits the description of the "carrier" is the neutrino, because neutrinos carry a variable amount of energy and have zero rest mass. From this concept develops a neutrino field theory of matter (Chemistry of Fundamental Particles). This concept differs from the usual composite particle models because the neutrino itself hasn't a well defined mass, instead it carries energy used for formation of photons, gravitons, and other fundumental particles. We are also led to conclude that the basic field equation, besides the gravitational, must be non-linear in order to account for "inter action."

The next point is that the basic neutrino field must be a spinor (Ref.2). This is so because from spinors one can construct tensors, i.e. the solutions of a non-linear spinor equation may be (either fermions, or) bosons.

We now proceed to develop a field equation in accordance with the foregoing principles. Utilizing the simple spinor equation of Dirac (Ref.2, 3)

$$\gamma_\mu \partial \psi + \chi \psi = 0 \qquad (1)$$

represents the arbitrary mass parameter of a fundamental particle. In a universal matter theory, the mass of the particle must be based upon a "carrier" self-energy effect rather than an individual characteristic. This χ must be replaced by a field energy potential V. This potential must be large where there is a large concentration of wave packets of energy yielding a material particle. In the Dirac theory, the density of matter is given by $\psi^* \psi$, and it is easily shown that V is proportional to this bilinear expression. Therefore

$$\gamma_\mu \partial \psi - l_0^2 \psi^* \psi \cdot \psi = 0 \qquad (2a)$$

has the dimension of length. For example, this equation can be written in the form

$$\gamma_\nu \partial \psi / \partial x_\nu - l_0^2 \psi (\psi^* \psi) = 0 \qquad (2b)$$

Equation (2b) can have solutions for the lepton $\psi = \psi^e$ such that $\psi^{*e} \psi$ equals a constant. The term $l_0^2 \psi^{*e} \psi$ can be replaced by the constant $\chi = \frac{m_e c}{\hbar}$. Thus is obtained the usual equation for a fundamental lepton with mass m_e. Identifying this with the electron, the numerical value of the universal length becomes fixed which is on order 10^{-13} cm.

Another solution of Equation (2b), $\psi = \psi^{\gamma}$ has the property that the bilinear $F_{\mu\nu} = \psi^{*\gamma}(\gamma_\mu \gamma_\nu - \gamma_\nu \gamma_\mu)\psi^{\gamma}$ satisfies the tensor form (see Equation (7)) of the Maxwell equations. Therefore, this particular solution can be identified with a photon, and the anti symmetric tensor $F_{\mu\nu}$ with the electromagnetic field strength.

Because of the non-linearity of Equation (2b), the superposition of example ψ^{e} and ψ^{γ} will not satisfy the equation any longer. However, modification to the solutions so as to satisfy Equation (2b) by their superposition $(\psi^{e'} + \psi^{\gamma'})$ gives a field which describes an interacting state of the electron and photon, i.e. compton scattering. Now, comparing the result with the cross-section for the classical low energy limit $\sigma = (8\pi/3)/(e^2/m_0c^2)^2$ (Thompson scattering), one obtains the value for the electric charge e. This is of the proper order of magnitude, which is a great accomplishment of the theory.

Actually the above procedure is over simplified. Equation (2b) should not be considered as a classical field equation, but rather as the field equation for a quantized field operator ψ and looked for "eigen solutions" of the Hamiltonian for the system. Great difficulty is encountered because there is no exact method of finding the quantized solution of a non-linear field equation. This is overcome by a difficult approximation method by allowing for a non-positive definite metric in Hilbert space. As long as a result from a realistic experiment is expected, i.e. comparing amplitudes of incoming and outgoing asymptotic states at a large distance from the zone of interaction, the severe difficulty of having states into which the transition probability becomes negative is eliminated. Negative transition probabilities only occur if measurements are performed in region less than $l_0 \doteq 10^{-13}$ cm. Thus, the concept of probability is complementary to that of description in a small space- and time-scale.

Equation (2b) cannot be considered as complete. In particular it doesn't account for an isobaric spin and baryon number (Ref. 2). The symmetric properties of Equation (2) can be enlarged to contain the generalized phase-transformation $\psi \rightarrow e^{i\alpha\gamma_5}\psi$ and the Pauli group. These Pauli spin matrices and groups define the baryon number and iso spin respectively. (The latter is possible since the Pauli group is isomorphic with a three-dimensional relation group). The modified equation thus reads as follows:

$$\gamma_\mu \psi \pm l_0^2 (\psi^* \gamma_\mu \gamma_5 \psi) \gamma_\mu \gamma_5 \psi = 0 \quad (3a)$$

$$\gamma_\nu \frac{\partial \psi}{\partial x_\nu} \pm l_0^2 \gamma_\mu \gamma_5 \psi (\psi^* \gamma_\mu \gamma_5 \psi) = 0 \quad (3b)$$

γ signifies the usual gamma matrices and the linear term signifies interaction.

It is now suggested that the properties of the eigensolutions of this quantized field equation be concentrated upon. The previously suggested solutions in this paper (i.e. ψ^e, ψ^γ, $\psi^{e'} + \psi^{\gamma'}$ and other solutions identified with other particles as depicted in Table 1 herein) should basically reflect our analysis to equation (2b). It is readily seen that the enlarged equation (3a), basically agrees with the Dirac equation for a neutrino (ref.2).

For the case of the graviton we use the equation

$$\gamma_\mu \psi^g \pm l_0^2 (\psi^{*g} \gamma_\mu \gamma_5 \psi^g) \gamma_\mu \gamma_5 \psi^g = 0$$

where the curvature tensor

$$G_{\mu\nu} = \psi^{*g} (\gamma_\mu \gamma_g - \gamma_g \gamma_\mu) \psi^g e^{2i\alpha\gamma_5}$$

satisfies the tensor analogs of Maxwell's equations. Therefore, this particular solution can be identified with a quantized particle called a graviton, and the curvature tensor can be identified with the gravitation field weak interaction. It might be of interest to note that the graviton is a boson, and also has zero rest mass like photons and neutrinos. Actually the graviton, while in motion (as an energy carrier for energy exchange weak interaction), has an effective inertial mass.

<u>Topological Geometrodynamics</u>

Gravitational fields have a nonlinear character responsible for many unexplored consequences, i.e., a collection of immaterial energy (quanta) holds itself together by its own gravitational attraction. This is similar to the mechanism that holds the components of an explosive plasma together for a limited time (ref.4). By analyzing such an object, mathematically defined as a geon, the response of neutrinos to gravitational fields and production of gravitational fields by neutrinos is easily shown. This also indicates compliance with the de Broglie concept. In dealing with the Feynman quantization of general relativity, there is a topological invariance in dealing with hypersurface reflections from one hypersurface to another. In fact, in this topological theory, because of invariance, the Hamiltonian vanishes. From these results, worm holes (Ref.4) are shown to be convenient topographical approximations to hypersurfaces. An alternative more complex algebraic approach would be to incorporate and apply Georg Cantor's mathematics of transfinite numbering.

As a simple illustration, let us consider a two-dimensional worm hole shrinking until the worm hole breaks in half. This leaves two stumps where the topologies are now Euclidean. If such a process exists, it is reasonable that the inverse exists; i.e., two stumps can grow until they join (Fig.1). Because of this, an observer at the end of either stump could, by studying the behavior of the metric around him, presumably infer that the metric is about to become singular in such a way that space shall "tear open" and join into something else, i.e. a geon. If four stumps are forming from the geon (graviton) and tear simultaneously, they could pair off as i.e. four neutrinos.

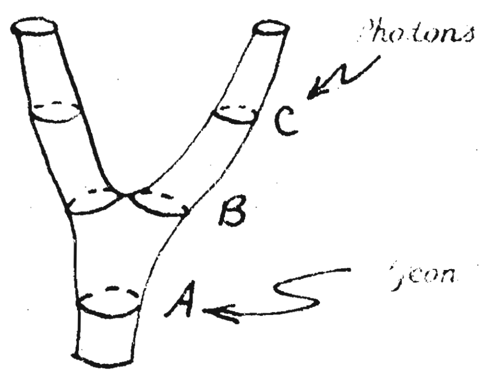


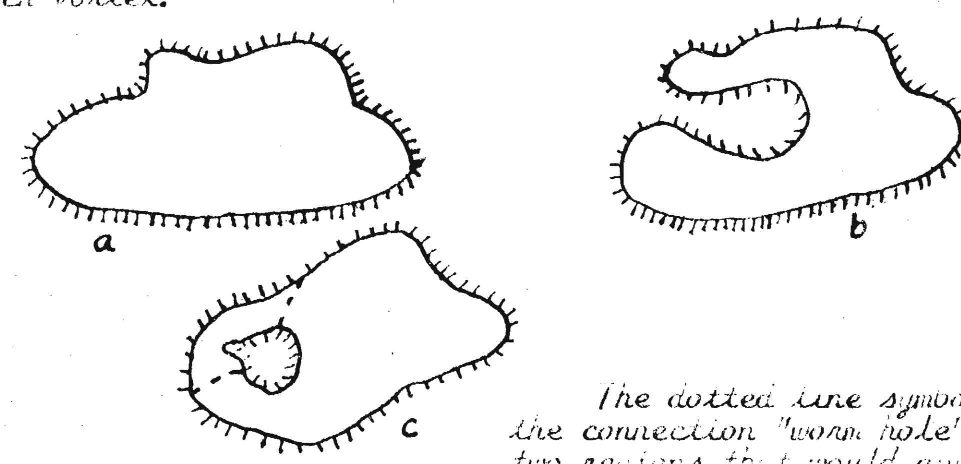
Fig. 1 Topology Change.

According to Wheeler (Ref.6), classical gravitation, electromagnetism, charge, and mass can be described in terms of specialization of Riemannian geometry of a curved empty space (void of organized matter). When this is accomplished, the science of geometrodynamics appears, which on the surface seems to be unrelated to the world of particle physics.

In dealing with geometrodynamics, all kinds of sub-fields emerge: neutrino fields, photon fields, graviton fields, electron fields, meson fields, plus numerous other fields. These sub-fields can be described separately by sub-field equations (Ref. 3) or they can be derived from the generalized field equation as described herein. Theoretically each fundamental particle of energy has a sub-field associated with it because it exerts an influence on the medium surrounding it along with any other bodies which may be in the vacinity. Conversely, each sub-field can be quantized into a "wave packet" or "energy bundle".

The object of this paper is to show that there is no absolutely defined fundamental building block of energy in the universe. Instead, there are various energy spectrums, each corresponding to a particular range of energies associated with particular wave packets. The waves are treated as pilot neutrino waves formed by disturbances in the universal energy field of space.

Before we treat the problem of quantizing the various fields previously mentioned, it is convenient to further introduce topological concepts. Take, for example, a typical multiple connected space as is shown in Figure 2. By proper warping as illustrated, a channeling configuration (Ref. 3) "worm hole" develops where the net flux of the energy lines of force are channeled. These lines are, figuratively speaking, trapped by the topology of space. For example, these lines give the appearance of a "positive charge" at one end of the worm hole and a "negative charge" at the other. In treating the gravitational analog, we have a "positive mass" and a "negative mass" formed at each vortex.



The dotted line symbolizes the connection "worm hole" between two regions that would appear if the cut were made in another plane.

Fig. 2

This leads to either a topological "worm hole", or a multidimensional hyperspace concept of the universe as far as the elementary particles, and force fields (including gravitational) is concerned (Ref. 5).

Graviton, Photon, Neutrino Quanta

R. P. Feynman showed the graviton, photon, and neutrino had spins of 2, 1, and ½, respectively. Table 1 (Ref. 4) illustrates easily found relationships between these and other quantized particles. A definite relationship can be shown between Bose-Einstein particles and Fermi-Dirac particles to obtain a uniformity relationship.

It can be shown from our previous discussions that all fundamental particles are different forms of manifestation of the "Urmaterie", interrelated to each other by symmetry, and are derivable from energy carried by fundamental neutrino quanta. For example, the photon is made up of two indiscrete Dirac corpuscles rather than by one. These corpuscles or demiphotons can be complementary in much the same manner that the positive electron is complementary to the negative electron in Dirac's theory of holes. These complementary corpuscles can annihilate themselves on contact with matter by giving up all their energy, thus accounting for the characteristics of the photoelectric effect. In addition, these corpuscles with a spin of $\pm\hbar/2$ should obey the Bose-Einstein statistics, as the exactness of Planck's law of black-body radiation demands. Finally, this model permits definition of an electromagnetic field connected with the probability of annihilation of the photon, a field that obeys Maxwell's equations and possesses all the characteristics of the electromagnetic light wave. It should be possible to extrapolate this result to the case of the graviton. Ramakrishnan's wave equation for a neutrino (Ref. 3) indicates that the demiphoton mentioned by de Broglie fits the description of the neutrino. Table 1 shows that approximately two neutrinos form a photon and four neutrinos (two photons) form a graviton. The angular momentum and spin of such a particle determine whether the particle is an ordinary or anti-particle of positive or negative mass.

Table 1 Basic Relationships between Fundamental Particles

Particle	Symbol	Charge	Spin	Magnetic Moment	Rest Mass m_e	Mean Life	Decay Mode	Other Basic Interactions
Leptons								
Neutrino	ν°	0	$\frac{1}{2}(\frac{h}{2\pi}) = \hbar/2$	0	$\sim 5\cdot10^{-4}$	Stable	$\nu^\circ \rightleftarrows x$ [illegible]	ν° + [illegible]
Antineutrino	$\bar{\nu}^\circ$	0	$\frac{1}{2} = -\hbar/2$	0	$>-5\cdot10^{-4}$		[illegible]	
Photon	γ	0	$1\ \hbar$	0	~ 0	Stable	$\gamma \rightleftarrows \nu^\circ + \nu^\circ$	[illegible]
Antiphoton	$\bar{\gamma}$	0	$-1\ \hbar$	0	~ 0		$\bar{\gamma} \rightleftarrows \bar{\nu}^\circ + \bar{\nu}^\circ$	
Graviton	g	0	$2\ \hbar$	0	$\sim 10^{3}$	Stable	$g \rightleftarrows$ [illegible] $+ \gamma +$ [illegible]	$g + \bar{g}$ [illegible]
Antigraviton	$\bar{g}$	0	$-2\ \hbar$	0	$\sim 10^{-3}$		$\bar{g} \rightleftarrows \bar{\gamma} + \bar{\gamma} +$ [illegible]	
Electron	e^-	-1	$\frac{1}{2}\ \hbar$	--	$1\ m_e = 9.1083 \times 10^{-31} kg$	Stable	$\gamma + \bar{\nu}^\circ$, $\nu^\circ + \bar{\nu}^\circ + \bar{\nu}$	$e^- + e^+$ [illegible] $\nu^\circ + \nu^\circ$, $\gamma + \bar{\gamma}$, [illegible]
Positron	e^+	+1	$-\frac{1}{2}\ \hbar$	--	-1		$\bar{\gamma} + \nu^\circ$	
Mesons								
Muon	μ^- μ^+	-1 +1	$\frac{1}{2}\ \hbar$ $-\frac{1}{2}\ \hbar$	-- Strangeness	207 -207	2.2×10^{-6} 2.2×10^{-6}	$e^- + \nu^\circ + \bar{\nu}^\circ$ $e^+ + \nu^\circ + \bar{\nu}^\circ$	$\mu^+ + \nu^\circ \rightarrow e^+ + \nu^\circ$ $\mu^- + p \rightarrow n + \gamma$
Pion	π^-	-1	0	0	-273.2	2.6×10^{-8}	$\mu^- +$ [illegible]ν°, $e^- + \bar{\nu}^\circ + \gamma^\circ$	$\pi^+ + \pi^- \xrightarrow{strong} p + \bar{p}$ $\pi^+ + \pi^\circ \xrightarrow{strong} p + \bar{n}$
	π^+	+1	0	0	273.2	2.6×10^{-8}	$\mu^+ +$ [illegible]ν°, $e^+ + \nu^\circ +$ [illegible]	
	π°	0	0	0	± 264.2		$\gamma + \gamma$, $e^+ + e^- +$ [illegible], $e^+ + e^- +$ $e^+ + e^-$	
Heavy Mesons								
K	K_2° (θ_2°)	0	[illegible] $\hbar$		965	3×10^{-8} to 10^{-8}	$\pi^+ + e^+ +$ [illegible] $\pi^- + e^+ +$ [illegible] $\pi^+ + \mu^- + \nu$ $\pi^- + \mu^+ + \nu$ $\pi^+ + \pi^- + \pi^\circ$ $\pi^\circ + \pi^\circ + \pi^\circ$	$K^- + p \rightarrow \Lambda^\circ + KE$, $K^- + p \rightarrow \Lambda^\circ + \pi^\circ$, $K^- + p \rightarrow \Lambda^\circ + \pi^+ + \pi^-$
	K_1°(θ_2°)	-1	0	+1	-965		$\pi^+ + \pi^-$ $\pi^\circ + \pi^\circ$	$K^- + p \rightarrow \Sigma^- + \pi^+$, $K^- + p \rightarrow \Sigma^+ + \pi^-$; $K^- + p \rightarrow \Sigma^\circ + \pi^\circ$,
Theta	θ° θ^+ $\bar{\theta}^\circ$	0 +1 0	0 0 0	0 + 0	966		$K^+ + K^- +$ [illegible] $K^+ + K^\circ +$ [illegible] $K^- + K^+ +$ [illegible]	$K^- + n \rightarrow \Lambda^\circ + \pi^-$, $K^- + n \rightarrow \Lambda^\circ + K^- n + K^\circ$ [illegible] $K^- + n \rightarrow$ [illegible] $+ \pi^\circ$ $K^- + n \rightarrow \Sigma^- + KE$ $K^- + n \rightarrow \Sigma^- + \pi^\circ$
[illegible]	[illegible] K^+	+1	0	+1	966.5	1.2×10^{-8}	[illegible]	
	[illegible] K^-	-1	0	-1	-966.5	1.2×10^{-8}	[illegible]	

Table 1 (concl)

Particle	Symbol	Charge	Spin	~~Magnetic Moment~~ Strangeness	Rest Mass m_e	Mean Life	Decay Mode	Other Basic Interactions
Nucleons								
Neutron	n°	0	$+\frac{1}{2}\hbar$	0	1838.6	12.8 Min	$p + e^- + \bar{\nu}$, [illegible]	$p + n \rightarrow p + p + K^-$ $p + n \rightarrow$ [illegible]
Antineutron	$\bar{n}^{\circ}$	0	$-\frac{1}{2}\hbar$	0	-1838.6		$\bar{p} + e^+ + \nu$, [illegible]	$K^+ + n + n$
Proton	p	+1	$\frac{1}{2}\hbar$	0	1836.1	Stable	$n + [illegible] + \mu^+$	$p + \bar{n} \rightarrow$ [illegible]
Antiproton	$\bar{p}$	-1	$+\frac{1}{2}\hbar$	[illegible]	-1836.1		$n + \mu^- + \bar{\nu}$	$p^+ + p \rightarrow$ [illegible] $+ \bar{\nu}^{\circ}$, ν°, $\bar{\nu}^{\circ}$, [illegible] $+ \bar{\gamma}$, [illegible] $p + e^- \rightarrow n + \nu^{\circ} +$ [illegible] $p + \mu^- \rightarrow n +$ [illegible]
Hyperons								
Lambda	Λ°	0	0	+1	2182	2.7×10^{-10}	$p + \pi^-$, $p +$ $\mu + \nu^{\circ}$, $N + \pi^{\circ}$, $p +$ $e^- + \nu$	$p + n \rightarrow$ [illegible] $+ K^{\circ} + p$
Anti-Lambda	$\bar{\Lambda}^{\circ}$	0	0	-1	-2182		$\bar{p} + K^+ +$ [illegible]	
Heavy Hyperon								
Sigma	Σ°	0	$1\hbar$	-1	2324		$\Lambda^{\circ} + K^- +$ [illegible]	
	Σ^-	-1	$-1\hbar$	-1	2341	1.5×10^{-10}	$n + \pi^-$, $\Lambda^{\circ} +$ [illegible]	$\Sigma^- + p \rightarrow \Lambda^{\circ} + n$
	Σ^+	+1	$+1\hbar$	-1	2325	0.7×10^{-10}	$p + \pi^{\circ}$ $n + \pi^+$	
Anti-Sigma	$\bar{\Sigma}^{\circ}$	0	$1\hbar$	+1	-2324		$K + \bar{n}$	
	Σ^-	-1	$+1\hbar$	+1	-2325		$\Lambda^{\circ} + \bar{\gamma}$	
	Σ^+	+1	$-1\hbar$	+1	-2325		$p + \pi^{\circ}$	
Xi	Ξ°	0	$\frac{1}{2}\hbar$	-2	2585	$10^{-10} - 10^{-9}$	[illegible]	[illegible] $+ p \rightarrow$ [illegible] $+ \Lambda^{\circ}$
	Ξ^-	-1	$+\frac{1}{2}\hbar$	-2	2585		$\Lambda^{\circ} + \pi$	$p + n \rightarrow$ [illegible] $+ K^+ + K^+$
Anti-Xi	$\bar{\Xi}^{\circ}$	0	$\frac{1}{2}\hbar$	+2	2585		$\Lambda^{\circ} + \pi^{\circ}$	$n + \pi$ [illegible] $+ K^{\circ} + K^{\circ}$
	$\bar{\Xi}^+$	+1	$\frac{1}{2}\hbar$	+2	2585		$\pi^+ + \Lambda^{\circ}$	

Gravitational Field Quantization

One feature which causes particular difficulty in working with the gravitational field is the non-linearity of the gravitational field equations. Because of this feature, exact information is only obtained by approximation methods, or by extrapolating particular physical situations.

The elements entering into a manifestly covariant formalism for the quantum theory of gravitation are Green's functions describing the propagation of small disturbances. Considering the propagation of small disturbances due to weak interaction, the following qualitative approach is given. From relativity, we have the linearized form of the Riemann Christoffel curvature tensor.

$$R_{\mu\nu} = -\frac{1}{2}\left(T_{\mu\nu} - \frac{1}{2}\eta_{\mu\nu} T\right)$$

where the potential $\eta_{\mu\nu} = -\left(\delta_{\mu\nu} + \frac{X_\mu X_\nu}{R^2 - (X_1^2 + X_2^2 + X_3^2)}\right)$

also $\delta_{\mu\nu} = \begin{cases} 1, & \mu = \nu \\ 0, & \mu \neq \nu \end{cases}$; $R^2 \cong X_1^2 + X_2^2 + X_3^2 + X_4^2$

The propagation function is found by operating on the metric potentials $G^{\pm}_{\mu\nu\rho'\gamma'} = (\eta_{\rho\mu}\eta_{\nu\gamma} + \eta_{\mu\gamma}\eta_{\nu\rho} - \eta_{\mu\nu}\eta_{\rho\gamma}) D^{\pm}(x - x')$

where

$$D \equiv D^{+} - D^{-} \; ; \; \Box^2 D_{(x-x')} \equiv 0 \qquad (4)$$

The propagation function $G_{\mu\nu\rho'\gamma'}$ is easily shown to be uncoupled to the propagation tensor functions $G_{\mu\nu'}$ and G in the weak field approximation. The Poisson bracket commutation relations for the components are shown in equation (5).

$$[E_{ab}, E_{c'd'}] = [H_{ab}, H_{c'd'}] =$$
$$\tfrac{1}{4} i \left(\delta T_{ac}\, \delta T_{bd} + \delta T_{ad}\, \delta T_{bc} - \delta T_{ab}\, \delta T_{cd}\right) \nabla^4 D(x - x')$$
$$[E_{ab}, H_{c'd'}] = -[H_{ab}, E_{c'd'}] =$$
$$\tfrac{1}{4} i\, \varepsilon_{cef} \left(\delta T_{ae}\, \delta T_{bd} + \delta T_{ad}\, \delta T_{be} - \delta T_{ab}\, \delta T_{ed}\right) \nabla^2 \dot{D}_{ef}(x - x')$$

where $\delta T_{ab} \equiv \delta_{ab} - \partial/\partial X^a \, \nabla^{-2} \, \partial/\partial X^b$

also

$$E_{ab} \equiv R_{a(0)b(0)} \; ; \; H_{ab} \equiv \tfrac{1}{2} \epsilon_{acd} R_{cd\,b(0)} \qquad (5)$$

These components of the linearized convature tensor are related to the stress tensor components through the following partial differential equations:

$$\Box^2 E_{ab} = -\frac{1}{2}\left[\ddot{T}_{ab} - \frac{1}{2}\delta_{ab}\ddot{T} + (T_{(0)(0)} + \frac{1}{2}T)_{ab} - \dot{T}_{a(0),b} - \dot{T}_{b(0),a}\right];$$

$$\Box^2 H_{ab} = -\frac{1}{2}\epsilon_{acd}\left[(\dot{T}_{bc} - \frac{1}{2}\delta_{bc}\dot{T})_d - T_{c(0),\,db}\right];$$

(6)

where E and H are the Riemann tensor components, ϵ is the permeability, and T is the stress-energy density of the energy-field medium. From the homogenious forms of the tensor analogs to Maxwell's equations

$$\nabla \cdot \vec{E} = \nabla \vec{J}; \qquad \nabla \times \vec{E} + \vec{H} = 0;$$
$$\nabla \cdot \vec{H} = 0; \qquad \nabla \times \vec{H} - \vec{E} = -J;$$

(7)

the free solution components of E_{ab} and H_{ab} that remain after the retarded (or advanced) solutions have been subtracted out are symmetric and have vanishing traces of the form:

$$\vec{E}_{tr}^{free} = (4\pi)^{-3/2}\int \vec{k}^2[(\hat{e}_1\hat{e}_1 - \hat{e}_2\hat{e}_2)a_1 + (\hat{e}_1\hat{e}_2 + \hat{e}_2\hat{e}_1)a_{11}]e^{ik_\mu x^\mu}\left(\frac{d^3\vec{k}}{\sqrt{k_0}}\right) + h.c.$$

$$\vec{H}_{tr}^{free} = (4\pi)^{-3/2}\int \vec{k}^2[(\hat{e}_1\hat{e}_2 + \hat{e}_2\hat{e}_1]a_1 - (\hat{e}_1\hat{e}_1 - \hat{e}_2\hat{e}_2)a_{11}]e^{ik_\mu x^\mu}\left(\frac{d^3\vec{k}}{\sqrt{k_0}}\right) + h.c.$$

(8)

where the $\hat{e}$'s are field unit vectors and K is the polarization wave vector.

The free components of the solutions E_{ab} and H_{ab}, obtained by Fourier Decomposition of Equation (6) lead to the concept of gravitational quanta or gravitons. B. Dewitt (Ref. 4) has demonstrated that there is an effect that a polarized plane gravitational wave has on the strain tensor, T, of a medium with which it interacts. From the concepts of creation and annihilation operations, a graviton spin operator:

$$\vec{\sigma} \equiv S\,\hat{e}_3 \qquad (9)$$

is obtained.

From Equations (8) and (9) one may conclude that:

$$\hat{e}_1'\hat{e}_1' - \hat{e}_2'\hat{e}_2' = \hat{e}_1\hat{e}_2 + \hat{e}_2\hat{e}_1 = \hat{e}_3 \times (\hat{e}_1\hat{e}_1 - \hat{e}_2\hat{e}_2)$$
$$\hat{e}_1'\hat{e}_2' + \hat{e}_2'\hat{e}_1' = -(\hat{e}_1\hat{e}_1 - \hat{e}_2\hat{e}_2) = \hat{e}_3 \times (\hat{e}_1\hat{e}_2 + \hat{e}_2\hat{e}_1)$$

In order for this to be true

$$\hat{e}_1' \equiv 2^{-1/2}(\hat{e}_1 + \hat{e}_2); \quad \hat{e}_2' \equiv 2^{-1/2}(-\hat{e}_1 + \hat{e}_2)$$

Treating the amplitude, then $a\pm \equiv 2^{-1/2}(a_1 \mp i a_{11})$

also $\delta(\hat{e}_i\hat{e}_i - \hat{e}_j\hat{e}_j) = 2(\hat{e}_i\hat{e}_j + \hat{e}_j\hat{e}_i)\,\delta\phi$

$$\delta(\hat{e}_i\hat{e}_j + \hat{e}_j\hat{e}_i) = -2(\hat{e}_i\hat{e}_i - \hat{e}_j\hat{e}_j)\,\delta\phi$$

Finally we have

$$[S, a_1] = 2i\, a_{11}$$
$$[S, a_{11}] = -2i\, a_1 \qquad (10)$$

Also, from Equation (9), the following infinitesimal notations are recognized:

$$[S, \vec{E}^{free}(k)] = i\,\delta\vec{E}^{free}(k),$$
$$[S, \vec{H}^{free}(k)] = i\,\delta\vec{H}^{free}(k), \qquad (11)$$

where $\hat{e}_3$ is a unit vector, and δ is the Dirac Kronecker delta. Equations (9) and (10) yield the graviton spin:

$$S \equiv 2\left[a_+ a_+^\dagger - a_- a_-^\dagger\right] \qquad (12)$$

The factor 2 identifies the gravitational field as a spin-2 field.

This, then relates to the fundamental result, where gravitational wave disturbances are divided into discrete energy packets or quanta, as is also shown by P.A.M. Dirac (Ref.3,4) and also A. Peres (Ref.4,5). Quantizing the gravitational field equation shows the energy of gravity quanta, or gravitons, is equal to Plank's constant, h, times their frequency (identical to the energy of light quanta or photons). However, as shown in Equation (12), the spin of the graviton is twice the spin of the photon.

Summary

All sub-fields are special cases of the generalized field equation, and can be quantized into discrete quanta. These fields consist of disturbances, within the universal force-field medium, which interact to give proper phase relationships resulting in quanta formation. Utilizing a topological-model for describing various energy channeling configurations, bundles of energy (wave packets) containing possibility waves (pilot wave disturbances) are formed. Pilot wave bundles correspond to neutrinos - the basic energy carrier for matter formation.

To better understand gravity, experimental investigation into the nature of photon and de Broglie demiphoton interactions relating to the fundamental nature of light is necessary. It is proposed to accomplish this by focusing multi-in-phase and out-of-phase laser beams (Ref.7). Any interference or interaction should be measured to see whether gravitons or neutrinos are manifested as byproducts of such intense photon-photon coupling interactions.

It is also proposed that an attempt be made to focus neutrino beams, to see whether neutrinos can interact, and whether they produce gravitons and photons as byproducts of their interactions.

It also may be possible to obtain experimental evidence through high-energy accelerators, quasar and cosmic ray research with particles of 10^4 MeV or higher to substantiate all the relationships proposed herein for gamma ray, photon, neutrino, graviton, and antigraviton interactions.

The field equations of general relativity suggest that the source of the gravitational field is the stress-energy tensor. Devices for the detection of gravitational waves operate essentially upon the principle of measuring the Fourier Transform of the Riemann Tensor.

For example, consider two masses, which are separated, an integral value corresponding to the wave length of the mathematically derived quanta of gravitational radiation - the graviton. Such masses would have forces exerted upon them by the gravitational wave. The phase difference set up between the two masses

would result in one mass being driven relative to the other. Correspondingly, strains would also be set up in the material by a gravitational wave.

Time-dependent stresses could quite possibly be produced electrically in a piezo-electric crystal, thus giving rise to a discharge current. A laser amplifier used in conjunction with a cross correlator, as suggested by J. Weber (Ref.8), could compare the stress-strains of two piezo-electric crystal masses, acted upon by the gravitational field and separated from each other by an integral value of the wave length of the graviton.

An alternate experiment suggested by this author, which also measures time-dependent stresses and strains, involves the use of laser-holography. This technique has one chief advantage, that the mass structures under analysis need not be modified (Ref.5), whereas the piezo-electric experiment does need some modification. In the proposed experiment, stress concentrations in solid, opaque objects can be revealed by an interference hologram.

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