Gravity

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This paper presents a new theory of gravity with the basic premises and fundamental laws of the theory. Then the paper presents some immediate results of the laws and shows how these results lead to an Arrow of Time that has eluded physical theories to date. Isentropic states are then showed to require gauge potentials with specific functional dependences upon space, time and mass. The character of these dependences is then used to compare theoretical predictions with existing experimental data and to discuss new experiments that may be conducted.

1. Introduction

Gravity is a fact of our everyday life and scientists have forever been trying to understand it. Newton formed his laws of motion, but still had to assume a law of gravity in order to determine the motions of bodies interacting through gravitational forces. Newton did not explain what gravity is. Rather he gave a prescription on how to find the dynamics produced by bodies interacting through gravity. Einstein sought to determine the motions of gravity without using a force. Einstein sought a system of equations by which the dynamics of bodies interacting through gravity were determined by the least distance between two points in a curved space. This did little to help explain gravity and to a good many made even the determination of the dynamics more difficult. This article is not an attempt to display the accuracy of these two approaches to the dynamics of bodies interacting through gravitation or to compare them. It should be pointed out here that in both of these approaches gravity was basically independent of other forces of nature. Newton's approach was to provide a system of equations that determined the motion of bodies interacting through forces in any choice of geometry. Einstein's approach was to require that the force of gravity determined the geometry since he sought to find the motions without using a force.

This article will discuss another approach to describing the affects of gravity that may lend a different light on the subject. However, even this approach does not seem up to the task of explaining what gravity is, but rather gives a different prescription of how to find the motion of bodies that is caused by gravity. This approach is akin to Newton's approach in that the geometry in which the motion is to be described is free to be chosen, but the approach differs from Newton's in how to determine the motion. Newton gave three laws of motion in equations that could be used to find various types of energy such as potential energy, the energy possessed by a body due to its separation from another body, or kinetic energy, the energy a body possessed due to motion with respect to another body. This arrangement has the forces determining the energy of interactions. The approach to be discussed here basically reverses these roles of the energy and the forces. It starts with a law stating the conservation of energy which states how any exchange of energy between a system and its surroundings affects the system's energy and the work it can perform. It is a law stating how these three energies, exchange energy, system energy, and work, can interact. Of course, it may be noted that within the expression for work we must use a force through a distance and this is where the force enters into the description of motion. Further, it must be noted that since the work is the result of a force through a distance this term must be a path dependent term which also makes the exchange energy path dependent. However, the system's energy is not path dependent. The difference between the path dependence of the work and the path independence of the system's energy is crucial to the law's determination of dynamics.

1.1. Basic Premise

The premise upon which this article is based is that the fundamental laws are sufficiently general to be used to determine both the forces that ultimately cause dynamical interaction and the dynamics that results from interactions.

Thus, the fundamental laws should be expected to provide the force laws, the equations of motion, and whether any the geometry in which to specify the dynamics may be freely chosen or if a particular geometry is required. Further, the fundamental laws will indicate whether the various forces such as gravitational and electromagnetic are independent or are inductively coupled. If the fundamental laws indicate that gravity is independent of other forces of nature then the other forces need not enter into an article on gravity alone. If the fundamental laws indicate an inductive coupling between the various forces of nature then n particular force may be singled out for discussion by itself.

1.2. Fundamental Laws

The first law, the conservation of energy, does not state how the dynamics must go [1]. This means that the conservation of energy statement says nothing explicitly about time. Newton's laws of motion also did not explicitly involve time either. Time was, however, implicitly involved in Newton's laws as the acceleration, to which the force was related, was the time rate of change of velocity. The conservation of energy, however, does not even include time implicitly. This approach must then have a second law which tells how the dynamics must go. The adopted second law seems rather vague as its statement does not seem to depend upon time, but instead is a statement that in essence denies perpetual motion. The second law is a statement that surrounding any state point that a system may occupy there exists neighboring points to which the system may not go reversibly. That is if the system goes to these specific points and then returns to the original point it will be changed due to the round trip.

To summarize and simplify these adopted laws they are [2, 3]:

1st Law: Conservation of Energy,

$$đE = dU - F_i dx^i \text{, where } i = 1,2,3,4 . \tag{1}$$

2nd Law: Denial of Perpetual Motion.

Neighboring any state point there exist points that the system may not go to reversibly tests!

1.3. Some Immediate Results

Some immediate results of using these laws together become important later where gravity is concerned. The first immediate result is that the 2nd law guarantees the existence of an integrating factor for the 1st law that is a function of velocity only. Then

$$dS = \frac{dU}{\phi} - \frac{Fdx}{\phi} = \frac{dU}{\phi} - fdx . \tag{2}$$

This is important for two reasons. The first reason is that the existence of an integrating factor guarantees the existence of an absolute velocity. This is important since it provides a means of defining time. Plus, this method of defining time, since it relates time to space in an absolute fashion, provides a description of dynamics based upon absolute space and time. Secondly, the existence of the integrating factor guarantees the existence of another state function that can be obtained from the 1st law by multiplying the 1st law by the integrating factor. This new state function, that may be called the entropy, as it is in thermodynamics, has several extremely important roles in the dynamics of the system. These roles include: 1. determining the flow of motion through the principle of maximum entropy for isolated systems which do not exchange energy with their surroundings, 2. determining the important distinction between the very stable constant entropy systems and those systems whose entropy is changing so as to seek a maximum, and 3. determining the characteristic properties of bodies whose characteristics do not change as these bodies move around in space and time.

The third role of the entropy might well prove to be the most important role where trying to learn what gravity is as compared to how gravity causes dynamics, which is done by the first role. Bodies, or perhaps one might say fundamental particles, have various characteristics by which we describe them. For example, we talk of electrically charged particles to mean that particle possesses an electric charge. In the same manner we speak of a particle having a gravitational property through which the particle interacts with other particles. The standard model of physics assigns these characteristics to particles almost by assumption. The electrically charged particles are assumed to be those that have gauge potentials that obey the Maxwell equations of electromagnetism. Every particle is also assumed to have a gravitational potential through which it interacts with other gravitating particles. This third role of the entropy specifies the characteristics of particles that do not change as the particle moves through space and time. This means that it specifies what characteristics a particle must have if its entropy is to remain constant as the particle moves through space and time.

1.4. Time and Physical Time

In Newtonian dynamics time did not really have a definition and a common sense notion of time was used. There appeared two types of time in the relativistic theories of Einstein. The 'local' time played a role essentially like the role of time in Newtonian dynamics. A new type of time appeared when the relativistic theories introduced a differential element of space-time geometry. This differential element was called the proper time. Proper time was thus defined in terms of the local time and a geometric space.

The Dynamic Theory (DT), based upon the laws stated above, does not show a time in the statement of the laws. However, when the two laws are used together it may be shown that they require any dynamics to adhere to the stability conditions which are the second order derivatives of a set of energy functions with respect to a set of the independent variables. There is nothing specifying which variables are to be included in the set to be used. The 1st law consists of the differential of the system energy and differential path elements for each force applicable. This means that the number of variables required is the number of independent forces applicable plus one more. For three space forces as used in Newtonian dynamics there must be three plus one, or four independent variables. One is free to choose which set of four variables are to be used in the stability conditions. One convenient set of independent variables consists of the entropy and space variables. When this choice is made the stability conditions require that [4]

$$\begin{gathered}
\frac{\partial^2 U}{\partial S^2}(dS)^2 + 2\frac{\partial^2 U}{\partial S \partial x} dSdx + \frac{\partial^2 U}{\partial x^2}(dx)^2 > 0 \\
-\frac{\left(m_o c^2\right)^2}{U^3}(dS)^2 - 2\frac{\left(m_o c^2\right)^2 f}{U^3} dSdx \\
+\frac{m_o c^2}{U^3}\left[U^2 f_x - m_o c^2 f^2\right](dx)^2 > 0
\end{gathered} \tag{3}$$

This quadratic form must be positive definite and can be parameterized using the time and the absolute velocity, c, as

$$-\frac{\left(\dfrac{f_o}{m_o c^2}\right)^2}{U^{*3}}(cd\tau)^2 - 2\frac{\left(\dfrac{f_o}{m_o c^2}\right)}{U^{*3}} fdxcd\tau - \left[\frac{f^2}{U^{*3}} - \frac{1}{U^*}\frac{\partial f}{\partial x}\right](dx)^2 \equiv (cdt)^2$$

when $S \equiv f_o c\tau$, where $f_o \equiv 1$ Newton. $\Rightarrow S^* = \dfrac{S}{m_o c^2} = \dfrac{f_o c\tau^*}{m_o c^2} \equiv c\tau$

and $U^* \equiv \dfrac{U}{m_0 c^2} = \dfrac{1}{\phi}$ where $\phi \equiv \sqrt{1-\beta^2}$

(4)

It should be noted that in Eq. (4) the independent variables are space and entropy with time as a dependent variable and is defined by Eq. (4). The units of the independent variable entropy has been converted to units of time in keeping with its role given to it by the 2nd law as the measure of the flow of the dynamics created by the force. In this role it might be called the physical time, or the dynamic time, as its role is to establish how the dynamics must go as determined by the Entropy Principle.

One reason the set of independent variables of entropy and space becomes convenient is due to requirement that an isolated system which does not exchange energy with its surroundings must obey the Entropy Principle which requires that the differential of the entropy never be negative. This requires us to determine the expression for the differential of the entropy. For the simple case of a single force in the x-direction this expression for the differential of the entropy may be shown to be given by

$$cd\tau = \left(\frac{m_o c^2}{f_o}\right) U^{*\frac{3}{2}} \left\{ -\frac{f}{U^{*\frac{3}{2}}} dx + \left[\left[\frac{2f^2}{U^{*3}} - \frac{1}{U^*}\frac{\partial f}{\partial x} \right] (dx)^2 - (cdt)^2 \right]^{\frac{1}{2}} \right\}. \quad (5)$$

Several things might be noted in Eq. (5). The first is that the physical time, as denoted by τ, does not differ from the time in the absence of a force. This means that a space-time manifold does not exist outside of the dynamics created by the force. This is also consistent with the notion that the physical time gives the flow of the motion. Another way of stating this is that within the DT a kinematic space-time, as developed in Einstein's relativistic theories, does not exist. One other thing should be noted here and that is the multiplicative factor that is common to all terms on the right hand side of Eq. (5). Such a common factor on a manifold was named a gauge function by Weyl as he showed such a function acted to establish the distance measure, or gauge, of the manifold. In Eq. (5) it acts to set the gauge of the physical time for the isolated system.

1.5. Stable, Isentropic States

The common multiplicative term on the right hand side establishes a means of investigating the very stable states that occur when looking into constant entropy states. This also is the connection that allows the DT to apply the two fundamental laws into additional, interesting areas of physics. One area that it leads into is that should one be given an electrostatic gauge potential then an investigation of isentropic states leads to Schrodinger's quantum mechanics. But what if one asks where the electrostatic potential is given? Does one need to assume Maxwell's electromagnetic field equations in addition to the 1st and 2nd laws? The same question might be asked concerning whether one also needs to assume a force law for gravity. Must a gravitational force law be assumed here just as Newton found a force law to be needed?

1.6. Fundamental Particles [3], pp. 171-198

In addition to asking what states might be possible given an electrostatic potential, there is another question that may be asked of the requirement imposed by isentropic states. This one turns the question around and asks, "What are the gauge potentials that may exist for isentropic states where these gauge potentials do not change as they are moving around in space and time? This basically is asking if the isentropic requirement establishes the characteristics of fundamental particles. If it does than the gauge function is the starting point for this investigation. However, we are more concerned with the first and second order derivatives of the gauge function.

Before going further with this line of discussion we must return to the 1st law and ask how many independent work terms must be considered in a study of natural phenomena. Of course we know of the possibility of three independent forces in each of the three space directions. We also know of a fourth force when considering thermodynamic systems. If this force were independent of the three space forces we would have four independent forces and our expression for the physical time would depend upon four force variables and one time variable. This would also mean that our gauge function is based upon five independent variables and there would be five gauge potentials since the gauge potentials are the first order derivatives of the gauge function.

Any integrable geometric manifold of any number of independent variables must satisfy the Bianchi conditions and these conditions establish interrelationships between the second order derivatives of the gauge function. When there are four independent variables, three of space and one of time, these relationships among the second order derivatives are the Maxwell equations of electromagnetism. For five independent variables additional equations are specified by the Bianchi conditions for a total of eight different equations relating the second order derivatives of the gauge function. There are five gauge potentials. When the time derivative of the gauge function is taken the result is the electrostatic potential. The three space derivatives of the gauge function produce the three vector potentials. However, it is the fifth gauge potential that is the subject of this investigation. This gauge potential turns out to be the gravitational potential and if the isentropic condition specifies the characteristics of the gauge potentials that a particle may have that does not change as it moves around in space and time it is this fifth gauge potential that will specify the gravitational character of the particle.

It may be instructive to present the five variable field equations here without their derivation. First, the five variable fields may be presented in matrix form as

$$F_{ij} = \begin{bmatrix} 0 & E_1 & E_2 & E_3 & V_0 \\ -E_1 & 0 & B_3 & -B_2 & V_1 \\ -E_2 & -B_3 & 0 & B_1 & V_2 \\ -E_3 & B_2 & -B_1 & 0 & V_3 \\ -V_0 & -V_1 & -V_2 & -V_3 & 0 \end{bmatrix} \quad (6)$$

The field equations are

$$\begin{aligned} &\overline{\nabla} \bullet \overline{B} = 0 && \frac{1}{c}\frac{\partial \overline{B}}{\partial t} + \overline{\nabla} \times \overline{E} = \overline{0} \\ &\overline{\nabla} \times \overline{B} - \frac{1}{c}\frac{\partial \overline{E}}{\partial t} + a_0 \frac{\partial \overline{V}}{\partial \gamma} = \frac{4\pi \overline{J}}{c} && \overline{\nabla} \times \overline{E} + a_0 \frac{\partial V_4}{\partial \gamma} = 4\pi\rho \\ &\frac{\partial \rho}{\partial t} + \overline{\nabla} \bullet \overline{J} + a_0 \frac{\partial J_4}{\partial \gamma} = 0 && \overline{\nabla} \times \overline{V} + a_0 \frac{\partial \overline{B}}{\partial \gamma} = 0 \\ &\overline{\nabla} V_4 + \frac{1}{c}\frac{\partial \overline{V}}{\partial t} = a_0 \frac{\partial \overline{E}}{\partial \gamma} && \overline{\nabla} \bullet \overline{V} + \frac{1}{c}\frac{\partial V_4}{\partial t} = -\frac{4\pi}{c} J_4 . \end{aligned} \quad (7)$$

Isentropic states may exist in two ways. The physical time may be identically zero or it may swing positive and then negative but must always return to zero periodically like a sine wave. The isentropic condition, in this fashion, quantizes the gauge potentials with a quantum number. This is important as it establishes the quantized electric charge on fundamental particles. This is also important as it establishes a distinction between different fundamental particles.

The steps in the process of determining the gauge requirements of the isentropic condition are many and tedious and, therefore, will be left to references. However, the process starts with the quantization of the gauge potentials and then forming the fields from these quantized potentials and ensuring that the gauge function and its derivatives satisfy all of Eqs. (7). After this is done the logarithm of the square root of the gauge function is given by

$$\ln f^{\frac{1}{2}} = \left(\frac{r_o}{r}\right) e^{-\left(\frac{\lambda_N}{r}\right)} e^{-H_o t} e^{-K_\gamma \gamma}\text{, with } K_\gamma = \frac{H_o}{a_o c}\,. \tag{8}$$

In Eq. (8) H_o is Hubble's constant and $a_o c$ is a constant pertaining to the limiting rate of mass conversion.

From this gauge function the fields become

$$\frac{F_{ij}}{\left(\frac{e}{4\pi\varepsilon_o}\right)} \approx \begin{vmatrix} 0 & Z\left(\frac{r_o H_o}{\alpha r^2}\right)\left(1-\frac{\lambda_N}{r}\right)e^{-\left(\frac{\lambda_N}{r}\right)} & 0 & 0 & 0 \\ -Z\left(\frac{r_o H_o}{\alpha r^2}\right)\left(1-\frac{\lambda_N}{r}\right)e^{-\left(\frac{\lambda_N}{r}\right)} & 0 & 0 & 0 & -Ze\frac{a_o c}{H_o} r_o K_\gamma \left(\frac{1}{r^2}\right)\left(1-\frac{\lambda_N}{r}\right)e^{-\frac{\lambda_N}{r}} \\ 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 \\ 0 & Ze\frac{a_o c}{H_o} r_o K_\gamma \left(\frac{1}{r^2}\right)\left(1-\frac{\lambda_N}{r}\right)e^{-\frac{\lambda_N}{r}} & 0 & 0 & 0 \end{vmatrix} \tag{9}$$

In both Eq. (8) and (9) it may be noted that the potentials and the fields are non-singular in that they return to zero as r tends to zero. This feature of the electric and the gravitational fields is very different from the classical $1/r^2$ character from Maxwell's electromagnetism and Newton's gravity.

An interesting feature of this process for finding the characteristics of fundamental particles includes the ability to theoretically form the ratio of the electromagnetic and the gravitational forces to get

$$F_{ratio} \approx \frac{H_o^2}{a_o^2 c^2 K_\gamma^2} = \frac{\frac{e^2}{4\pi\varepsilon_o}}{Gm^2} \tag{10}$$

which is, of course, the experimentally measured ratio of the electrostatic and gravitational forces.

In the preceding two fundamental laws were adopted and used to show that they require a certain form of gauge potential for all particles that do not change their gauge characteristics as they move around in space and time. The gauge potential of these unchanging fundamental particles show gauge properties known to exist for most particles. For example, they possess long range electrostatic and gravitational potentials that diminishes with distance as $1/r$. They also possess long range forces that vary as $1/r^2$. However, these gauge potentials also possess some properties not previously considered for fundamental particles. Two of these new properties are the time dependence of the gravitational potential and the non-singularity of both the electrostatic and gravitational potentials which requires that these potentials vanish as r tends to zero.

With respect to gravity these two new properties of the gravitational potential produce many new gravitational predictions that agree with previously obtained data such as planetary orbital perihelion advancement, cosmological red shifts, dark matter, and dark energy. In addition to the new properties of the gauge potentials of fundamental particles, the inductive coupling between the electromagnetic and the gravitational fields provide new predictions of physical phenomena that have either already been measured or may be measured.

2. Comparison between Theory & Experiment

The following is a partial list of phenomena where predictions from the new theoretical properties of gravity have been compared to existing experimental data. While there also exists many ways of comparing the new theoretical properties of the electrostatic potential to existing and not-yet-obtained data this article will only address those involving the gravitational properties.

2.1. **Perihelion Advance** [3], pp. 296-302

The gravitational force differs from the Newtonian gravitational force through the influence of the non-singular character of the potential. This deviation depends, therefore, upon the λ in the multiplicative exponential function. This deviation predicts an advancement of the perihelion of planetary orbits.

2.2. Red Shifts [3], pp. 314-318

The time dependence of the gravitational potential predicts a red shift in light received from distant stars.

2.3. No Big Bang [3], pp. 303-308

The non-singular character of the gravitational potential predicts that there exists a point in time in the history of the universe where the expansion velocity of the universe was zero. At that point in time the universe was not at a point of singularity but was still of finite size and possessed a non-zero expansion acceleration. Therefore, the non-singular gravitational potential denies the existence of a big bang beginning of the universe.

2.4. Dark Matter [3], pp. 319-324

The time dependence of the gravitational field gives rise to the prediction that stars in the outer arms of spiral galaxies possess tangential velocities that correspond to the greater gravitational field strength of the center of the galaxy at a previous point in time corresponding to the distance the star is from the center of the galaxy divided by the speed of light. Thus, the tangential velocities do not fall off as predicted by Newtonian gravity.

2.5. Dark Energy [3], pp. 325-333

The time dependence of the gravitational field changes the prediction of Chandrasekhar limiting mass. This time variation of the Chandrasekhar limiting mass prevents the use of the Type Ia supernovas as a standard candle with a constant luminosity. The result of this is that there is no dark energy necessary to explain the data currently interpreted as requiring dark energy.

2.6. Fifth Force of Nature [5]

Previously there were reports of a slight variation in the strength of the Earth's gravitational field with distance below the Earth's surface when compared to Newtonian gravity. However, the reported gravitational strength did not differ from Newtonian gravity with distance above the Earth's surface. The non-singular character of the gravitational potential means that the near proximity of mass surrounding each mass element under the Earth's surface slightly reduces the gravitational attraction of that mass element toward the center of the Earth and, thus, shows a slight difference to the prediction of Newtonian gravity. On the other hand, a mass element above the Earth's surface does not have its gravitational field changed by near mass elements and shows no difference from the Newtonian mass elements above the Earth's surface. This is just what the below the surface and the above the surface data showed, but neither are discussed today.

3. Experiments with Inductive Coupling

The gauge fields of the fundamental laws are inductively coupled. This means that the gravitational and the electromagnetic fields are not totally independent fields. Each is tied to the other. There are several experiments that may display this inductive coupling. This list is only representative of the possible experiments that use the inductive coupling of these fields.

3.1. Radiation Energy Density and Pressure [3], pp. 356-358

The inductively coupled gravitational and electromagnetic fields predict a radiation energy density given by the sum of the squares of the electromagnetic and gravitational field components. However, the radiation pressure is given by the sum of the squares of the electromagnetic components minus the square of the gravitational component. Therefore, the radiation pressure will always be a little less than the radiation energy density. This is just what the Nichols and Hull experiment showed. It is true that the difference was less that the expected experimental error, but new experiments using interferometer techniques may be used to reduce the experimental error below that of the Nichols and Hull experiment

3.2. Cosmic Background Radiation

The difference in the expression for the radiation energy density and the radiation pressure gives rise to the case where, in space where no pressure can be supported due to the absence of inertial material, the pressure must be zero. Since radiation pressure is the difference between the sum of the squares of the electromagnetic field components and the square of the gravitational field then the point of zero radiation pressure still requires that the radiation energy density be non-zero. If the Nichols and Hull data is used to estimate a value for the constant ao in Eq. (8) then the temperature of the zero pressure radiation may be determined. Initial estimates place the temperature in the low single digit temperatures.

3.3. Electromagnetogravitic Waves [3], pp. 358-388

As mentioned in the section on radiation energy density of the inductively coupled gauge fields consists of the addition of the squares of the components of the electromagnetic and gravitational fields. This results comes from solutions to the wave equations that may be developed from the field equations of Eqs. (7). The totality of these waves include three electric field components, three magnetic field components, three gravitational field components and a gravitational potential for a total of ten wave components. The solution of the wave equations includes two types of waves. The first wave type is the transverse wave where the vector field components are perpendicular to the direction of wave propagation while the second wave type may be called non-transverse as none of the field components are perpendicular to the direction of wave travel.

The transverse wave solution consists of three components rather than the two components of standard electromagnetic theory. The third component is a gravitational field component which is directed opposite to the electric field component and contains only a small part of the wave energy when compared to the energy contained in the electric and magnetic components. This is the reason for the small difference between the radiation energy density and pressure. The non-transverse wave also consists of three components which are an electric field component, a magnetic field component and a gravitational potential component. This wave is rather peculiar in that it consists of two vector components and one scalar component. If all three components were vector components directed parallel, or anti-parallel, with the direction of wave travel, the wave might best be referred to as a longitudinal wave. However, since one wave component is a scalar component it would be misleading to call the wave a longitudinal wave.

Several predictions have been made using the electromagnetogravitic (EMG) wave solutions but these may be best addressed in other formats. What may be most useful herein is to present the influence of gravity upon EMG waves. The first influence has already been discussed in the immediately preceding sections on radiation energy density and pressure and the cosmic background radiation. Two other influences may be useful to mention here.

3.3. Alternate Communications

All of our communications systems that depend upon wave propagation utilize the transverse wave type. However, one may also use the non-transverse waves to communicate between two distant locations. The major problem is using the non-transverse waves to communicate is that a means of creating and detecting these waves must be found. The transverse and the non-transverse wave solutions appear as independent waves in the wave equations. However, when a transverse wave strikes a material interface, such as between air and glass, at an oblique angle some of the transverse wave energy may be converted into non-transverse wave energy depending upon the orientation of the electric field component with respect to the normal to the interface. Similarly, a non-transverse wave may have some of its energy converted into transverse wave energy when it strikes a material interface a certain way.

The design of a means of converting transverse wave energy into non-transverse wave energy constitutes a non-transverse wave sending antenna. Alternatively, a means of converting non-transverse wave energy into transverse wave energy constitutes a non-transverse wave receiving antenna. Designs of both the sending and receiving non-transverse wave antennas have been done, but have not been tested.

3.4. Neutrinos

Neutrinos have the interesting property that they can pass through any material almost at will without being detected. There is an interesting similar property that involves the non-transverse wave. In transverse waves the electric field may accelerate electrons in a dipole antenna because the electric field is directed perpendicular to the direction of wave propagation. However, the electric field in a non-transverse wave is in the direction of propagation and this prevents the electric field from accelerating a free electron. This allows the non-transverse wave to propagate virtually without attenuation through materials that would stop a transverse wave. The skin depth for a non-transverse wave in copper has been calculated to be some 10^{10} meters. This sort of skin depth makes stopping a non-transverse wave as difficult as a neutrino.

Another feature of this theory upon gauge potentials lies in the fact that isentropic states may be found just as the section above showed that a fundamental particle may have certain quantized electrostatic potential properties. There are, however, five gauge potentials within this theory. In addition to the electrostatic potential there exist three vector potential components just as are seen in standard electromagnetism. Should one investigate an isentropic propagation of these vector potential one finds their energy to be quantized as $\varepsilon = N^2 h\nu$. Of course this quantized energy is similar to Einstein's quantized photon energy except that this energy displays the quantum number. But there is still another gauge potential in the theory and this is the gravitational potential. When isentropic propagation of this potential is sought one finds that the energy is also quantized as $\varepsilon_n = N^2 h\nu$. The subscript has been used to indicate that this energy is the energy of a non-transverse particle which, because of the large skin depth of the non-transverse wave, behaves similar to the neutrino.

3.5. Earth's Magnetic Moment [3], pp. 292-296

The inductive coupling between the electromagnetic and gravitational fields leads to the prediction that an electrically neutral mass will have a magnetic moment. A theoretical determination of the inductive coupling constant gives a charge to mass ratio of $\beta = \sqrt{4\pi\varepsilon_o G}$ where the dielectric and gravitational constants combine to give the inductive coupling constant. If this constant is used the magnetic moment of the Earth is predicted to be 8.6 x 10^{22} amp-m^2 instead of the experimentally determined 8.1 x 10^{22} amp-m^2. This is a rather amazingly accurate prediction given that it was made using the assumption of a uniform mass density for the Earth.

3.6. Direct Measurement of the Coupling Constant

Northrop Grumman hired a researcher at Carnegie Melon University to measure the coupling constant. This researcher, Dr. Dennis Shure, devised an experiment that dropped an electrically neutral mass, such as pure water among other type of neutral mass, through a sensitive toroid coil and measured the electrical signal as the mass went through the coil. The data showed the inductive coupling constant to be the β above as predicted. This result has not yet been accepted for publication.

3.7. Earth Flyby Anomalies

Flyby anomalies have been recognized for decades and many good references may be found. What is to be considered here is the phenomenological formula

$$\frac{\Delta v_\infty}{v} = K\left(\cos\delta_i - \cos\delta_f\right) \qquad K = \frac{2\omega_e R_e}{c} = 3.099x10^{-6} \tag{11}$$

In Eq. (11) the angles are the initial and final declination angles. These angles appearing in the formula prompted the authors to ask about the potential of declination producing a physical effect.

The results presented here have not been published yet so no reference exists. Plus, it may be instructive to present the mathematical details that are representative of the detail avail in the references for al of the above.

The Dynamic Theory, due to its five dimensional basis, predicts an inductive coupling between the gravitational and the electromagnetic fields. This inductive coupling was shown to be

$$\beta = \sqrt{2\pi\varepsilon_o G} \tag{12}$$

where ε_o is the dielectric constant and G is the gravitational constant. It has been shown that this coupling predicts the magnetic moment of the Earth as

$$\mu = \left(\frac{q_{\text{eff}}}{2M}\right) I\omega_e \qquad q_{\text{eff}} = \beta M . \tag{13}$$

where M is the mass of the Earth, I is the Earth's moment of inertia and q_{eff} is the effective electric charge due to the mass of the Earth.

The magnetic force on a satellite with velocity, $\overline{v}$ is given by

$$\overline{f} = q\left(\overline{v} \times \overline{B}\right). \tag{14}$$

The magnetic field associated with a magnetic moment of a sphere is given by

$$\overline{B} = \frac{\mu_o}{4\pi} \frac{\left[3\overline{r}\left(\overline{\mu} \bullet \overline{r}\right) - \overline{\mu} r^2\right]}{r^5} . \tag{15}$$

Using Eq. (13) the magnetic moment becomes

$$\overline{\mu} = \left(\frac{q_{eff}}{2M}\right)\overline{I}\omega_e = \frac{\beta}{2}\frac{2MR^2}{5}\hat{\mu}\omega_e = \frac{\beta MR^2\omega_e}{5}\hat{\mu} . \tag{16}$$

To find a change in velocity one may look at the change of momentum due to an impulse, or

$$\Delta\overline{v} = \frac{\Delta\overline{p}}{m} = \int \frac{q}{m}\left(\overline{v} \times \overline{B}\right) dt . \tag{17}$$

The effective charge for the satellite is

$$q_{eff} = \beta m . \tag{18}$$

Using Eqs. (15), (16) and (18) in Eq. (17) obtains

$$\begin{aligned} \Delta\overline{v} &= \int \beta \frac{\mu_o}{4\pi r^5} \frac{\beta MR^2\omega_e}{5} \left(\overline{v} \times \left[3\overline{r}\left(\hat{\mu} \bullet \overline{r}\right) - \hat{\mu} r^2\right]\right) dt \\ &= \frac{\beta^2 M\mu_o R^2\omega_e}{20\pi} \int \frac{1}{r^3}\left(\overline{v} \times \left[3\hat{r}\left(\hat{\mu} \bullet \hat{r}\right) - \hat{\mu}\right]\right) dt \\ &= \frac{2\pi\varepsilon_o\mu_o GMR^2\omega_e}{20\pi} \int \frac{1}{r^3}\left(\overline{v} \times \left[3\hat{r}\left(\hat{\mu} \bullet \hat{r}\right) - \hat{\mu}\right]\right) dt \\ &= \frac{2GMR^2\omega_e}{20c} \int \frac{1}{r^3}\left(\overline{v} \times \left[3\hat{r}\left(\hat{\mu} \bullet \hat{r}\right) - \hat{\mu}\right]\right) dt . \end{aligned} \tag{19}$$

It should be noted that the speed of light appears in the denominator because the dielectric constant of the charge to mass ratio, β, combines with the magnetic permeability.

Satellites in hyperbolic orbits have the radial position in the orbital plane given by

$$r = \frac{a\left(\varepsilon^2 - 1\right)}{\left(1 + \varepsilon\cos\phi\right)} . \tag{20}$$

where $\quad a = \left|\frac{K}{2E}\right| \quad$ where $\quad K = -GMm \qquad (21)$

and
$$\varepsilon = \frac{1}{\cos\alpha} \quad \text{where} \quad \alpha \equiv \frac{\pi - \Theta}{2} \tag{22}$$

with Θ being the deflection angle. The angular momentum is found to be given by

$$L = mr^2 \dot{\phi} . \tag{23}$$

Eq. (20) may be differentiated with respect to time to get the radial component of the velocity as

$$\dot{r} = \frac{dr}{dt} = \frac{\varepsilon r^2 \sin\phi}{a\left(\varepsilon^2 - 1\right)} \dot{\phi} = \frac{\varepsilon r^2 \sin\phi}{a\left(\varepsilon^2 - 1\right)} \frac{L}{mr^2} = \frac{\varepsilon L \sin\phi}{ma\left(\varepsilon^2 - 1\right)} \tag{24}$$

while the azimuthal component of the velocity is

$$v_\phi = r\dot{\phi} = \frac{L}{mr} . \tag{25}$$

Therefore, the total velocity in the orbital plane is

$$\begin{aligned}
\overline{v} &= \frac{\varepsilon L \sin\phi}{ma\left(\varepsilon^2 - 1\right)} \hat{r} + \frac{L}{mr} \hat{\phi} + 0\hat{\theta} \\
&= \frac{\varepsilon L \sin\phi}{ma\left(\varepsilon^2 - 1\right)} \hat{r} + \frac{L\left[1 + \varepsilon\cos\phi\right]}{ma\left(\varepsilon^2 - 1\right)} \hat{\phi} + 0\hat{\theta} \\
&= \frac{L}{ma\left(\varepsilon^2 - 1\right)} \left\{ \varepsilon \sin\phi \hat{r} + \left[1 + \varepsilon\cos\phi\right]\hat{\phi} + 0\hat{\theta} \right\} \\
&= \frac{L\sqrt{\varepsilon^2 + 1 + 2\varepsilon\cos\phi}}{ma\left(\varepsilon^2 - 1\right)} \left\{ \begin{array}{l} \dfrac{\varepsilon \sin\phi}{\sqrt{\varepsilon^2 + 1 + 2\varepsilon\cos\phi}} \hat{r} \\ + \dfrac{\left[1 + \varepsilon\cos\phi\right]}{\sqrt{\varepsilon^2 + 1 + 2\varepsilon\cos\phi}} \hat{\phi} + 0\hat{\theta} \end{array} \right\} \\
&= \frac{L\sqrt{\varepsilon^2 + 1 + 2\varepsilon\cos\phi}}{ma\left(\varepsilon^2 - 1\right)} \hat{v} .
\end{aligned} \tag{26}$$

Now we may substitute Eq. (26) into Eq. (19) to get

$$\begin{aligned}
\Delta\overline{v} &= \frac{2GMR^2\omega_e}{20c} \int \frac{1}{r^3} \left(\frac{L\sqrt{\varepsilon^2 + 1 + 2\varepsilon\cos\phi}}{ma\left(\varepsilon^2 - 1\right)} \hat{v} \times \left[3\hat{r}\left(\hat{\mu} \bullet \hat{r}\right) - \hat{\mu}\right] \right) dt \\
&= \frac{2GMR^2\omega_e}{20c} \frac{L}{ma\left(\varepsilon^2 - 1\right)} \frac{mr^2}{L} \int \frac{\sqrt{\varepsilon^2 + 1 + 2\varepsilon\cos\phi}}{r^3} \left(\hat{v} \times \left[3\hat{r}\left(\hat{\mu} \bullet \hat{r}\right) - \hat{\mu}\right]\right) d\phi \\
&= \frac{GMR^2\omega_e}{10ca^2\left(\varepsilon^2 - 1\right)^2} \int \sqrt{\varepsilon^2 + 1 + 2\varepsilon\cos\phi} \left[1 + \varepsilon\cos\phi\right] \left(\hat{v} \times \left[3\hat{r}\left(\hat{\mu} \bullet \hat{r}\right) - \hat{\mu}\right]\right) d\phi
\end{aligned} \tag{27}$$

Eq. (27) has the qualitative features of the phenomenological formula of Eq. (11) in that it has the same coefficient that depends upon the Earth's rotation rate and the speed of light. The speed of light enters into the equation because the effective charge of both the masses is used. The vector products left in the brackets show that the final value of the change in velocity depends upon the angle of the orbit with respect to the Earth's magnetic moment. Since the Earth's magnetic North pole is nearly the normal to the equatorial plane, the dot product and the cross product may be seen to vanish for a satellite whose orbit is strictly in the equatorial plane. This argues that the satellite must have an orbit with some inclination in order to show a change in velocity. Eq. (27) shows that for various orbits the change in velocity might be positive or negative as has been measured. Also, since R is a major fraction of r the overall magnitude of the bracketed portion of Eq. (26) will lie within the zero to 2 value of the difference of declinations in Eq. (11).

Only an integration of an actual satellite path will show final validity of the ability of Dynamic Theory to predict the anomalous velocities measured, however, the correct qualitative features are there and the quantitative value appears to be within the ballpark.

4. Einstein's General Relativity

Einstein sought to find a system of equations whereby the dynamics of gravity could be described as the curvature of space rather than as the result of gravitational forces. In mechanics it has long been known that motion due to a force may also be transformed into another space where the motion appears as geodesics in a curved space without the presence of a force.

In the above gravity appears as one aspect of the gauge potentials and fields. Motion due to gravitational forces may be described in the manifold of the five variables of space, time and mass. In most of the phenomena where motion due to gravitational forces is of interest the mass is conserved. This conservation of mass provides a separate equation to the equations of motion in the five variable manifold allowing the motion to be determined using the four equations of motion in space and time. Alternatively, the conservation of mass restriction may be applied to the five variable manifold so that the restriction embeds a four variable hyper-surface into the five variable manifold. The resulting equations describing the curvature of the hyper-surface are Einstein's field equations.

Therefore, Einstein's field equations do not require space to be curved as Einstein thought. Rather, his field equations specify the curvature of the hyper-surface that conservation of mass embeds into the space-time-mass manifold. This is similar to the two-dimensional surface that restricting motion to the Earth's surface embeds into the three dimensional space. The restriction does not impose a curvature to the underlying manifold. Rather, it allows for a second method of describing the motion.

5. Conclusion

The above shows that the two fundamental laws may be used not only to determine the equations of motion, but may also be used determine the form of the gravitational potential of fundamental particles. The laws also show that they require the gravitational field to be inductively coupled with the electromagnetic field as a five variable gauge field in a manifold of space, time and mass. By being inductively coupled with the electromagnetic field the gravitational field predicts several previously unknown concepts, such as the non-transverse waves. This inductive coupling also allows a different understanding of previous concepts such as the magnetic moment of the Earth and the Earth flyby anomalies.

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