ANOTHER THEORY OF GRAVITATION: AN ALTERNATIVE TO EINSTEIN'S GENERAL THEORY OF RELATIVITY†

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The second of Einstein's two relativity theories, his ***general theory of relativity****, is a theory of* ***gravitation****. Its wide acceptance and his original fame may be attributed largely to the presumed verification of predictions that he made relative to three effects in astronomy. Now, however, it turns out that all three of these effects should have been expected from other considerations; they can be shown to follow from more conventional physical analyses without the need for his theory and its rather drastic "nonphysical" concepts. A theory of gravitation is developed in this paper that follows the same analytical form as that which has proved to be so successful in electric theory, namely the form of Maxwell's four field equations in his electromagnetic theory of light. This theory yields all of the applications known from Newton's theory of gravitation* **plus** *the "expected" dynamical effects of gravitational waves and radiation, minute effects that Newton failed to provide for.* ***If this new theory of gravitation is accepted, it will greatly alter the foundations of modern cosmology****. Although the predicted gravitational radiation effects have the same order of magnitude as Einstein's, there is enough difference in value that if these effects are ever measured with sufficient accuracy this theory may be the "winner". This theory has not yet been completely explored; but it appears to be a satisfying alternative to Einstein's general theory of relativity, with much greater physical plausibility.*

Introduction

The universal law of gravitation developed by Sir Isaac Newton is the law that is employed in practical problems related to gravitation. For example, it is the law that has been used so successfully in space flights, accurately predicting the trajectories of space crafts in their flights to the moon, and beyond.

However, without detracting from the genius of Newton, nor of the applicability of his law of gravitation, it appears that this law is a limited one. It is an *action-at-a-distance* law, meaning that its force is supposed to act throughout space instantaneously. Whereas it is believed that this gravitational effect is propagated through space with a finite velocity, not an infinite velocity.

Action-at-a-distance laws in other areas of physics have been shown to be limited laws, holding only for those cases where the travel time can be neglected. The effects have actually been found to be propagated with the speed of light.

After developing his *special theory of relativity*, from which the useful concept of equivalence of mass and energy was deduced, Albert Einstein developed a second theory of relativity known as the *general theory of relativity*, a theory of *gravitation*. It is not a simple extension of his special theory, but a complete venture into new concepts. These new concepts associate gravity with accelerated frames of reference and include the concept of "curved space". This concept of "curved space" appears to be a "nonphysical" and inconsistent concept in relativity; because special theory of relativity is based on the assumption that space is not a measurable physical quantity, that there is no fixed frame of reference in space.

Even though the general theory of relativity appears to be "nonphysical", this theory gained wide acceptance and gave Einstein his first fame. His fame came when observations apparently verified predictions that he had made. He predicted three effects in astronomy, but these Einstein effects can now be accounted for by other means. The general theory is not needed to produce any of these effects. Nevertheless Einstein's general theory of relativity is still used as a foundational principle upon which modern cosmology rests.

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The Three Einstein Effects

The three effects predicted by Einstein[1] are: 1) A slight revolving motion of the elliptical orbit of a planet (the advance of its perihelion), 2) A slight curving of light rays by gravitational attraction, and 3) A redshift in the spectral lines of light emitted from very massive stars, or even from the Sun.

All of these effects are considered to have been observed:

1) The orbital motion effect has been measured on Mercury.

2) The bending of light rays from stars by the gravitational field of the sun is believed to have been observed during solar eclipses when observational conditions were optimum.

3) The redshift associated with some stars has been interpreted as a gravitational effect.

Several scientists have deduced these three effects by other theories. One of the most impressive demonstrations of an alternate means of deducing the three effects, without recourse to general relativity, is developed in the paper by L. Rongved entitled, "Mechanics in Euclidean Terms Giving All Three Einstein Effects".[2]

The authors of this paper have deduced these effects in still another way. Hence there is ample evidence that one does not need the general theory of relativity to predict these effects and they are not "proofs" of that theory. Discussion here will be confined mainly to the first two effects, however.

An Alternative Theory of Gravitation

A theory of gravitation is developed in this paper as an alternative to the general theory of relativity. This theory is developed from the same type of physical concepts that have been successful in electromagnetic theory. It employs the same form as that in Maxwell's four field equations. There are four field equations in gravitation and they contain four *field vectors* that are analogous to the four electric and magnetic field vectors of Maxwell's electromagnetic theory. This gravitational theory yields, besides the three things mentioned, all the "expected" dynamical effects that Einstein's theory yields, such as transverse gravitational wave radiation from accelerated masses and a finite propagation speed.

Gravitational solutions are obtained that are similar to classical solutions in electromagnetism theory. For example, the same type of solution is obtained for the gravitational power radiated from a revolving binary star system as from quadrupole radiation in electromagnetic theory.

It should be noted, however, that the computed magnitudes of these gravitational effects are quite small compared with the analogous electromagnetic effects, making them much more difficult to measure. Nevertheless this theory should convince one that these "over and above Newtonian effects", such as gravitational radiation are physically plausible because they follow from this development in the familiar electromagnetic theory form.

Fundamentals of the Theory

Gravitational field theory is developed from field equations that have the same form as Maxwell's field equations. To facilitate the development, four gravitational field vectors **d**, **g**, **h**, and **b**, are assumed. They are respectively analogous to the four Maxwell electromagnetic field vectors **D**, **E**, **H**, and **B**. Then *four gravitational field equations* are postulated, namely:

$$\nabla \cdot \mathbf{d} = -\rho \tag{1}$$

$$\nabla \cdot \mathbf{b} = 0 \tag{2}$$

$$\nabla \times \mathbf{h} = \mathbf{J}_m - \frac{\partial \mathbf{d}}{\partial t} \tag{3}$$

$$\nabla \times \mathbf{g} = \frac{\partial \mathbf{b}}{\partial t} \tag{4}$$

where ρ is mass density and $\mathbf{J}_m$ is mass current density ($kg/m^2 sec$). The sign on the right side of Equation (1) is the negative of that in the analogous Maxwell equation because gravitational *attraction* has replaced *repulsion* in the electrical analogy. Three additional postulates are made that are analogous to those in electromagnetic theory, namely:

$$\mathbf{d} = \epsilon_g \mathbf{g} \tag{5}$$

$$\mathbf{b} = \mu_g \mathbf{h} \tag{6}$$

and

$$\mathbf{F} = m\mathbf{g} + m\mathbf{b} \times \mathbf{v} \tag{7}$$

in which ϵ_g and μ_g are analogous to permittivity and permeability and **F** is the force of the gravitational field on point mass m.

In the *gravostatic* case Equation (7) reduces to the familiar

$$\mathbf{F} = m\mathbf{g} \tag{8}$$

and Newton's gravitational law applies. Hence, for point mass m at distance r from spherical mass m'

$$mg = \frac{Gmm'}{r^2} \tag{8'}$$

yielding the familiar Newtonian equation for the acceleration of gravity

$$g = \frac{Gm'}{r^2} \tag{9}$$

where G is the universal gravitational constant.

From Equations (1) and (5) one may easily show that the gravostatic field g at distance r from the spherical mass is of magnitude

$$g = \frac{m'}{4\pi\epsilon_g r^2} \tag{10}$$

Equating (9) and (10) yields

$$\epsilon_g = \frac{1}{4\pi G} \tag{11}$$

from which one may evaluate the constant ϵ_g.

Gravitational Poynting Theorem

A gravitational Poynting Theorem may be derived from Equations (3) and (4) in the same way that the electromagnetic Poynting Theorem is derived.[3] The gravitational Poynting's theorem, is

$$\oint (\mathbf{g} \times \mathbf{h}) \cdot \mathbf{n} dS = \int (\mathbf{g} \cdot \frac{\partial \mathbf{d}}{\partial t} + \mathbf{h} \cdot \frac{\partial \mathbf{b}}{\partial t}) dV \tag{12}$$

The *gravitational Poynting vector* is $\mathbf{g} \times \mathbf{h}$. It gives the intensity (the power flow per unit area) in a gravitational wave. Similarly the energy density u in a gravitational wave or field is[4]

$$u = -\frac{\epsilon_g g^2}{2} - \frac{\mu_g h^2}{2} \tag{13}$$

Gravitational Wave Equation

The gravitational wave equation is derived by the same mathematical processes employed in deriving the electromagnetic wave equation.[5] For an unbounded region with constant ϵ_g and μ_g and containing no masses, the wave equation is

$$\nabla^2 \mathbf{g} = \mu_g \epsilon_g \frac{\partial^2 \mathbf{g}}{\partial t^2} \tag{14}$$

and the speed

$$c = \frac{1}{\sqrt{\mu_g \epsilon_g}} \tag{15}$$

It is assumed that the speed c of the gravitational wave is equal to the speed of light, but Equation (15) holds whether or not c is equal to the speed of light.

From Equations (11) and (15)

$$\mu_g = \frac{4\pi G}{c^2} \tag{16}$$

So μ_g can be evaluated from the known values of the gravitational constant and the speed of light.

Applying the same type of theoretical development as in electromagnetic theory shows that these gravitational waves are *transverse* waves and have an *intrinsic gravitational impedance* of free space

$$\eta = \sqrt{\frac{\mu_g}{\epsilon_g}} = \frac{4\pi G}{c} \tag{17}$$

Gravitational Moments and Induction Field

Gravitational moment $\boldsymbol{m}$ is, by analogy with *magnetic moment*, defined for a mass current density distribution $\mathbf{J}_m(\mathbf{r}')$ in volume V' as

$$\boldsymbol{m} = \tfrac{1}{2} \int \mathbf{r}' \times \mathbf{J}_m(\mathbf{r}') dV' \tag{18}$$

The magnetic moment of a spherical mass M spinning with angular velocity ω has the familiar form

$$\boldsymbol{m} = \tfrac{1}{5} M r^2 \omega \tag{19}$$

The *gravitational induction field* **b** at distance r in direction **n** from the gravitational "dipole" moment $\boldsymbol{m}$ is, by analogy with the familiar induction field of a magnetic dipole,

$$\mathbf{b} = \frac{\mu_g}{4\pi} \left[\frac{3\mathbf{n}(\mathbf{n} \cdot \boldsymbol{m}) - \boldsymbol{m}}{r^3} \right] \tag{20}$$

This induction field ordinarily has a negligible magnitude but it is important in gravitational radiation.

Perihelion Advance and Light Bending

Two phenomena that have been commonly considered to be governed by the general theory of relativity are the advance of the perihelion of Mercury and the bending of star light in the sun's gravitational field. These phenomena are, however, questionable "evidence" for the general theory of relativity.

One may obtain the famous results of the advance of the perihelion of Mercury and the deflection of starlight using the concepts of special *relativity*, without recourse to the general theory of relativity. This is achieved by using a set of inertial frames of such small size that the gravitational field can be considered to be locally uniform. Utilizing the Lorentz transformations between coordinates systems and associating the primed with the frame at "rest" and the unprimed with a *falling* frame, one obtains

$$dt = \frac{dt'}{\sqrt{1 - 2\phi/c^2}} \tag{21}$$

and

$$dr = dr' \sqrt{1 - 2\phi/c^2} \tag{22}$$

where $\phi = \frac{Gm}{r}$ = gravitational potential, and dr' = incremental displacement in the radial component of the primed coordi-

nate system. This represents a translation of the clock rate and scale length in a gravitational field.

From special relativity the total energy of a particle is[6]

$$p_x^2 + p_y^2 + p_z^2 + m_o^2c^2 = E^2/c^2 \qquad (23)$$

where p_x, p_y and p_z are the components of the momentum, m_o is the mass of the particle, and E is the total energy. Transforming to spherical coordinates and utilizing Equations (21) and (22) and Hamilton-Jacobi theory, one obtains the advance of the perihelion of any planet in a gravitational field, namely

$$\delta\phi = \frac{6\pi Gm}{c^2 a(1 - e^2)} \qquad (24)$$

where $\delta\phi$ is the angular advance of the perihelion of the planet per revolution and e is the eccentricity and a the semi-major axis of the ellipse. If one assumes that $m_o = 0$, as in the case of a photon, the deflection of starlight may be shown, by an extension of this analysis, to be

$$\Delta\phi = \frac{4Gm}{c^2 r} \qquad (25)$$

Here $\Delta\phi$ is the deflection angle and r is the distance of the ray from the sun at closest approach.

Gravitational Radiation from an Accelerated Mass Particle

Both the general theory of relativity and theory of gravitation as developed in this paper may be used in the study of the generation of gravitational radiation. Utilizing the gravitational vector potential equation

$$\mathbf{A}_g = \frac{\mu_g}{4\pi} \int \frac{\mathbf{J}_m d\,V}{r} \qquad (26)$$

and following standard mathematical methods similar to those employed in electrodynamics, the gravitational field of an accelerated particle of rest mass m_o is, at velocity $v \ll c$,

$$\mathbf{g} = -\frac{Gm_o}{r^2}(\mathbf{n}-\beta) - \frac{Gm_o}{cr}[\mathbf{n} \times (\mathbf{n} \times \dot{\beta})] \qquad (27)$$

where $\mathbf{n}$ is unit vector in the direction of the field point with respect to the particle, the dot indicates differentiation with respect to time, and

$$\beta = \mathbf{v}/c \qquad (27')$$

Employing the relationship

$$\mathbf{b} = \nabla \times \mathbf{A}_g \qquad (28)$$

and Equation (26), one can show that

$$\mathbf{b} = -\frac{\mathbf{n} \times \mathbf{g}}{c} \qquad (29)$$

Utilizing the $1/r$ term in Equation (27) and assuming that $v \ll c$ one obtains the total power radiated from an accelerated particle

$$\text{Power} = \frac{2Gm_o{}^2\dot{\beta}^2}{3c} \qquad (30)$$

Gravitational Quadrupole Radiation

Starting with the vector potential Equation (26) and employing methods similar to those in electrodynamic development, the quadrupole power radiated by gravitational bound systems, such as double star systems, may be obtained. It is readily apparent that the dipole term goes to zero because $m_1r_1 = m_2r_2$, where m_1 = mass of star one, m_2 = mass of star two, r_1 = distance of star one from center of gravity, and r_2 = distance of star two from center of gravity. Therefore, one must go to the quadrupole term. The gravitational power radiated is given by[7]

$$\text{Power} = \frac{G}{180c^5} \sum_{\alpha\beta} |\dddot{Q}_{\alpha\beta}|^2 \qquad (31)$$

where

$$Q_{\alpha\beta} = \int (3x_\alpha x_\beta - r^2\delta_{\alpha\beta})\,\rho(x)\,d^3x \qquad (32)$$

and

$$\dddot{Q}_{\alpha\beta} = \frac{\partial^3}{\partial t^3} Q_{\alpha\beta} \qquad (33)$$

and $\rho(x)$ = density of matter. The result for a double star system is

$$\text{Power} = \frac{32G}{20c^5}(m_1r_1^2 + m_2r_2^2)^2\,\omega^6 \qquad (34)$$

in which $\omega = 2\pi/T$, T = period of revolution of the double star. This differs from the value given by the general theory of relativity, being only one fourth as large as that in the general theory of relativity. Present measurements cannot be used to confirm either of these gravitational radiation values; but if future experimental results yield the smaller value it would support the theory developed in this paper.

Conclusion

A gravitational field theory has been developed from *four* field vectors that are analogous to the Maxwell field vectors. This is much simpler than the gravitational field of general relativity where *ten* field potentials are required.[8] This theory appears to yield all of the important physical phenomena expected, but with enough difference in the quadrupole radiation intensity, compared to general relativity, so that future experimentors may be able to develop confirmation or rejection to this theory.

Acknowledgement

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References

[1]Einstein, Albert 1934. Essays in science. Philosophical Library, New York, p. 58.
[2]Rongved, L. 1966. Mechanics in Euclidian terms giving all the three Einstein effects, *Il Nuovo Cimento*, XLIV B (2): 255-371.
[3]Barnes, T. G. 1965. Foundations of electricity and magnetism. D. C. Heath and Co., pp. 155-159.
[4]The negative signs, which arise here but not in the electromagnetic case, can be interpreted by considering that the quantities $\epsilon_g g^2/2$ and $\mu_g h^2/2$ represent the "exhaustion" of gravostatic and gravomagnetic potential energy density. Hence the negative signs in Equation (13) are required to express these quantities as increases in gravostatic and gravomagnetic potential energy density. (For more about this notion of exhaustion see Heaviside's work, cited in Note Added.)
[5]Barnes, *Op. cit.*, pp. 284-287.
[6]Eisenberg, Jacob L. 1961. Fundamentals of modern physics. John Wiley and Sons, New York, p. 35.
[7]Landau, L. and E. Lifshitz 1951. The classical theory of fields. Addison-Wesley Press, p. 206.
[8]Sciama, D. C. 1971. Modern cosmology. Cambridge University Press, pp. 110 and 111.

Note Added: After this manuscript was submitted the Editor called attention to a paper written in 1893 by Oliver Heaviside entitled, "A Gravitational and Electromagnetic Analogy". It may be found in Heaviside's *Electromagnetic Theory*, reprinted by Dover, 1950. Unabridged Edition, Vol. 1, Appendix B, pp. 455-465. Heaviside proposed Maxwell-type equations for gravitation. It is encouraging to the authors to learn that much of their challenge to Einstein's gravitation theory is supported by this brilliant analysis of Heaviside.

Unfortunately the Heaviside paper did not go as far as one would wish. For example, it did not spell out some basic equations, such as Equation (7) of this paper; nor did it go into radiation from twin stars to afford a basis of comparison with Einstein's work. (Of course, Einstein's work had not been done in 1893.) However, Heaviside's insight into the concept of field energy proved very helpful to the authors, and prompted some alterations which have been included in this paper.

Editor's Note: Perhaps it might be better to say that the precession of the perihelion of Mercury is compatible with the theory of relativity, rather than predicted by it. For the behavior of the peri-

helion was known at least as early as Leverrier's work, about the middle of the last century. Toward the end of the century Newcomb, having studied the matters very extensively, concluded that there are several anomalies in the orbits of at least the four innermost planets. See Poor, Charles Lane 1922. Gravitation versus relativity. G. P. Putnam's Sons, New York. (See also Morgan, Herbert R., 1930. The observed motion of the perihelion of Mercury, *Journal of the Optical Society of America*, 20 (4): 225-229. The theory of relativity, it appears, helps with some of these anomalies, leaves some unchanged, and actually makes some worse.)

The two other effects of Einstein were not looked for evidently until the question of relativity had been raised. Actually some scientists have questioned whether the explanation given by relativity is really needed. See Poor, *Op. cit.;* also Burns, Keivin, 1930. A comparison of laboratory and solar wavelengths, *Journal of the Optical Society of America*, 20 (4): 212-224; also Poor, Charles Lane, 1930. The deflection of light as observed at total solar eclipses, *Journal of the Optical Society of America*, 20 (4): 173-211.

For an attempt at a theory of gravitation analogous to a theory of electrodynamics rather different from the Maxwellian one, see Ritz, Walther, 1908 and 1909, in papers collected in his *Oeuvres*, published in 1911 by La Société Suisse de Physique and Gauthier-Villars, Paris, pp. 419-422 and 462-492.

Further Editor's Comment

If anyone should ask what this topic has to do with Creationism, it is relevant in at least three ways. In the first place, gravitation and related matters have to do very closely with cosmology and cosmogony; and those topics clearly have to do with Creation. In the second place, it is possible that consideration of the radiation of energy through gravitational waves might help to prove the youth of the universe, by setting an upper limit on the ages of double stars, planetary systems, etc.

The third point is a little different. According to the theory proposed here, gravitation and electrodynamics are very closely analogous. When similarity is found in living beings, evolutionists often claim that it is evidence of descent. But surely no one will maintain that the electromagnetic field descended from the gravitational, or vice versa. Rather, the similarity is due to the Designer's use of one basic plan, with variations. Having seen this happen in inorganic nature, creationists shall not be surprised to see the same kind of thing among living beings. There, too, the similarities point to the Designer's methods, and have not necessarily anything to do with descent.

DARWIN DENIED: THE SUPERSTITION OF STOCHASTIC SUCCESSION

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The scene is a meeting of experts to discuss the reality, or otherwise, of UFO's. The narrator is a physical anthropologist whose avocation is exobiology. Pictures, alleged to be of the crew of a UFO, have just been shown. As the curtain rises, the narrator is commenting on the pictures.

Excerpts from Fictional Novelette

"Have those artfully staged photos fooled you all? Look at the slides of the alleged UFOnauts. Unmistakably human beings! Don't you gentlemen know what the mathematical odds are against the random evolution on another biosphere of creatures so extraordinarily like ourselves? Haven't you read George Gaylord Simpson's, "On the Non-prevalence of Humanoids?"[1] Or Harold Blum's independent corroborative calculations?[2]

"Even if we consider our present planet Earth to be starting all over again, back in the days when it had a reducing atmosphere, some four billion years ago, the odds against the evolution of sentient beings similar to ourselves were easily 10^{18} to one! Isaac Asimov has shown that the total number of different possible genomes existing in the visible universe is less than 3×10^{63}, while the total number of possible genomes exceeds 3×10^{622}."

"Garrett Hardin's figure for the latter is 10^{3000}; Hardin assumes that only one in a million million million million million gene combinations is viable, but that would still leave 10^{2970} adaptive peaks theoretically possible."[3]

"At any rate, no matter how you calculate it, the chances of humanoid evolution a second time anywhere else in the universe is negligibly small!"

"Excuse me," interrupted Porterhouse, "but Professor Asimov himself has partially countered that argument, by demonstrating the functional advantages of approximately humanoid form: two eyes, for steroscopic vision; brain near eyes for rapid responses, etc. Also, Carl Sagan has pointed out that if we are considering only a single pathway, then we have to multiply probabilities, and the product soon becomes negligible; but if there are many parallel paths to an approximately similar end, then we have to *add* the probabilities."

"There may be only one chance in a billion of exactly human life evolving under certain conditions, but if there are a billion other possible, viable kinds of creatures who phenotypically resemble the humanoid gross morphology, to the point where a superficial external inspection would accept identity (without consideration of biochemical differences), then the probability of evolution of a humanoid being could be so high as to have order of magnitude unity."

"Your logic and mathematics are correct," I replied, "but your assumptions are completely unsupportable. The well-proved principle of genetic homeostasis shows that as soon as you start to get away significantly from an adaptive genome, sterility or inviability sets in and drastically limits the amount of departure available." (See References 13 and 18.)

"Granted," replied Porterhouse, "but if you follow that line of evidence to its inevitable conclusion, you arrive at the result that the theory of macro-evolution (beyond species, genera and families to actual transformation of orders) by random point-mutations and Darwinian natural selection (differential reproduction)—that is, the conventional theory of stochastic macro-evolution—falls of its own weight as a mathematical absurdity." (See Reference 19.)

"Surely you aren't serious?"

"Indeed I am," answered Porterhouse. "Haven't you read my book, *Darwin Discredited: the superstition of stochastic succession?"*

"Teleology!" exclamed Damsel, picking up a copy of his magnum opus, *UFO's.*

"Orthogenesis!" blurted I, grabbing a Morocco-bound gilt-edged copy of my monograph on exobiology.

"Vitalism!" snapped Amizov, clutching a fat paperback edition of his masterpiece, *Amizov's Amazing Assorted Assertions.*

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