Electrodynamic Origin of Gravitational Forces

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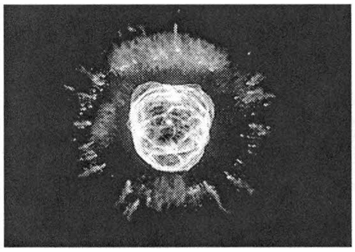
From the derived universal classical electrodynamic contact force law for finite-size elastic particles the force of gravity is identified as a statistical residual force of the fourth order term in v/c due to vibration of neutral electric dipoles consisting primarily of atomic electrons and nuclear protons plus polarized vibrating neutrons in the nucleus. The gravitational force is calculated and found to be a relativistic version of the customary radial term of Newton's Universal Law of Gravitation plus a new non-radial term. From the radial term the gravitational mass is defined in terms of electrodynamic parameters. The non-radial term gives rise to an **(R·V)R** x (**R** x **V**) force that causes the orbits of the planets about the sun to spiral about a circular orbit giving the appearance of an elliptical orbit tilted with respect to the equatorial plane of the sun with periods in agreement with Bode's Law. The vibrational mechanism causing the gravitational force decays over time giving rise to the cosmic background radiation and Hubble's Law for red shifts versus distance due to gravitational red shifting. Halton Arp's discovery of quasars bound to galaxies with significantly different red shifts is explained in terms of the younger quasar galaxy's neutral dipole vibrations having decayed for a shorter period of time than the older and larger associated galaxy. The decay of gravity also explains Tifft's measured decay of the magnitude of red shifts over time, and the high velocity of stars in the spiral arms of galaxies.

1. Introduction

In the past natural philosophers and astronomers thought that we lived in a disconnected universe consisting of the Milky Way Galaxy with a vacuum or void between the stars and other objects. In recent times astronomers have discovered that space is filled with charged particles forming dynamic plasmas. From Figs. 1 and 2 we can see that there are magnetic fields stretching across vast intergalactic distances in these plasmas.



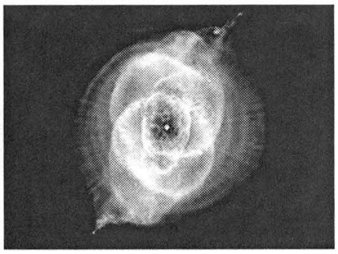


Fig. 1. Eskimo Nebula [1] **Fig. 2.** Cat's Eye Nebula [2]
Plasma Structure of Galaxies Controlled by Magnetic Fields

These magnetic fields appear as filaments or threads extending for millions of light years connecting things together. Stars appear as something like streetlights along the fibers of the electric universe. This is very different from the universe of Isaac Newton's day which consisted primarily of empty space with astronomical bodies orbiting one another due to the action-at-a-distance gravitational force. The electrodynamic plasma force is 10^{40} times as strong as the gravitational force and appears to play a more dominant role in the universe than the gravitational force as it connects things together.

Einstein's General Relativity Theory, the replacement theory for Newton's theory of gravity, has run into great difficulty in these days. It can not explain the role of electrodynamic plasmas in the organization of the universe. Furthermore, it can not explain the observed structure of spiral galaxies without inventing dark matter, such that the universe consists of 90-95% dark matter which can not be observed in the laboratory like other types of matter. In addition, in order to explain the expansion of the universe using relativity theory, it has been necessary to invent dark energy which can not be observed directly either.

Instead of pursuing these problematic approaches to a disconnected universe, it would seem better to consider an electrodynamic approach for a connected universe in agreement with Mach's Principle. Ever since the discovery of Coulomb's electrostatic force law (Coulomb, 1785) between charges q_1 and q_2 and Newton's universal gravitational force law (Newton, 1687) between masses m_{g1} and m_{g2}

$$\vec{F}_{Coulomb} = \frac{1}{4\pi\epsilon_0}\frac{q_1 q_2}{\vec{R}^2} \quad F_{Gravity} = G\frac{m_{g1}m_{g2}}{\vec{R}^2} \quad (1)$$

$$where\ \vec{R} = \vec{r}_2 - \vec{r}_1$$

Scientists have imagined that there might be a relationship between electrodynamics and gravity, because the form of the force laws is identical.

The philosopher Poincare [40] argued from logic that any two fundamental forces that employed the same fundamental constants or the same mathematical form were not both fundamental. The most advanced theory of gravity, Einstein's General Relativity Theory as represented in equation (2), is expressed in terms of c the velocity of light which is the fundamental constant of electrodynamics.

$$G_{\mu\nu} = -\frac{8\pi}{c}GT_{\mu\nu} \quad (2)$$

Einstein also said in his Principle of Equivalence that gravity and inertia are intimately related. Poincare suggested that electrodynamics might be the origin of both the gravitational force as well as the related inertial force, because both force laws involve mass and the velocity of light which is the fundamental constant of electrodynamics.

According to the Lorentz force law combined with Ampere's law of induction for a moving charge ($B_i = qv/cE_0$)

$$\vec{F} = q\vec{E}_0 + \vec{v}/_c \times \vec{B}_i = q\vec{E}_0 + \vec{v}/_c \times \left(q\, {}^{v}/_c \times \vec{E}_0\right) \approx q\vec{E}_0\left(1 + {}^{v^2}/_{c^2}\right) \quad (3)$$

the induced $\mathbf{B}_i$ field adds a term to the static Coulomb field E_0 proportional to v^2/c^2. The free electron drift velocity in conductors is typically on the order of 0.03 m/sec such that

$$\frac{v^2}{c^2} \approx \left(\frac{3 \times 10^{-2} m/sec}{3 \times 10^{8} m/sec}\right)^2 \approx 10^{-20} \quad (4)$$

Now the gravitational force is approximately 10^{-40} times smaller than the static Coulomb electric force, suggesting that the gravitational force might be a higher order v^4/c^4 term multiplying the static Coulomb force.

The derived universal electrodynamic contact force [3] as given in equation (5) below gives terms of this sort. In the past such higher order terms in the electrodynamic force were never fully investigated.

$$\vec{F}(\vec{r},\vec{v},\vec{a}) = \frac{qq'}{\vec{r}^2} \frac{(1-\vec{\beta}^2)\vec{r} + \dfrac{2\vec{r}^2\vec{a}}{c^2}}{\left[\vec{r}^2 - \dfrac{\left\{\vec{r} \times \left(\vec{r} \times \frac{\vec{v}}{c}\right)\right\}^2}{\vec{r}^2}\right]^{\frac{1}{2}}} - \frac{qq'(1-\vec{\beta}^2)}{\vec{r}^2} \frac{\left\{\left(\vec{r} \cdot \frac{\vec{v}}{c}\right)\vec{r} \times \left(\vec{r} \times \frac{\vec{v}}{c}\right) - (\vec{r} \cdot \vec{r})\vec{r} \times \left(\vec{r} \times \frac{\vec{a}}{c^2}\right)\right\}}{\left[\vec{r}^2 - \dfrac{\{\vec{r} \times (\vec{r} \times \vec{v}/c)\}^2}{\vec{r}^2}\right]^{\frac{3}{2}}} \quad (5)$$

For acceleration $\mathbf{a}=0$ and writing out $\beta = v/c$ terms obtain...

2. Origin of Gravitational Forces

$$\vec{F}(\vec{r},\vec{v},\vec{a})_{\vec{a}=0} = \frac{qq'}{\vec{R}^2} \frac{\left[1 - \frac{v^2}{c^2}\right]\hat{R}}{\left[1 - \frac{v^2}{c^2} sin^2\theta\right]^{1/2}} + \frac{qq'}{\vec{R}^2} \frac{\left[1 - \frac{v^2}{c^2}\right]\left(\hat{R} \cdot \frac{\vec{v}}{c}\right)\left\{\hat{R} \times \left(\hat{R} \times \frac{\vec{v}}{c}\right)\right\}}{\left[1 - \frac{v^2}{c^2} sin^2\theta\right]^{3/2}} \quad (6)$$

In the universal force equation (5) the first acceleration **a** term above gives rise to Newton's Second Law (**F=ma**) for the force of inertia and the second acceleration term **r** x **a** gives rise to absorption and emission of electromagnetic radiation or light. This universal contact force in the limit of constant velocity, i.e. **a**=0 equation (6) corresponds, mathematically speaking, to the action-at-a-distance covariant relativistic electrodynamic force based on Maxwell's equations. [4 p. 555 or 5 p. 560]

The force of gravity is normally measured between neutral charge bodies. Since the time of Newton, scientists have learned that the neutral atom consists of electrons, protons, and neutrons. Even elementary charged particles such as the neutron and proton consist of smaller components of positive and negative charge such as quarks or charge fibers. This work explores the possibility that the attractive force of gravity is due to a small residual electrodynamic force between vibrating or oscillating neutral electric dipoles. These dipoles could be inside an elementary particle or an atom, but for this work we will assume that the primary effect is from protons and electrons in atoms.

Assuming constant velocity **a**=0 and **v**/c=β is very small, one may expand the terms in the equation (6) for the universal electrodynamic force for the radial term using the binomial expansion and keeping only terms to order β^4 to obtain

$$\vec{F}(\vec{r},\vec{v}) = \frac{qq\hat{r}}{4\pi\epsilon_0\vec{r}^2}(1-\beta^2)\left[1 + \frac{1}{2}\beta^2 sin^2\theta + \frac{\left(\frac{1}{2}\right)\left(\frac{3}{2}\right)}{2}\beta^4 sin^4\theta + \cdots\right] - \frac{qq}{4\pi\epsilon_0\vec{r}^2}(\vec{\beta}\cdot\vec{r})\vec{r} \times (\vec{r} \times \vec{\beta})(1-\beta^2)\left[\begin{array}{c} 1 + \frac{3}{2}\beta^2 sin^2\theta \\ + \frac{\left(\frac{3}{2}\right)\left(\frac{5}{2}\right)}{2}\beta^4 sin^4\theta + \cdots \end{array}\right]$$

$$= \frac{qq\hat{r}}{4\pi\epsilon_0\vec{r}^2}\left[1 - \frac{1}{2}\beta^2 - \frac{1}{2}\beta^2 cos^2\theta - \frac{1}{8}\beta^4 - \frac{1}{4}\beta^4 cos^2\theta + \frac{3}{8}\beta^4 cos^4\theta + \cdots\right] - \frac{qq}{4\pi\epsilon_0\vec{r}^2}(\vec{\beta}\cdot\vec{r})\vec{r} \times (\vec{r} \times \vec{\beta})\left[\begin{array}{c} 1 + \frac{1}{2}\beta^2 - \frac{3}{2}\beta^2 cos^2\theta - \frac{3}{8}\beta^4 \\ -\frac{9}{4}\beta^4 cos^2\theta + \frac{15}{8}\beta^4 cos^4\theta + \cdots \end{array}\right] \quad (7)$$

Consider the force between two neutral electric dipoles each consisting of positive protons and negative electrons. If we label the charges q_{1+}, q_{1-}, q_{2+}, and q_{2-}, the total force between the two neutral dipoles is given by equation (8)

$$F = F_{2+,1+} + F_{2+,1-} + F_{2-,1+} + F_{2-1-} \quad (8)$$

where the dipoles are defined in Fig. 3 for hydrogen atoms where the larger toroid is the electron and the smaller toroid is the proton.

$$\vec{r}_{1+2+} = \vec{r}_{2+} - \vec{r}_{1+} \quad \omega_1 = 2\pi f_1 \quad \omega_2 = 2\pi f_2$$

$$\vec{r}_{1-2+} = \vec{r}_{2+} - \vec{r}_{1-} - \vec{A}_1 \cos(\omega_1 t + \phi_1) \quad A_1 f_1 = v_1$$

$$\vec{r}_{1+2-} = \vec{r}_{1+} - \vec{r}_{2-} - \vec{A}_2 \cos(\omega_2 t + \phi_2) \quad A_2 f_2 = v_2$$

$$\vec{r}_{2-1-} = \vec{r}_{2-} - \vec{r}_{1-} - \vec{A}_2 \cos(\omega_2 t + \phi_2) - A_1 \cos(\omega_1 t + \phi_1)$$

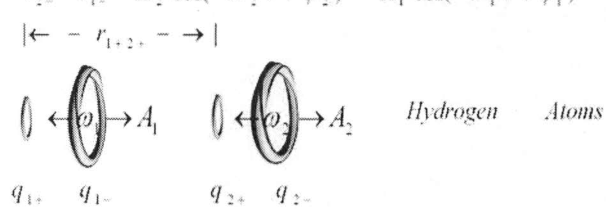


Fig. 3. Oscillations of Electrons in Neutral Dipoles

The amplitudes of oscillation A_1 and A_2 should be on the order of the size of the atom 10^{-10} m or less. From the wave equation Af=c, the frequencies of oscillation ω_1 and ω_2 must be in the microwave range $\approx 10^{10}$ per second. At t=0 the amplitude of vibration is maximum as represented by $\cos(\omega t + \varphi)$.

In order to simplify the calculations assume that the positively charged proton is much more massive than the negatively charged electron, such that the vibratory motion of the dipole can be considered as due primarily to the motion of the electron. Since the mass of the proton is 1836 times the mass of an electron, this is a reasonable approximation.

In order to calculate a quantity comparable to the force of gravity, it will be necessary to perform a number of averages. Each oscillating dipole has a different phase that must be averaged over. Each oscillating dipole may have a different physical orientation that needs to be averaged over for all the dipoles in the material body. In order to obtain a time independent value it will be necessary to perform a time average on each of the oscillating dipoles. Thus the force to be compared with gravity is

$$\vec{F}(\vec{r},\vec{v}) = \frac{1}{T_1}\int_0^{T_1} dt_1 \frac{1}{T_2}\int_0^{T_2} dt_2 \frac{1}{2\pi}\int_0^{2\pi} d\varphi_1 \frac{1}{2\pi}\int_0^{2\pi} d\varphi_2 \frac{1}{2\pi}\int_0^{2\pi} d\varphi \frac{1}{\pi}\int_0^{\pi} \sin\theta\, d\theta$$
$$\vec{F}(r,\theta,\varphi,\vec{A}_1,\omega_1,\varphi_1,t_1,\vec{A}_2,\omega_2,\varphi_2,t_2,v) \quad (9)$$

For simplicity consider that there are two collections of dipoles to average over and that the two collections have spherical symmetry. In this case the integral over φ becomes just 2π giving

$$\vec{F}(\vec{r},\vec{v}) = \frac{1}{T_1}\int_0^{T_1} dt_1 \frac{1}{T_2}\int_0^{T_2} dt_2 \frac{1}{2\pi}\int_0^{2\pi} d\varphi_1 \frac{1}{2\pi}\int_0^{2\pi} d\varphi_2 \frac{1}{\pi}\int_0^{\pi} \sin\theta\, d\theta$$
$$\vec{F}(r,\theta,\varphi,A_1,\omega_1,\varphi_1,t_1,A_2,\omega_2,\varphi_2,t_2,v) \quad (10)$$

Note that there are two fundamental type terms in the force given in equation (7). The first term is radial and is proportional to r. The second term is non-radial and proportional to (β·R){Rx(Rxβ)}. The v4/c4 part of the first term will lead to Newton's universal law of gravitation. The v4/c4 part of the second term will lead to a new (previously unknown?) gravitational force term which causes a corkscrew type motion and quantization of orbits. Since the first term can be used to identify with Newton's universal force of gravitation, it will be calculated first.

3. Computation of Radial Force Term

The four radial force terms of equation (8) are shown below where the coordinates are given explicitly:

$$\vec{F}_{2-,1+} = \frac{q_1 q_2 \hat{r}_{21}}{4\pi\epsilon_0 \left|\vec{r}_2 + \vec{A}_2 - \vec{r}_1\right|^2}\Big[1 - \frac{1}{2}(\vec{\beta}_2 - \vec{\beta}_1)^2 - \frac{1}{2}(\vec{\beta}_2 - \vec{\beta}_1)^2 \cos^2\theta - \frac{1}{8}(\vec{\beta}_2 - \vec{\beta}_1)^4 - \frac{1}{4}(\vec{\beta}_2 - \vec{\beta}_1)^4 \cos^2\theta + \frac{3}{8}(\vec{\beta}_2 - \vec{\beta}_1)^4 \cos^4\theta + \cdots\Big]$$

$$\vec{F}_{2+,1+} = \frac{q_1 q_2 \hat{r}_{21}}{4\pi\epsilon_0 |\vec{r}_2 - \vec{r}_1|^2}\Big[1 - \frac{1}{2}(\vec{\beta}_2 - \vec{\beta}_1)^2 - \frac{1}{2}(\vec{\beta}_2 - \vec{\beta}_1)^2 \cos^2\theta - \frac{1}{8}(\vec{\beta}_2 - \vec{\beta}_1)^4 - \frac{1}{4}(\vec{\beta}_2 - \vec{\beta}_1)^4 \cos^2\theta + \frac{3}{8}(\vec{\beta}_2 - \vec{\beta}_1)^4 \cos^4\theta + \cdots\Big]$$

$$\vec{F}_{2+,1-} = \frac{q_1 q_2 \hat{r}_{21}}{4\pi\epsilon_0 \left|\vec{r}_2 - \vec{r}_1 - \vec{A}_1\right|^2}\Big[1 - \frac{1}{2}(\vec{\beta}_2 - \vec{\beta}_1)^2 - \frac{1}{2}(\vec{\beta}_2 - \vec{\beta}_1)^2 \cos^2\theta - \frac{1}{8}(\vec{\beta}_2 - \vec{\beta}_1)^4 - \frac{1}{4}(\vec{\beta}_2 - \vec{\beta}_1)^4 \cos^2\theta + \frac{3}{8}(\vec{\beta}_2 - \vec{\beta}_1)^4 \cos^4\theta + \cdots\Big]$$

$$\vec{F}_{2-,1-} = \frac{q_1 q_2 \hat{r}_{21}}{4\pi\epsilon_0 \left|\vec{r}_2 + \vec{A}_2 - \vec{r}_1 - \vec{A}_1\right|^2}\Big[1 - \frac{1}{2}(\vec{\beta}_2 - \vec{\beta}_1)^2 - \frac{1}{2}(\vec{\beta}_2 - \vec{\beta}_1)^2 \cos^2\theta - \frac{1}{8}(\vec{\beta}_2 - \vec{\beta}_1)^4 - \frac{1}{4}(\vec{\beta}_2 - \vec{\beta}_1)^4 \cos^2\theta + \frac{3}{8}(\vec{\beta}_2 - \vec{\beta}_1)^4 \cos^4\theta + \cdots\Big] \quad (11)$$

Now the force of gravity is normally measured in lab experiments where $r_2 - r_1 >> A_1$ and $r_2 - r_1 >> A_2$. Thus to good approximation the A_1 and A_2 terms in the denominator may be dropped such that

$$\vec{F}_{q_2,q_1} = \frac{q_1 q_2 \hat{r}_{21}}{4\pi\epsilon_0 |\vec{r}_2 - \vec{r}_1|^2}\Big[1 - \frac{1}{2}(\vec{\beta}_2 - \vec{\beta}_1)^2 - \frac{1}{2}(\vec{\beta}_2 - \vec{\beta}_1)^2 \cos^2\theta - \frac{1}{8}(\vec{\beta}_2 - \vec{\beta}_1)^4 - \frac{1}{4}(\vec{\beta}_2 - \vec{\beta}_1)^4 \cos^2\theta + \frac{3}{8}(\vec{\beta}_2 - \vec{\beta}_1)^4 \cos^4\theta + \cdots\Big] \quad (12)$$

For the velocity terms in the [] of the expression for the force above, $\beta_2 \approx \beta_1$ and $\beta_2 - \beta_1 \approx 0$ for most laboratory measurements of gravity. In this case only the $A_1\omega_1$ and $A_2\omega_2$ terms are left as shown below where $q_1 = q_2 = e$ is the charge of the proton and $-e$ is the charge of the electron.

$$\vec{F}_{2+,1+} = \frac{-e^2 \hat{r}_{21}}{4\pi\epsilon_0 |\vec{r}_2 - \vec{r}_1|^2}[1]$$

$$\vec{F}_{2+,1-} = \frac{-e^2 \hat{r}_{21}}{4\pi\epsilon_0 |\vec{r}_2 - \vec{r}_1|^2}\left[1 - \left(\frac{A_1\omega_1}{c}\sin(\omega_1 t_1 + \varphi_1)\right)^2 \left(\frac{1+\cos^2\theta}{2}\right) + \left(\frac{A_1\omega_1}{c}\sin(\omega_1 t_1 + \varphi_1)\right)^4 \left(-\frac{1}{8} - \frac{1}{4}\cos^2\theta + \frac{3}{8}\cos^4\theta\right)\right]$$

$$\vec{F}_{2-,1+} = \frac{-e^2 \hat{r}_{21}}{4\pi\epsilon_0 |\vec{r}_2 - \vec{r}_1|^2}\left[1 - \left(\frac{A_2\omega_2}{c}\sin(\omega_2 t_2 + \varphi_2)\right)^2 \left(\frac{1+\cos^2\theta}{2}\right) + \left(\frac{A_2\omega_2}{c}\sin(\omega_2 t_2 + \varphi_2)\right)^4 \left(-\frac{1}{8} - \frac{1}{4}\cos^2\theta + \frac{3}{8}\cos^4\theta\right)\right]$$

$$\vec{F}_{2-,1-} = \frac{e^2 \hat{r}_{21}}{4\pi\epsilon_0 |\vec{r}_2 - \vec{r}_1|^2}\left[1 - \left(\frac{A_1\omega_1}{c}\sin(\omega_1 t_1 + \varphi_1) + \frac{A_2\omega_2}{c}\sin(\omega_2 t_2 + \varphi_2)\right)^2 \left(\frac{1+\cos^2\theta}{2}\right) + \left(\frac{A_1\omega_1}{c}\sin(\omega_1 t_1 + \varphi_1) + \frac{A_2\omega_2}{c}\sin(\omega_2 t_2 + \varphi_2)\right)^4 \left(-\frac{1}{8} - \frac{1}{4}\cos^2\theta + \frac{3}{8}\cos^4\theta\right)\right] \quad (13)$$

One can see that the sum of the first terms, i.e. 1 terms, in the [] of the four forces is just 0. The sum of the second terms in the [] does not sum to 0, since the cross term remains. Two parts of the third term in the [] cancel, leaving the cross terms. The resulting sum of the four forces gives

$$\vec{F} = \vec{F}_{2+,1+} + \vec{F}_{2+,1-} + \vec{F}_{2-,1+} + \vec{F}_{2-,1-}$$
$$\frac{e^2 \hat{r}_{21}}{4\pi\epsilon_0 |\vec{r}_2 - \vec{r}_1|^2}\Big[2\frac{A_1\omega_1}{c}\sin(\omega_1 t_1 + \varphi_1)\frac{A_2\omega_2}{c}\sin(\omega_2 t_2 + \varphi_2)\left(\frac{1+\cos^2\theta}{2}\right) + 4\frac{A^3{}_1\omega^3{}_1}{c}\sin^3(\omega_1 t_1 + \varphi_1)\frac{A_2\omega_2}{c}\sin(\omega_2 t_2 + \varphi_2)\left(-\frac{1}{8} - \frac{1}{4}\cos^2\theta + \frac{3}{8}\cos^4\theta\right) + 4\frac{A^3{}_2\omega^3{}_2}{c}\sin^3(\omega_2 t_2 + \varphi_2)\frac{A_1\omega_1}{c}\sin(\omega_1 t_1 + \varphi_1)\left(-\frac{1}{8} - \frac{1}{4}\cos^2\theta + \frac{3}{8}\cos^4\theta\right) - 6\frac{A^2{}_1\omega^2{}_1}{c}\sin^2(\omega_1 t_1 + \varphi_1)\frac{A^2{}_2\omega^2{}_2}{c}\sin^2(\omega_2 t_2 + \varphi_2)\left(-\frac{1}{8} - \frac{1}{4}\cos^2\theta + \frac{3}{8}\cos^4\theta\right)\Big] \quad (14)$$

Now the integrals in equation (10) can be evaluated. The symmetry of the integrals over φ_1 and φ_2 will cause the odd powers of $\sin(\omega_1 t_1 + \varphi_1)$ and $\sin(\omega_2 t_2 + \varphi_2)$ to average to zero, i.e.

$$\frac{1}{T}\int_0^T \frac{1}{2\pi}\int_0^{2\pi} \sin(\omega t+\varphi)d\phi dt = \frac{\omega}{2\pi}\int_0^{\frac{2\pi}{\omega}} \frac{1}{2\pi}\int_0^{2\pi} \sin(\omega t+\varphi)d\varphi dt \quad (15)$$

$$= \frac{1}{2\pi}\int_0^{2\pi} \frac{1}{2\pi}\int_0^{2\pi} \sin(x+\varphi)d\varphi dx \quad (x=\omega t)$$

$$= \frac{1}{2\pi}\int_0^{2\pi} \frac{1}{2\pi}\int_0^{2\pi} (\sin x\cos\varphi - \cos x\sin\varphi)d\varphi dx$$

$$= \left(\frac{1}{2\pi}\right)^2 \int_0^{2\pi} (-\cos x\cos\varphi + \sin x\sin\varphi)d\varphi \Big|_0^{2\pi}$$

$$= \left(\frac{1}{2\pi}\right)^2 (-2)(0-0) = 0$$

Thus from the symmetry of the integrals the average force of equation (14) may be reduced to

$$\vec{F}(\vec{r}) = \frac{1}{T_1}\int_0^{T_1} dt_1 \frac{1}{T_2}\int_0^{T_2} dt_2 \frac{1}{2\pi}\int_0^{2\pi} d\varphi_1 \frac{1}{2\pi}\int_0^{2\pi} d\varphi_2 \frac{1}{\pi}\int_0^{\pi} \sin\theta d\theta$$
$$\vec{F}(r,\theta,\varphi,\vec{A}_1,\omega_1,\varphi_1,t_1,\vec{A}_2,\omega_2,\varphi_2,t_2) \quad (16)$$

$$= \frac{\omega_1}{2\pi}\int_0^{2\pi/\omega_1} dt_1 \frac{\omega_2}{2\pi}\int_0^{2\pi/\omega_2} dt_2 \frac{1}{2\pi}\int_0^{2\pi} d\varphi_1 \frac{1}{2\pi}\int_0^{2\pi} d\varphi_2 \frac{1}{\pi}\int_0^{\pi} \sin\theta d\theta$$
$$\frac{e^2\hat{r}_{21}}{4\pi\epsilon_0|\vec{r}_2-\vec{r}_1|^2} 6\frac{A_2{}^2\omega_2{}^2}{c^2}\sin^2(\omega_2 t_2+\varphi_2)\frac{A_1{}^2\omega_1{}^2}{c^2}\sin^2(\omega_1 t_1 + \varphi_1)\left(-\frac{1}{8}-\frac{1}{4}\cos^2\theta+\frac{3}{8}\cos^4\theta\right)$$

$$= -\frac{\omega_1}{2\pi}\int_0^{2\pi/\omega_1} dt_1 \frac{\omega_2}{2\pi}\int_0^{2\pi/\omega_2} dt_2 \frac{1}{2\pi}\int_0^{2\pi} d\varphi_1 \frac{1}{2\pi}\int_0^{2\pi} d\varphi_2$$
$$\frac{e^2\hat{r}_{21}}{4\pi\epsilon_0|\vec{r}_2-\vec{r}_1|^2} 6\frac{A_2{}^2\omega_2{}^2}{c^2}\sin^2(\omega_2 t_2+\varphi_2)\frac{A_1{}^2\omega_1{}^2}{c^2}\sin^2(\omega_1 t_1 + \varphi_1)\frac{4}{15\pi}$$

$$= -\frac{\omega_1}{2\pi}\int_0^{2\pi/\omega_1} dt_1 \frac{\omega_2}{2\pi}\int_0^{2\pi/\omega_2} dt_2 \frac{e^2\hat{r}_{21}}{4\pi\epsilon_0|\vec{r}_2-\vec{r}_1|^2} 6\frac{A_2{}^2\omega_2{}^2}{c^2}\frac{A_1{}^2\omega_1{}^2}{c^2}\frac{1}{2}\frac{4}{15\pi}$$

$$= -\frac{e^2\hat{r}_{21}}{4\pi\epsilon_0|\vec{r}_2-\vec{r}_1|^2}\frac{A_2{}^2\omega_2{}^2}{c^2}\frac{A_1{}^2\omega_1{}^2}{c^2}\frac{2}{5\pi}\ (attractive\ force\ only)$$

This attractive only force is to be compared with Newton's Universal Law of Gravitation

$$\vec{F}(\vec{r}) = -G\frac{m_{g1}m_{g2}\hat{r}_{12}}{|\vec{r}_2-\vec{r}_1|^2} \quad (17)$$

where in the calculation of equation (16) above $-\sin\theta\, d\theta = d\cos\theta$, $x = \omega t$, $dx = \omega dt$, such that

$$\frac{1}{2\pi}\int_0^{2\pi} \sin^2(\omega t+\varphi)d\varphi$$
$$= \frac{1}{2\pi}\int_0^{2\pi}(\sin^2\omega t\cos^2\varphi + 2\cos\omega t\sin\omega t\sin\varphi\cos\phi + \cos^2\omega t\sin^2\varphi)d\varphi$$

$$= \frac{1}{2\pi}(\pi\cos^2\omega t + 0 + \pi\sin^2\omega t) = \frac{1}{2}(\cos^2\omega t+\sin^2\omega t) = \frac{1}{2} \quad (18)$$

and

$$\frac{1}{\pi}\int_0^{\pi}\sin\theta d\theta\left(-\frac{1}{8}-\frac{1}{4}\cos^2\theta+\frac{3}{8}\cos^4\theta\right)$$
$$= \frac{1}{\pi}\int_{-1}^{1} d\cos\theta\left(-\frac{1}{8}-\frac{1}{4}\cos^2\theta+\frac{3}{8}\cos^4\theta\right)$$
$$= \frac{1}{\pi}\left(-\frac{\cos\theta}{8}-\frac{1}{4}\frac{\cos^3\theta}{3}+\frac{3}{8}\frac{\cos^5\theta}{5}\right)\Bigg|_{-1}^{1}$$
$$= \frac{1}{\pi}\left(-\frac{2}{8}-\frac{1}{4}\frac{2}{3}+\frac{3}{8}\frac{2}{5}\right) = \frac{4}{15\pi} \quad (19)$$

We need to see if the following relationship is reasonable.

$$Gm_{g1}m_{g2} = \frac{1}{4\pi\varepsilon_0}\frac{2e^2}{5\pi}\frac{A_1{}^2\omega_1{}^2}{c^2}\frac{A_2{}^2\omega_2{}^2}{c^2} \quad (20)$$

Note that for two bodies with N_1 and N_2 atoms of atomic number Z_1 and Z_2 this formula becomes

$$Gm_{g1}m_{g2} = \frac{1}{4\pi\varepsilon_0}\frac{2}{5\pi}\frac{N_1Z_1eA_1{}^2\omega_1{}^2}{c^2}\frac{N_2Z_2eA_2{}^2\omega_2{}^2}{c^2} \quad (21)$$

There will be a range of combinations of amplitude A and frequency ω for which equation (20) above holds. Although equation (16) looks very similar to Newton's Universal Law of Gravitation, it is very different. First it is a local contact force. Second it says gravity is decaying over time. Third the second term of the gravitational force will turn out to be a non-radial term causing many effects including the quantization of gravity. All of these gravitational effects must be observed in order to claim that this force law is valid. If the properties of the derived force of gravity are supported by experimental data, then it can be claimed to be superior to the previous theories of gravity such as Newton's Universal Law of Gravitation and Einstein's General Relativity Theory.

4. Corroborating Circumstantial Evidence

If the conjecture that the source of gravity is due to a statistical residual electromagnetic force between vibrating neutral electric dipoles originating from the $(v/c)^4$ terms of the electromagnetic force is correct, then there are consequences which can be used to verify the conjecture. According to electrodynamics these oscillating dipoles must radiate energy. Since the gravitational force dominates on the large scale in the physical universe, the energy radiated by these oscillating dipoles in every atom should be greatest in the vicinity of matter, and be easily observable in its microwave frequency range.

Now hydrogen is the most dominant element in the universe comprising 75% of all visible matter.[6] In order to test this conjecture on the origin of the force of gravity, let us calculate the wavelength λ for this dipole radiation assuming hydrogen atoms. For simplicity assume $N_1 = N_2 = 1$, $q_1 = q_2 = e$, $\omega_1 = \omega_2 = \omega$, $m_1 = m_2 = m$ of hydrogen, and $A_1 = A_2 = A \le$ size of hydrogen atom. From the wave equation $\lambda f = c$, we have $\omega = 2\pi f = 2\pi c/\lambda$. Thus

$$Gm^2 \ge \frac{1}{4\pi\varepsilon_0}\frac{2}{5\pi}\frac{e^2A^4\omega^4}{c^4} = \frac{1}{4\pi\varepsilon_0}\frac{2}{5\pi}\frac{e^2A^4}{c^4}\left(\frac{2\pi c}{\lambda}\right)^4 \quad (22)$$
$$= \frac{1}{4\pi\varepsilon_0}\frac{2e^2}{5\pi}\frac{16\pi^4A^4}{\lambda^4}$$

Solving for λ obtain

$$\lambda^4 \leq \frac{1}{4\pi\varepsilon_0}\frac{2e^2}{5\pi}\frac{16\pi^4 A^4}{Gm^2} \quad (23)$$

Using the following values for the hydrogen constants from the **CRC Handbook of Chemistry and Physics**[7] and the radius of the hydrogen atom from Zumdahl [8] one obtains for an upper limit for λ

$$G = 6.67390x10^{-11}Nm^2/kg^2$$

$$\frac{1}{4\pi\varepsilon_0} = 9.0x10^9\ Nm^2/C^2$$

$$A \leq 0.37x10^{-10}\ m$$

$$e = 1.60217733x10^{-19}\ \mathrm{C}$$

$$m = 1.6726x10^{-27}\ kg$$

$$\lambda^4 \leq \frac{2}{5\pi}\left(1.60217733x10^{-19}\ C\right)^2 9.0x10^9\ Nm^2/C^2 \times \frac{16\pi^4\left(0.37x10^{-10}\ m\right)^4}{6.67390x10^{-11}Nm^2/kg^2(1.6726x10^{-27}\ kg)^2}$$

$$\lambda \leq 146\ mm \quad (24)$$

Note that λ is in the microwave range. The less than relation comes from the assumption that the electron could not stay bound to the atom if it oscillated too far away from the nucleus beyond the size of the atom.

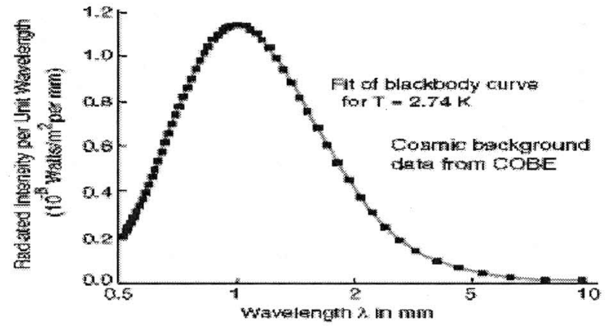


Fig. 4. Cosmic Background Radiation, NASA's COBE Satellite (COBE1)

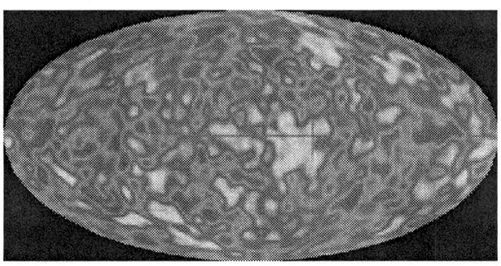


Fig. 5. Cosmic Background Radiation, COBE NASA Two Year Skymap (COBE2)[9]

One of the most significant sources of radiation in the universe is known as the 2.735 ^{0}K cosmic background radiation as shown in Fig. 4 as measured by NASA's COBE satellite. Note that the peak in the radiation is at 1 mm wavelength which is much less than 146 mm. Our calculation shows that the derived force of gravity can be made to simultaneously predict the measured experimental strength of the force of gravity and the observed cosmic background radiation by making the current amplitude of vibration of the electron equal to less than 1% of the radius of the atom. This is a very reasonable value and what one might expect. Note that the cosmic background radiation is non-isotropic and shows variations reflecting the matter distribution in space as shown in additional COBE satellite data in Fig. 5.

In summary the derived radial term of the electrodynamic force of gravity is not only able to predict the observed magnitude and radial direction of the force of gravity, but it also explains the origin of the cosmic background radiation at the same time. Thus it has an advantage over previous theories of gravity in that it explains more observed data. Note that the customary blackbody wavelength distribution as shown in Fig. 4 can be shown to be completely classical in origin for finite-size electrons in the shape of a toroid without any need of an auxiliary theory such as quantum mechanics.[10]

5. Decay of the Force of Gravity

Another consequence of this electrodynamic theory of gravitation is that the force of gravity is decreasing over time. The emission of the radiation above causes a decay of the force of gravity due to a decrease in the value of the mass. The rate of decay depends on an atom's position in an astronomical body and the size of the astronomical body. Since the oscillating electrons in all atoms can both absorb and emit radiation, those atoms nearest the center of an astronomical body lose their oscillation energy the slowest while those atoms nearest the surface of the astronomical body lose their energy the fastest. The rate of decay of the gravitational force of an astronomical body will depend on the ratio of the volume of the body to its surface area. Thus, the larger the radius of an astronomical body, the slower its force of gravity decays. So the force of gravity within a planet would decay faster than the force of gravity within the sun.

Applying these notions to the universe as a whole, the rate of weakening of gravity depends on a body's position in the universe. Since the oscillating electrons in all atoms can both absorb and emit radiation, those atoms in large astronomical bodies nearest the center of the universe lose their oscillation energy the slowest while those atoms in astronomical bodies nearest the edge of the universe lose their energy the fastest. Similarly those atoms near the center of a galaxy lose their oscillation energy slower than those atoms near the edge of the galaxy. Thus the rate of decay of the gravitational force depends on position in the universe.

Is there any evidence that the force of gravity has decayed? Yes, the expansion of the earth and the resulting separation of the continents have been documented. Figs. 6 and 7 show the three dimensional stretch marks under the oceans and through the continents that details the approximately 70% expansion of the earth since its surface solidified. The weakening of the force of gravity is the only reasonable explanation for the 70% expansion of the earth. Most cosmological models, such as the Big Bang model, have the earth contracting over time as it cools, with gravity being constant, and can not explain this data.

According to Hook's law of elasticity in three dimensions the elastic material of the crust of the earth expands very slowly due to the change in the strength of gravity, but it eventually reaches its elastic limits and starts to crack and come apart. The giant three-dimensional stretch marks below show that the origin of the bursting of a seam in the surface of the earth started at the position of the present Dead Sea in Palestine then proceeded down the Red Sea into the Indian Ocean where it forked to form the Pacific and Atlantic Oceans. Although the splitting up of the surface of the earth formed large pieces called plates, the continual movement of the plates apart from one another (See Figs. 10 and 11) can only be explained by an expanding earth. Only an expanding earth model can conserve energy and angular momentum for the movement of the continental plates.

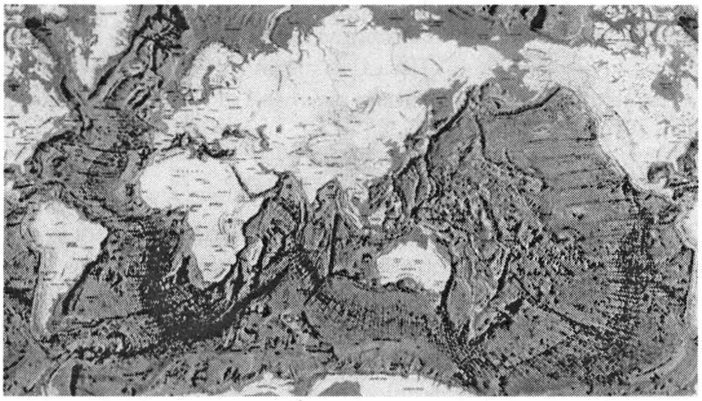


Fig. 6. Stretch Marks of Earth's Expansion. © Marie Tharp 1977/2003, One Washington Ave, South Nyack, NY 10960. Reproduced by permission.

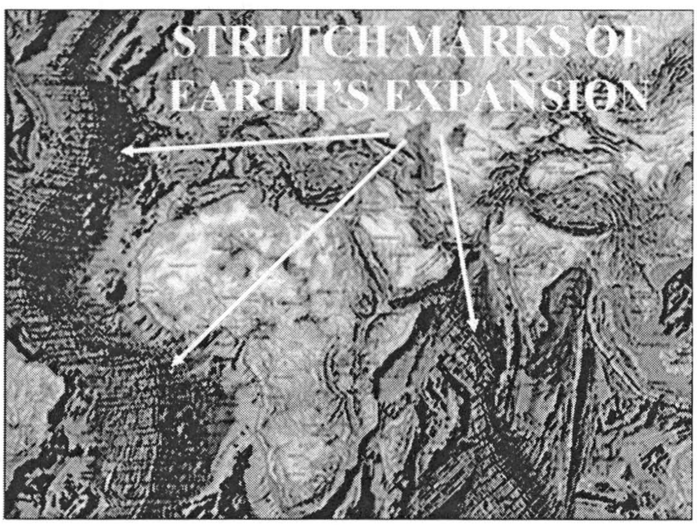


Fig. 7. Close-up of Earth's Expansion Stretch Marks

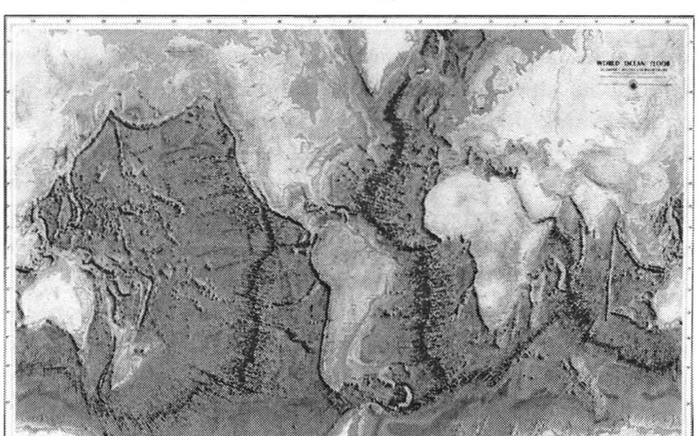


Fig. 8. US Office of Naval Research World Ocean Floor Map 1977 [11]

The maps by Marie Tharp (Figs. 6 and 7) were confirmed by the World Ocean Floor (1977) map of the U.S. Navy Office of Naval Research shown in Fig. 8 and the 1997 Sandwell-Smith NOAA Satellite Map of the Scripps Oceanographic Institute shown in Fig. 9. The motion of the continental plates away from each other in Figs. 10 also confirms the expansion of the earth of about 25 cm per year currently.

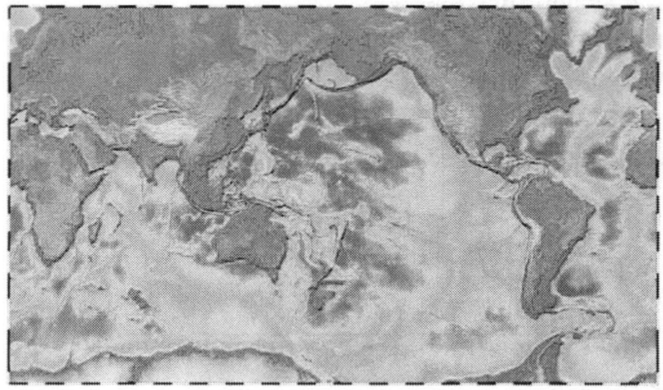


Fig. 9. Sandwell-Smith NOAA Satellite Map (Scripps Oceanographic Institute 1997) [12]

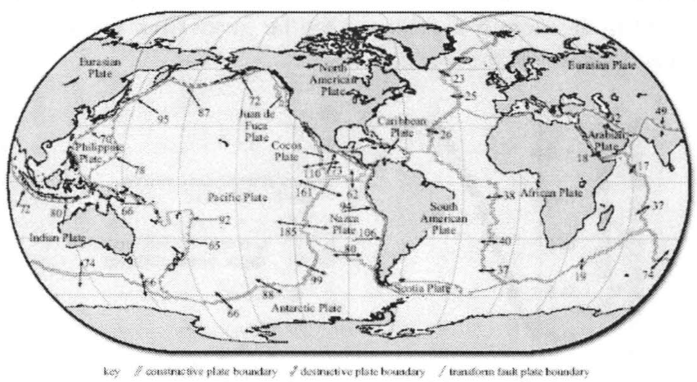


Fig. 10. Movement of Tectonic Plates [13]. Arrows Giving Direction in mm/yr Support Earth Expansion.

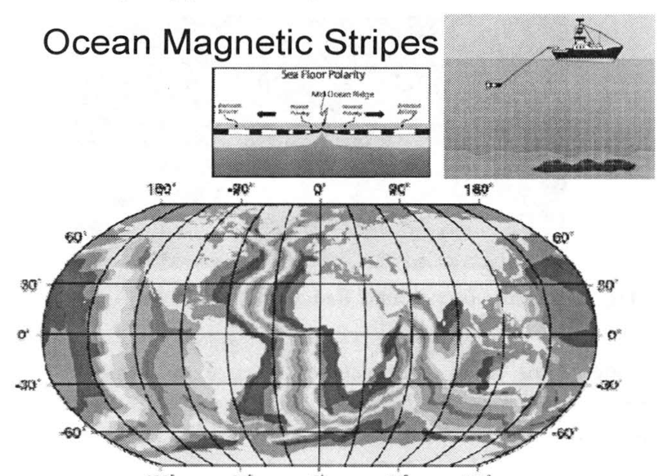


Fig. 11. Parallel Magnetic Ocean Floor Stripes on Both Sides of Mid Ocean Ridges [14]

The expansion of the earth caused the north pole of the earth to rotate with respect to the surface of the earth due to conservation of energy and angular momentum. This caused the newest stripes of matter being added to the ocean bottom along the mid-ocean ridges to be magnetized with varying degrees of magnetization and orientation. Scientists have measured the magnetization of the ocean bottom by measuring the magnetic field strength at a certain depth in the ocean using a cable dragged magnetometer and subtracting out the theoretically expected strength of the magnetic field of the earth as shown in Fig. 11. This reveals that there are stripes of similar magnetization that are parallel to the mid ocean ridges indicating that a three-dimensional expansion has occurred. A closer examination of the sea floor polarity in the central upper part of Fig. 12 reveals that rate of expansion of the ocean bottom was much greater in the past than it is now. This supports the notion of something like an exponential decay of the strength of the force of gravity with a very strong initial decay rate and a very weak decay rate at the present time.

The expansion of the earth should not be unique in our solar system. The pictures of the surface of Jupiter's moon Ganymede in Fig. 12 shows clearly the expansion cracks without the presence of oceans. Fig. 13 shows the mares or seas of the Earth's moon showing where it expanded. Fig. 14 shows where the expansion is presently occurring on the planet Venus.

Fig. 12. Expansion Cracks in Jupiter's Moon Ganymede (NASA) [15]

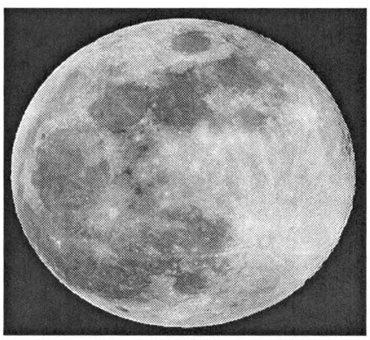


Fig. 13. Mares or Seas of the Moon Showing Where It Expanded [16]

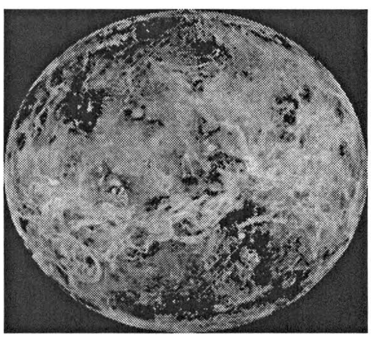


Fig. 14. Radar Image Showing Expansion of Venus [17]

Thus the electrodynamic derived force of gravity appears to be the only theory of gravity that describes an expanding earth, moon, planets, and stars as observed, due to the rapid decay of the strength of gravity producing the cosmic background radiation. The decay of gravity combined with conservation of energy explains the high velocity of stars in the arms of spiral galaxies.

6. Computation of Non-Radial Gravitational Force Term

In a manner similar to that for the radial term, the non-radial term of the gravitational force may be calculated from equation (6) to be

$$\vec{F}_{2+,1+} = \frac{-e^2}{4\pi\epsilon_0|\vec{r}_2-\vec{r}_1|^2}(\hat{r}_{12}\cdot\vec{\beta})\{\hat{r}_{12}\times(\hat{r}_{12}x\vec{\beta})\}[1] \quad (25)$$

$$\begin{aligned}\vec{F}_{2+,1-} = \frac{-e^2}{4\pi\epsilon_0|\vec{r}_2-\vec{r}_1|^2}(\hat{r}_{12}\cdot\vec{\beta})\{\hat{r}_{12}\times(\hat{r}_{12}x\vec{\beta})\}\Bigg[1 \\ -\left(\frac{A_1\omega_1}{c}sin\,(\omega_1t_1+\varphi_1)\right)^2\left(\frac{1+cos^2\,\theta}{2}\right) \\ +\left(\frac{A_1\omega_1}{c}sin\,(\omega_1t_1+\varphi_1)\right)^4\left(-\frac{1}{8}-\frac{1}{4}cos^2\,\theta\right. \\ \left.+\frac{3}{8}cos^4\,\theta\right)\Bigg]\end{aligned}$$

$$\begin{aligned}\vec{F}_{2-,1+} = \frac{-e^2}{4\pi\epsilon_0|\vec{r}_2-\vec{r}_1|^2}(\hat{r}_{12}\cdot\vec{\beta})\{\hat{r}_{12}\times(\hat{r}_{12}x\vec{\beta})\}\Bigg[1 \\ -\left(\frac{A_2\omega_2}{c}sin\,(\omega_2t_2+\varphi_2)\right)^2\left(\frac{1+cos^2\,\theta}{2}\right) \\ +\left(\frac{A_2\omega_2}{c}sin\,(\omega_2t_2+\varphi_2)\right)^4\left(-\frac{1}{8}-\frac{1}{4}cos^2\,\theta\right. \\ \left.+\frac{3}{8}cos^4\,\theta\right)\Bigg]\end{aligned}$$

$$\begin{aligned}\vec{F}_{2-,1-} = \frac{e^2}{4\pi\epsilon_0|\vec{r}_2-\vec{r}_1|^2}(\hat{r}_{12}\cdot\vec{\beta})\{\hat{r}_{12}\times(\hat{r}_{12}x\vec{\beta})\}\Bigg[1 \\ -\left(\frac{A_1\omega_1}{c}sin\,(\omega_1t_1+\varphi_1)\right. \\ \left.+\frac{A_2\omega_2}{c}sin\,(\omega_2t_2+\varphi_2)\right)^2\left(\frac{1+cos^2\,\theta}{2}\right) \\ +\left(\frac{A_1\omega_1}{c}sin\,(\omega_1t_1+\varphi_1)\right. \\ \left.+\frac{A_2\omega_2}{c}sin\,(\omega_2t_2+\varphi_2)\right)^4\left(-\frac{1}{8}-\frac{1}{4}cos^2\,\theta\right. \\ \left.+\frac{3}{8}cos^4\,\theta\right)\Bigg]\end{aligned}$$

From the symmetry of the integrals the average force of equation (24) for the non-radial terms may be reduced to

$$\begin{aligned}\vec{F}(\vec{r},\vec{v}) = \frac{1}{T_1}\int_0^{T_1}dt_1\frac{1}{T_2}\int_0^{T_2}dt_2\frac{1}{2\pi}\int_0^{2\pi}d\varphi_1\frac{1}{2\pi}\int_0^{2\pi}d\varphi_2\frac{1}{\pi}\int_0^{\pi}sin\,\theta\,d\theta \\ \vec{F}(\vec{r},\theta,\varphi,\vec{A}_1,\omega_1,\varphi_1,t_1,\vec{A}_2,\omega_2,\varphi_2,t_2,\vec{v}) \quad (25) \\ = \frac{\omega_1}{2\pi}\int_0^{2\pi/\omega_1}dt_1\frac{\omega_2}{2\pi}\int_0^{2\pi/\omega_2}dt_2\frac{1}{2\pi}\int_0^{2\pi}d\varphi_1\frac{1}{2\pi}\int_0^{2\pi}d\varphi_2\frac{1}{\pi}\int_0^{\pi}sin\,\theta\,d\theta\end{aligned}$$

$$\frac{e^2}{4\pi\epsilon_0|\vec{r}_2-\vec{r}_1|^2}(\hat{r}_{12}\cdot\vec{\beta})\{\hat{r}_{12}\times(\hat{r}_{12}\times\vec{\beta})\}$$
$$6\frac{A_2{}^2\omega_2{}^2}{c^2}sin^2(\omega_2 t_2+\varphi_2)\frac{A_1{}^2\omega_1{}^2}{c^2}sin^2(\omega_1 t_1+\varphi_1)\left(-\frac{3}{8}-\frac{9}{4}cos^2\theta+\frac{15}{8}cos^4\theta\right)$$
$$=\frac{\omega_1}{2\delta}\int_0^{2\pi/\omega_1}dt_1\frac{\omega_2}{2\delta}\int_0^{2\pi/\omega_2}dt_2\frac{1}{2\pi}\int_0^{2\pi}d\varphi_1\frac{1}{2\pi}\int_0^{2\pi}d\varphi_2$$
$$\frac{e^2}{4\pi\epsilon_0|\vec{r}_2-\vec{r}_1|^2}(\hat{r}_{12}\cdot\vec{\beta})\{\hat{r}_{12}\times(\hat{r}_{12}\times\vec{\beta})\}$$
$$6\frac{A_2{}^2\omega_2{}^2}{c^2}sin^2(\omega_2 t_2+\varphi_2)\frac{A_1{}^2\omega_1{}^2}{c^2}sin^2(\omega_1 t_1+\varphi_1)\left(\frac{-3}{2\pi}\right)$$
$$=\frac{\omega_1}{2\pi}\int_0^{2\pi/\omega_1}dt_1\frac{\omega_2}{2\pi}\int_0^{2\pi/\omega_2}dt_2\frac{e^2(\hat{r}_{12}\cdot\vec{\beta})\{\hat{r}_{12}\times(\hat{r}_{12}\times\vec{\beta})\}}{4\pi\epsilon_0|\vec{r}_2-\vec{r}_1|^2}$$
$$6\frac{A_2{}^2\omega_2{}^2}{c^2}\left(\frac{1}{2}\right)\frac{A_1{}^2\omega_1{}^2}{c^2}\left(\frac{1}{2}\right)\left(\frac{-3}{2\pi}\right)$$
$$=-\frac{e^2(\hat{r}_{12}\cdot\vec{\beta})\{\hat{r}_{12}\times(\hat{r}_{12}\times\vec{\beta})\}}{4\pi\epsilon_0|\vec{r}_2-\vec{r}_1|^2}\frac{A_2{}^2\omega_2{}^2}{c^2}\frac{A_1{}^2\omega_1{}^2}{c^2}\left(\frac{9}{4\pi}\right)\quad(27)$$

where

$$\frac{1}{\pi}\int_0^{\pi}sin\theta d\theta\left(-\frac{3}{8}-\frac{9}{4}cos^2\theta+\frac{15}{8}cos^4\theta\right)$$
$$=\frac{1}{\pi}\int_{-1}^{1}dcos\theta\left(-\frac{3}{8}-\frac{9}{4}cos^2\theta+\frac{15}{8}cos^4\theta\right)$$
$$=\frac{1}{\pi}\left(-\frac{3cos\theta}{8}-\frac{9}{4}\frac{cos^3\theta}{3}+\frac{15}{8}\frac{cos^5\theta}{5}\right)\Bigg|_{-1}^{1}$$
$$=\frac{1}{\pi}\left(-\frac{3}{8}2-\frac{9}{4}\frac{2}{3}+\frac{15}{8}\frac{2}{5}\right)=-\frac{3}{2\pi}\qquad(28)$$

From equations (16) and (27) the full gravitational force F_G may be rewritten using the definition of mass from the first term to show this second term in more familiar notation as

$$\vec{F}_G=-G\frac{m_{g1}m_{g2}}{|\vec{r}_2-\vec{r}_1|^2}\left[\hat{r}_{12}-\frac{45}{8}(\hat{r}_{12}\cdot\vec{\beta})\{\hat{r}_{12}\times(\hat{r}_{12}\times\vec{\beta})\}\right]\ (28)$$

The first term is Newton's universal gravitational force. The second term is a new term that gives rise to a corkscrew type of spiraling motion. The strength of the second term is much less than the first due to the β^2 factor. The first term causes planets to orbit the sun with a circular orbit in the equatorial plane of the sun. The second term modifies the orbit to lie on a spiral that is centered on a circle in the equatorial plane of the sun. Is this notion supported by observations?

7. Corroborating Circumstantial Evidence for Spiraling Orbits

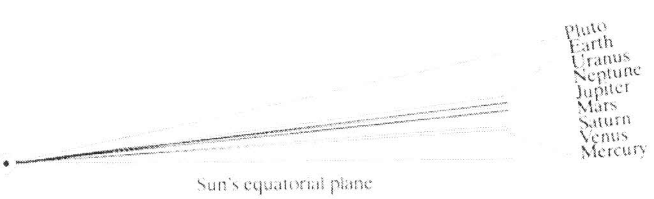


Fig. 16. Tilt of Planetary Orbits with Respect to the Equatorial Plane of the Sun [18]

Astronomers have found that the elliptical orbits of the various planets are tilted with respect to the equatorial plane of the sun as shown in Fig. 16.[18] This is also true of the orbits of the moons about the planets. As a planet goes around the sun on a spiral, the effective orbit appears to be an elliptical orbit tilted with respect to the equatorial plane of the sun.

Fig. 17 shows the motion of four of Jupiter's moons about the orbit of Jupiter about the sun. Note the spiral or corkscrew orbits of the moons about Jupiter's orbit. Also note the relative periods of the spirals are integer multiples of one another, i.e. Io = 2, Europa = 4, Ganymede = 8, Callisto=16. The quantization of the orbits of the moons of Jupiter is a necessary condition for the stability of a system in order to periodically return to the same point on the spiral of its orbit.

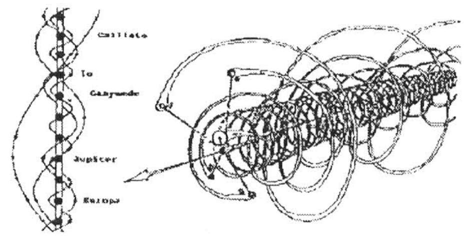


Fig. 17. Spiral orbits of the moons Io, Callisto, Europa, and Ganymede about the orbit of Jupiter [19]

This electrodynamic theory of gravity appears to be the only theory of gravity able to explain the tilting of the orbits of the planets with respect to the equatorial plane of the sun and the quantization of these orbits. In contrast Newton's Universal Law of Gravitation and Einstein's General Theory of Relativity predict that the orbits of all the planets of the sun should lie in the equatorial plane of the sun like the rings of Saturn and that there is no quantization of orbits due to gravity.

8. Origin of Hubble's Law

Edwin Hubble discovered that the light from distant stars is shifted in color toward the red part of the spectrum as shown in Fig. 18. The farther away the star the greater the red shift.

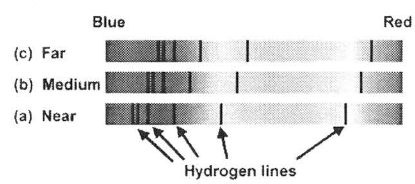


Fig. 18. Red shift of Hydrogen Absorption Lines for Near, Medium, and Far Distance Stars [20]

The decrease in the force of gravity over time has a significant effect on the light that we see from distant stars. From conservation of energy light emitted from a stellar surface on a star of mass M and radius R is expected to have a red shift equal to the difference in gravitational potential. Using G for Newton's universal gravitation constant this potential at the stellar surface is -GM/R and zero at infinity, so the red shift z may be defined as

$$z=\frac{\Delta\lambda}{\lambda}=\frac{GM}{c^2R}\qquad(30)$$

This equation for the gravitational red shift was confirmed experimentally by Pound & Rebka in 1960 [20].

If the force of gravity is decreasing, then GM/R would have been greater in the past when gravity was stronger. Thus, in general, the gravitational red shift of light from stars should be larger the farther away the star is independent of the star's velocity or type as shown in Fig. 19. The star's velocity can add to or reduce the red shift due to the Doppler Effect. Also stars or galaxies that are larger decay more slowly giving rise to a larger red shift at the same distance. Stars that are newer, such as quasars which are found at the center of active young galaxies, should have a significantly higher redshift than older galaxies around it, even if they are bound to another galaxy.

Halton Arp[21] discovered quasars that, according to gamma ray spectroscopy, are physically connected to galaxies, yet their respective cosmological redshifts are dramatically larger. For instance galaxy NGC 4319 and quasar Mark 205 are physically connected according to gamma spectroscopy. Mark 205 has a redshift of z=0.07 while the associated galaxy NCG 4316 has a redshift of only z=0.0056. (See Fig. 19)

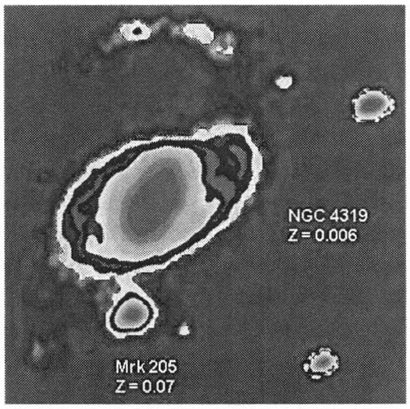


Fig. 19. Quasar Mark 205 Bound to NGC4319 Galaxy [21]

The data that Hubble used to formulate his famous law that red shifts are roughly proportional to distance is shown in Fig. 20. Note that the Doppler red shift due to velocity and size effects cause deviations from a perfect straight line which are small in comparison with the main effect of the gravitational red shift from earlier times.

According to equation (30) the gravitational red shift could have been much larger in the past due to smaller R and larger M than it is today where the electrons vibrate with very small amplitudes. Thus the electrodynamic theory of gravity is the only theory of gravity that is able to describe Hubble's Law for red shifts as a function of distance or equivalently time for light emitted in the past to reach the earth.

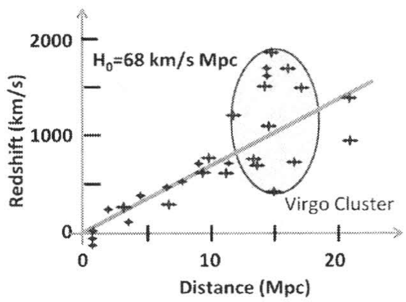


Fig. 20. Hubble's Law red shifts proportional to distance or brightness [22]

9. Significance of Quantized Red Shifts

One consequence of the classical universal electrodynamic force law is that all forces have a $1/R^2$ dependence on all size scales. This implies that the universe must have a center just as elementary particles have a center, the atom has a center, the solar system has a center, galaxies have a center, and nebula have a center.

In the case of our solar system, matter in the form of planets only exists at particular quantized radii as represented by Bode's Law. Also the matter of the moons about the planets such as Uranus only exists at particular quantized radii as represented by Bode's Law. Thus one might suspect that on a very large scale in the universe matter might also exist at particular quantized radii as represented by Bode's Law. (See Figs. 21, 22, 23)

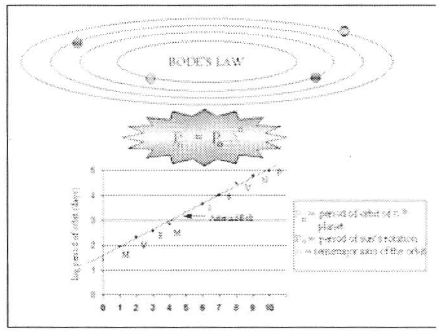


Fig. 21. Planetary Data supporting modern Bode's Law [23]

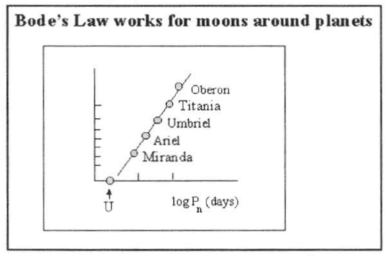


Fig. 22. Uranus Moon Data Supporting Bode's Law [23]

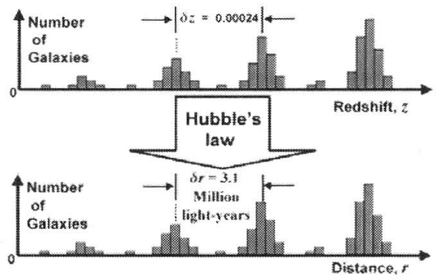


Fig. 23. Tifft's Quantized Red Shifts Support Bode's Law on Universal Scale (Idealized format without background) [24]

In the early 1970s William Tifft [25] at the Steward Observatory in Tucson, Arizona was analyzing the red shift data and began transforming the data into "power spectra" that show how the various spacings in the red shift data occur. This statistical technique shows difficult-to-see regularities as peaks rising above the random noise in a plot. The noise could be due to such things as the "local" or "peculiar" motions of the galaxies. Tifft [25] noticed a surprisingly strong peak corresponding to an interval between red shift z's of about 0.00024 and a weak peak at ½ of 0.00024.

In 1984 Tifft and Cocke[26] examined the 1981 Fisher-Tully survey of red shifts in the radiowave (21 cm wavelength line from hydrogen) part of the spectrum. They found sharp periodicities at exact submultiples 1/3 and ½ of 0.00024. However, despite Tifft's steady stream of publications, astronomers remained skeptical about the notion of quantized red shifts.

Then in 1997, an independent study of 250 galaxy red shifts by Napier and Guthrie[27] confirmed Tifft's basic observations. They found the red shift distribution to be strongly quantized in the galactocentric frame of reference with a very high confidence level. The galactocentric frame of reference is the frame at rest with respect to the center of our own galaxy, the Milky Way. When they compensated for the earth's motion around the sun and the sun's motion around the galaxy center, the quantizations appeared more clearly.

In 1996 and 1997 Tifft[28,29] showed that it is important to compensate the galactrocentric red shifts further by accounting for our galaxy's motion with respect to the cosmic microwave background radiation. Doppler shifts of the microwaves show that our galaxy is moving about 560 km/s in a direction south of the constellation Hydra[30]. Accounting for this motion converts the galactocentric red shifts to a frame of reference which is at rest with respect to the cosmic background radiation and presumably at rest with respect to the universe as a whole. In this frame the red shift groups are much more distinct from one another suggesting that the universe has a defined center. Additional periodicities of 1/4 and 1/8 of 0.00024 were observed. See Fig. 24 for the skewing effect of observing the red shifts away from the center of the universe.

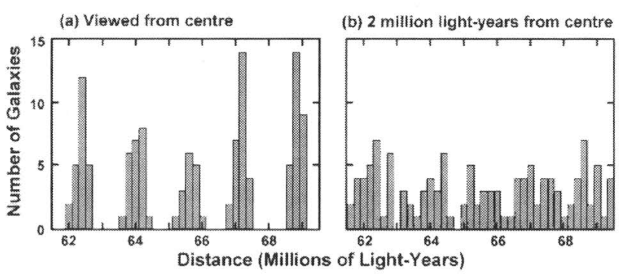


Fig. 24. Effect of Observing Red Shifts Away from the Center of the Universe [24]

In 1992 Tifft [31] in an anonymous paper claimed that galactic red shifts have actually decayed slightly in just a few years. This is consistent with red shifts being primarily intrinsic gravitational red shifts and the force of gravity declining rapidly far away near the edge of the universe. The electrodynamic theory of gravity is the only theory of gravity that predicts the general decay of all red shifts in the universe.

10. MOND vs. Dark Matter

The observed rotational speeds of objects in extragalactic systems exceed what can be explained by the visible mass of stars and gas. One approach to explain this discrepancy is to infer that there is more mass than meets the eye, i.e. dark matter and dark energy exist. Another approach that appears to be less drastic is to assume that there is a MOdified Newtonian Dynamics (MOND) in these regions. Fig. 25 shows the plot of the rotational velocity V versus distance R from the center of a typical spiral galaxy NGC 6946 and compares that with the predicted Newtonian values [32].

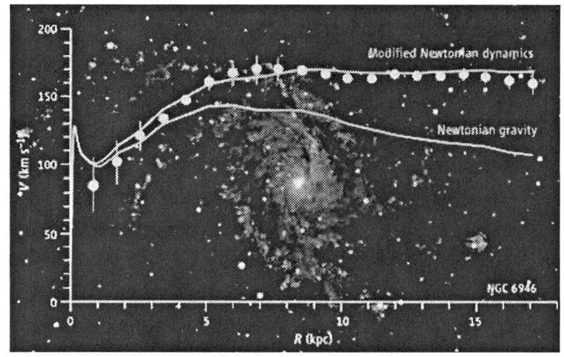


Fig. 25. NGC 6946 Spiral Galaxy with graph of Rotational Velocity vs Distance from the Center [33]

The astronomical data indicates that the velocity of rotation of the outer spiral arms is significantly higher than would be predicted by Newtonian dynamics which is expected to be valid in this region. Milgrom[34] in 1983 was the first astronomer to suggest that many different types of data could be explained by assuming some sort of Modified Newtonian Dynamics (MOND). He documented that MOND correctly maps the observed mass to the observed dynamics. Tulley-Fisher[35] examined many spiral galaxies and found a linear relationship between the orbital speed of a galaxy's outskirt stars and the galaxy's brightness. This data also matched the MOND predictions. (See Fig. 26 below.) However, astronomers are still looking for a satisfactory explanation of why the velocity increases like it does.

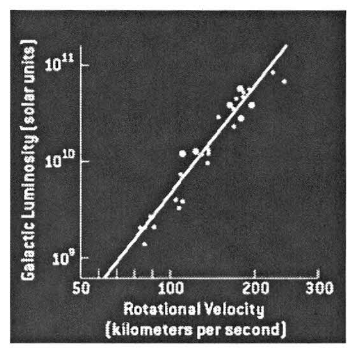


Fig. 26. Tulley-Fisher Relationship showing Linear Relationship between Rotational velocity and Galactic Luminosity [35]

In 1999 Roscoe [36] performed an extensive analysis of 900 Tulley-Fisher rotation curves for spiral galaxies. He confirmed the Tulley-Fisher relationship to a very high level of confidence >95% as shown in Fig. 27.

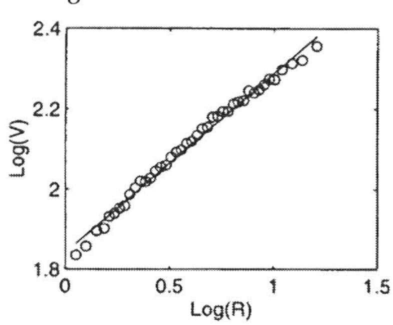


Fig. 27. Analysis of 900 Optical Rotation Curves of Spiral Galaxies [36]

Furthermore, Roscoe [36] was able to confirm by analysis that the size of spiral galaxies and their luminosities were discrete or quantized as shown in Fig. 28. Bode's law is reappearing here as it did for the red shifts. Thus there is a consistency.

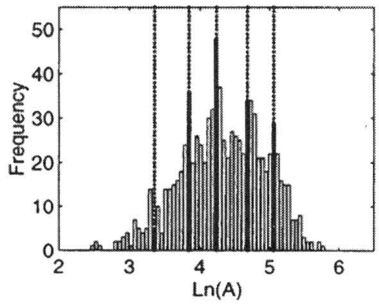


Fig. 28. Quantization of Galaxy Luminosity and Size [36]

The electrodynamic theory of gravity gives a satisfying explanation of the increased velocities of the outer arms of spiral galaxies over what would be expected from Newtonian dynamics. According to the derived electrodynamic theory of gravity, the mass in the outer stars of the galaxy decays faster than the mass in the center of the galaxy. Conservation of kinetic energy for the outer stars indicates that at some time in the past the mass of the galaxy center was significantly greater, such as when it was originally formed. Thus the outer stars in the spiral galaxy are now in the process of escaping from the galaxy whose mass has decayed to the point that it can no longer hold them captive. This electrodynamic approach to gravity does not require the invention of the illogical and unphysical dark matter and dark energy. Also its second term (described below) is able to explain the discrete sizes of the spiral galaxies in a fashion consistent with Bode's law for the solar system and the Tifft's measured quantization of red shifts.

11. Conclusion

From the previously derived universal classical electrodynamic contact force law for finite-size elastic particles the force of gravity was identified as a small average residual effect of the order $(v/c)^4$ due to vibration of atomic electrons with respect to the protons in the nucleus of neutral atoms. This electrodynamic force of gravity can also be derived from the action-at-a-distance covariant relativistic electrodynamic force law based on Maxwell's equations making it independent of version of electrodynamics. The derived gravitational force was found to have the customary radial term of Newton's Universal Law of Gravitation ($F=Gm_1m_2/R^2$) plus a new non-radial term. From the radial term the gravitational mass can be associated with certain electrodynamic parameters. The non-radial term gave rise to an $(\mathbf{R}\cdot\mathbf{V})\mathbf{R}\times(\mathbf{R}\times\mathbf{V})$ effect which causes the orbits of the planets about the sun to spiral around on a circle about the sun giving the appearance of an elliptical orbit tilted with respect to the equatorial plane of the sun.

The vibrational mechanism causing the gravitational force was found to decay over time giving rise to the cosmic background radiation and Hubble's red shifts versus distance law due to gravitational red shifting. A reasonable range of vibrational amplitude for the electron is able to explain at least 9 orders of magnitude change in the observed red shifts of light from distant stars. The vibrational mechanism combined with the $(\mathbf{R}\cdot\mathbf{V})\mathbf{R}\times(\mathbf{R}\times\mathbf{V})$ effect also explained Tifft's quantized red shifts as a type of Bode's Law indicating that there is a geometrical center to the universe. The vibrational mechanism by which gravity decays by radiation over time explained Tifft's measured rapid decay of the magnitude of red shifts over time. The Tulley-Fisher relationship for luminosity of spiral galaxies and Roscoe's observed quantization of the luminosity of 900 spiral galaxies in a manner reminiscent of Bode's Law is explained by the $(\mathbf{R}\cdot\mathbf{V})\mathbf{R}\times(\mathbf{R}\times\mathbf{V})$ term of the electrodynamic theory of gravity. The unexpectedly high velocity of the outer stars of spiral galaxies is explained simply by the decay of mass and conservation of energy without resorting to the use of outlandish ideas such as dark matter and dark energy. The measured quantization of the luminosity and size of spiral galaxies is also explained by the new $(\mathbf{R}\cdot\mathbf{V})\mathbf{R}\times(\mathbf{R}\times\mathbf{V})$ term in the derived gravitational force.

This electrodynamic explanation of gravity appears to indicate that mass is not a fundamental quantity of nature. Thus the notions of mass that are intrinsic to Newton's Universal Law of Gravitation and Einstein's General Relativity Theory appear to be false. This is further emphasized by the unexpectedly large number of diverse astronomical phenomena explained by this electrodynamic approach to gravity.

In the paper [37] that derives the force of inertia from the universal electrodynamic force, the electrodynamic definition of inertial mass was found to be equal to the definition of gravitational mass of this paper. When Albert Einstein developed his general theory of relativity, he started with the assumption that the correspondence between inertial and gravitational mass is not accidental: that no experiment will ever detect a difference between them. **In General Relativity theory the effects of gravitation are ascribed to space-time curvature instead of a force. Thus in General Relativity Theory gravitation is not a force, and not subject to Newton's third law. So from the framework of General Relativity Theory the equality of inertial and gravitational mass remains an unexplained mystery.**

Finally this approach to gravity, which is based on a derived universal electrodynamic force law, is more satisfying than all previous approaches. **First**, it confirms Bode's Law and the quantization of gravitation due to the $(\mathbf{R}\cdot\mathbf{V})\mathbf{R}\times(\mathbf{R}\times\mathbf{V})$ term which requires all physical systems involving motion to be quantized in order to have stability. The motion of the planets spiraling around the sun must return to the same starting point on the spiral or there is no stability. **Second**, this approach is simpler, since it is based on a single universal force law. **Third**, this force is a local contact force based on the electromagnetic fields of a charge extending the range of the force instead of an action-at-a-distance concept like that used in Newton's Universal Force Law and Einstein's General Relativity Theory which employ unphysical point particles. Natural philosophers have known for thousands of years that there is no such thing as an action-at-a-distance force. Some mechanism is needed to transfer forces. **Fourth**, this approach explains more gravity-relevant data than all previous theories of gravity combined including Bode's law for the quantization of gravity, the tilts of the orbits of the planets about the sun, the expansion of the planets and moons of the solar system, the origin of the cosmic background radiation, Hubble's law for red shifts, the quantization of red shifts, the general decay of all red shifts, the quantized Tulley-Fisher relationship for luminosity and size of spiral galaxies, and the unexpectedly high velocity of the outer arms of spiral galaxies.

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References

[1] Hubble Space Telescope image Eskimo Nebula NGC 2392 http://www.stsci.edu/~inr/thisweek1/thisweek029.html

[2] Hubble Space Telescope image Cat's Eye Nebula NGC 6543 http://apod.nasa.gov/apod/ap080804.html

[3] Lucas, Jr., Charles W., The Universal Electrodynamic Force, Proceedings of the Natural Philosophy Alliance 18, College Park, MD July 6-9, 2011.

[4] J. D. Jackson, Classical Electrodynamics-Second Edition (John Wiley and Sons, Inc., New York, 1975).

[5] J. D. Jackson, Classical Electrodynamics-Third Edition (John Wiley and Sons, Inc., New York, 1999).

[6] Palmer, David. "Hydrogen in the Universe" http://imagine.gsfc.nasa.gov/docs/ask_astro/answers/971113i.html

[7] CRC Handbook of Chemistry and Physics 73rd edition - edited by David R. Lide (CRC Press, Inc., Boca Raton, 1992).

[8] Zumdahl, Steven S., Chemistry - 4th Edition (Houghton Mifflin Co., New York, 1997), p. 327.

[9] COBE NASA Two Year Skymap (COBE2) http://www.astrosociety.org/education/publications/tnl/56/CMB.html

[10] Lucas, Jr., Charles W., A Physical Model for Atoms and Nuclei Part 4 Blackbody Radiation and the Photoelectric Effect, Foundations of Science Vol. 6 No. 3, pp 1-7 (2003).

[11] US Office of Naval Research World Ocean Floor Map http://www.columbia.edu/cu/news/06/08/tharp.html

[12] Sandwell-Smith NOAA satellite map of ocean floor http://gisremote.blogspot.com/2007/07/global-bathymetric-prediction-for-ocean.html

[13] Movement of tectonic plates in mm/yr http://labspace.open.ac.uk/mod/resource/view.php?id=357255

[14] Parallel magnetic ocean floor stripes http://eqseis.geosc.psu.edu/~cammon/HTML/Classes/IntroQuakes/Notes/plate_tect01.html

[15] Expansion cracks in Jupiter's moon Ganymede http://www.pooai.com/ganymede/

[16] Mares or seas of the moon http://www.amateurastronomy.org/blogs/index.php?blog=6&m=200712

[17] Radar image of planet Venus surface showing expansion http://www.solarspace.co.uk/Venus/frmVenusPics.php

[18] Spolter, Pari, Gravitational Force of the Sun (Orb Publishing Company, Granada Hills, CA, 1993) pp. 167-182.

[19] Spiral orbits of Jupiter's moons about the orbit of Jupiter http://www.miqel.com/random_images/random-images-2.html

[20] Pound, R. V. and Rebka (1960), G. A., Phys. Rev. Lett. 4, 337.

[21] Arp, Halton, Olympia Conference on Fundamentals of Physics – M. Barone and F. Selleri Editors (Plenum Press, 1994).

[22] Edwin Hubble's Law for red shift vs distance http://wapedia.mobi/en/Hubble's_law.

[23] Modern version of Bode's law http://www.astro.cornell.edu/academics/courses/astro2201/bodes_law.htm

[24] Humphreys, D. Russell (2002). Our Galaxy is the Centre of the Universe, 'Quantized' Red Shifts Show, The Journal, *16(2)*, 95-104.

[25] Tifft, W. G. (1976). Discrete States of Redshift and Galaxy Dynamics. I. Internal Motions in Single Galaxies. Astrophysical Journal. 206, 38-56.

[26] Tifft, W. G. and Cocke, W. J. (1984). Global Redshift Quantization. Astrophysical Journal, 287, 492-502.

[27] Napier, W. M. and Guthrie, B. N. G. (1997). Quantized Redshifts: A Status Report, Journal of Astrophysics and Astronomy, 18, 455-463.

[28] Tifft, W. G. (1996). Evidence for Quantized and Variable Redshifts in the Cosmic Background Rest Frame. Astrophysics and Space Science, 244, 29-56.

[29] Tifft, W. G. (1997). Redshift Quantization in the Cosmic Background Rest Frame. Journal of Astrophysics and Astronomy, 18, 415-433.

[30] Scott et al. (2000) in Allen's Astrophysical Quantities, 4th Edition, edited by A. N. Cox (Springer-Verlag, New York, 2000) pp. 658, 661. The sun is moving 370.6 $\pm$ 0.4 km/s with respect to the cosmic microwave background toward galactic longitude and latitude (264.^{0}31 $\pm$ 0.^{0}17, 48.^{0}05 $\pm$ 0.^{0}10) or a right ascension and declination of about (11^h, 9^0S). That direction is a little below the constellation Leo, in the lesser known constellation Sextans. From data in the reference one can calculate the following: the sun's velocity with respect to our galaxy's center is 240 km/s toward galactic coordinates (88^0, 2^0) and the velocity of the center of our galaxy with respect to the cosmic background is 556 km/s toward galactic coordinates (266^0,29^0). The latter corresponds to right ascension and declination (10^h 30^m, 24^0S) below the constellation Hydra. Note that the speeds above are much larger that the earth's average orbital velocity around the sun of 29.79 km/s.

[31] Tifft as Anonymous (1992), Quantized Redshifts: What's Going on Here? Sky and Telescope 84, 128.

[32] McGaugh, S. S.(2007), Seeing Through Dark Matter, Science, 317, 607-608.

[33] NGC 6946 spiral galaxy with graph of rotational velocity vs distance from the center. http://francisthemulenews.wordpress.com/2008/01/

[34] Milgrom, Mordehai (1983), A Modification of the Newtonian Dynamics as a Possible Alternative to the Hidden Mass Hypothesis, Astrophysical Journal, 270, 365-370.

[35] Tully, R. B. and Fisher, J. R., (1977) A New Method of Determining Distances to Galaxies, Astronomy and Astrophysics, 54, 661-673.

[36] Roscoe, D. F. (1999), An Analysis of 900 Optical Rotation Curves, International Astronomical Union Symposium, 194, 379-383.

[37] Lucas, Jr., Charles W., The Electrodynamic Origin of the Force of Inertia ($F=m_i a$) Parts 1, and 2, and 3, Foundations of Science Vol. 10, No. 4, 1-6 (2007), and Vol. 11, No.1, 1-6 (2008), and Vol. 11, No. 2, 1-6 (2008).

[38] Assis, A. K. T. (1992). Deriving Gravitation from Electromagnetism, Canadian Journal of Physics, 70, 330-340.

[39] Assis, A. K. T. (1995). Gravitation as a Fourth Order Electromagnetic Effect in Advanced Electromagnetism - Foundations, Theory and Applications, Singapore: World Scientific, 314-331.

[40] Poincare, Henri, Oeuvres, Vol. 9, p. 497 (1954).