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Classical Approach to a Unified Theory

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Abstract: ***This article examined the average electrical force exerted by the Earth over an object, considering the Earth a conductive sphere of charge +Q. Spherical coordinate's model was portrayed, and instantaneous electrical interaction (attraction over electrons minus repulsion over protons) was calculated, assuming electrons to be orbiting the corresponding protons. Integration of the instantaneous force over the orbital was performed, and following division by the orbital's area outlined the average electrical force. Using equations derived from the model, it was found that the average electrical force acting over the object was consistent with a gravitational force. Theoretical and practical implications were discussed.***

Keywords: unification, gravitation, electromagnetism, integration.

1. Introduction

Given the perspective that integration of gravitational and electromagnetic forces would simplify the laws of nature [9], the suggestion of prior research establishing a connection between gravitation and electromagnetism [11], the recent interest for classical unified theories [10] and the resistance of Nature's unification puzzle to be solved [12], we propose a classical approach to unification by integrating the instantaneous electromagnetic force acting over the atoms of an object (attraction over its spinning electrons minus repulsion over its protons) considering the Earth a conductive sphere of charge +Q.

2. Body

2.1 State of the art

The gravitational force exerted by the Earth (mass "M") over an object (mass "m") separated a distance "R" is given by:

$$F_g = G.\frac{m.M}{R^2} \qquad (1)$$

Newton considered that each particle of the Earth contributed to the gravitational attraction exerted over other objects. The distances and directions of the particles of the Earth to a certain object are different for each particle. Newton stated a daring vision that the Earth could be considered as if its mass were concentrated at its center [1].

The electrical force exerted by a charge "Q" over a charge "q" separated a distance "R" is given by:

$$F_e = k.\frac{q.Q}{R^2} \qquad (2)$$

Applying Gauss's theorem to an isolated sphere with a charge "Q" uniformly distributed over its surface (a condition that would automatically be achieved if the sphere were conducting) the external field due to the charged sphere is the same as the field that would be produced if the entire charge were concentrated at its center [2].

On calculating the relation between the electrical force and the gravitational force exerted amongst two protons:

$$\frac{F_e}{F_g} = 1.24 \, x \, 10^{36} \qquad (3)$$

Thus, the electrical force is 36 orders of magnitude (a billion billion-billion-billion time) stronger than the gravitational force [3], [4].

2.2 Hypothesis

Noticing similarities in the equations of gravitational force and electrical force, it is possible to express the gravitational force as an electrical interaction.

2.3 Method

Assuming the Earth to be a conductive sphere of radius "R" and charge "+Q", any object above its surface would experiment an attraction force over its negative charges (electrons) and a repulsion force over its positive charges (protons).

As electrons orbit around the protons they periodically approach and withdraw from the Earth. Each time an electron approaches the Earth closer than its proton, the attraction force over the electron is greater than the repulsion force over the proton resulting in an instantaneous attraction force transmitted to the object.

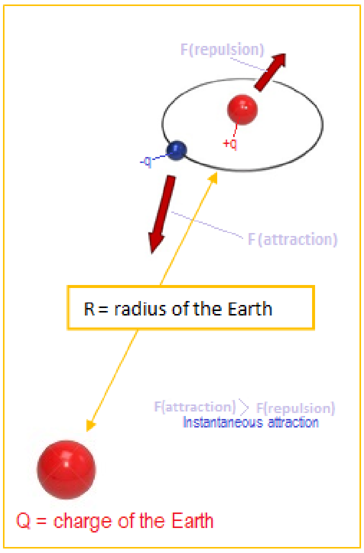

Figure 1(a): Electron closer to Earth than proton

Each time it withdraws from the Earth farther than the proton, the attraction force over the electron is smaller than the repulsion force over the proton resulting in an instantaneous repulsion force transmitted to the object.

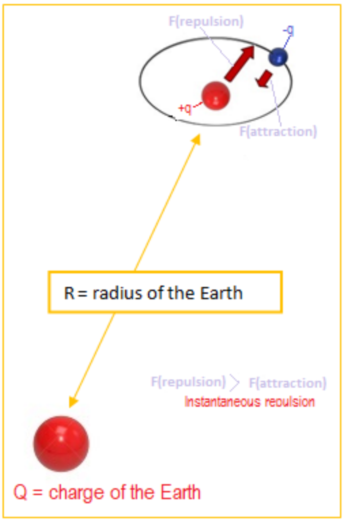

Figure 1(b): Proton closer to Earth than electron

Therefore, integration of the instantaneous force (attraction minus repulsion) over the orbital must be performed to calculate the average force acting on the object.

$$F_{average} = \frac{1}{area_{orb}} \iint \left(F_{attraction} - F_{repulsion}\right) . dS_{orb} \quad (4)$$

Considering Heisenberg's uncertainty principle, a distribution probability must be evaluated to determinate the radius "r" of the orbital of an atom [5]. Bohr considered that the electron could move in a certain orbital without radiating energy and explored a quantum condition for stable orbital's radius that would verify Rydberg-Ritz's formula, deducing $r = 0.0529\, nm$ as the first radius of Bohr [6], which is adopted throughout this article.

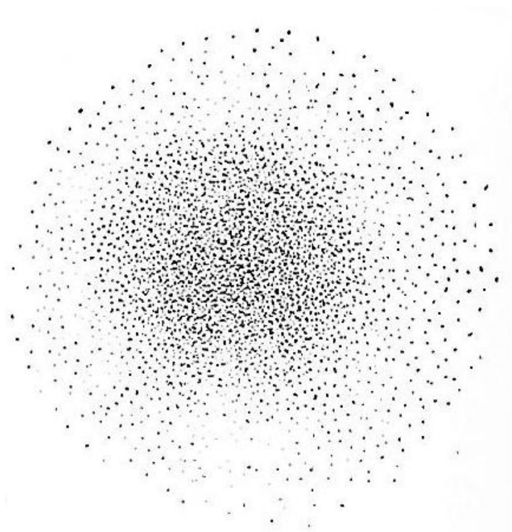

Figure 2: Relative probability of finding 1s electron

Magnetic force over the proton equals zero (because it has zero velocity with respect to the Earth) and average magnetic force over the electron vanishes, as the effect of the instantaneous magnetic force integrated over the orbital cancels by symmetry.

$$F_{mag\ (proton)} = \left|q . \vec{v}\ x\ \vec{B}\right| = 0 \quad (v = 0) \qquad (5)$$

$$F_{mag\ (elect\_avge)} = \frac{1}{area_{orb}} \iint F_{mag\ (elect\_inst)} . dS_{orb} = 0 \ (6)$$

The orbital's element of area (dS_{orb}) is the product of $r\, .\, d\theta$ times $r . \sin\theta\, .\, d\varphi$ as per figure 3 [7], [8].

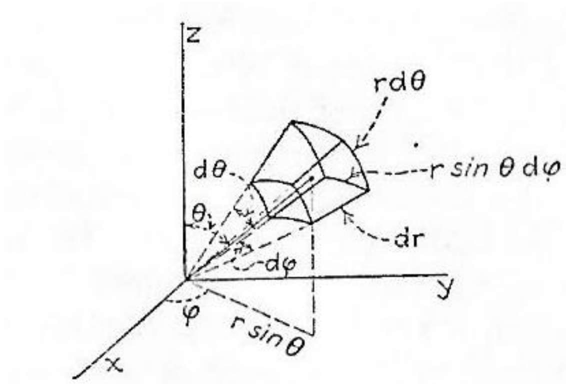

Figure 3: Element of area in spherical coordinates

The instantaneous force $\left(F_{attraction} - F_{repulsion}\right)$will introduce an instantaneous torque trying to rotate the atom, an instantaneous horizontal force in the "x-y" plane and an instantaneous vertical force in the "z" axis. The average torque vanishes, as the effect of the instantaneous torque integrated over the orbital cancels by symmetry. The average horizontal force in the "x-y" plane vanishes, as the effect of the instantaneous horizontal force integrated over the orbital cancels by symmetry.

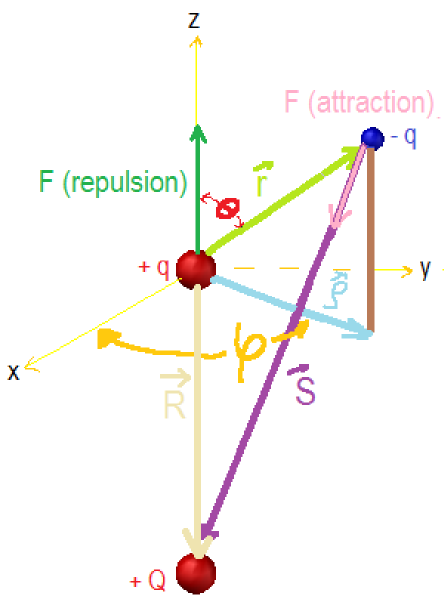

Figure 4: Instantaneous force $\left(F_{attraction} - F_{repulsion}\right)$

To calculate the instantaneous vertical force, the attraction force must be projected to the vertical axis:

$$F_{attraction\ \_vertical} = \vec{F}_{attraction} \cdot \widetilde{u_z} \quad (7)$$

Now we can proceed with equation (4)

$$F_{average} = \frac{1}{area_{\ orb}} \iint \left(F_{att\_vertical} - F_{repulsion}\right) . dS_{orb} \quad (8)$$

The calculated average force (which represents the Earth's attraction over the object, i.e. the object's weight, or gravitational force) is then expressed as a product of Coulomb's force multiplied by a coefficient:

$$F_{avge} (= Weight_{objt} = F_{grav}) = F_{Coulomb} \ .coefficient \ (9)$$

To verify the hypothesis the coefficient must be approximately 10^{-36}, which would cancel the 36 orders of magnitude stronger the electrical force was compared to the gravitational force (as per equation (3)) and would indicate that it is possible to derive the gravitational force from the electrical force.

2.4 Results

Equation (4) is solved introducing terms as per Figure 4:

$$\vec{F}_{repulsion} = \frac{1}{4\pi\varepsilon_0} \frac{qQ}{R^2} \widetilde{u_z} \quad (10)$$

$$\vec{F}_{attraction} = \frac{1}{4\pi\varepsilon_0} qQ \frac{\vec{S}}{|\vec{S}|^3} \quad (11)$$

$$\vec{S} = -R\widetilde{u_z} - r\widetilde{u_r} \quad (12)$$

$$\vec{S} = -R\widetilde{u_z} - r(sin\theta cos\varphi \widetilde{u_x} + sin\theta sin\varphi \widetilde{u_y} + cos\theta \widetilde{u_z}) (13)$$

$$\vec{S} = -r\ sin\theta cos\varphi \widetilde{u_x} - r\ sin\theta sin\varphi \widetilde{u_y} - (r\ cos\theta + R)\ \widetilde{u_z} \quad (14)$$

$$\vec{F}_{attraction} = -\frac{1}{4\pi\varepsilon_0} qQ. \left(\frac{r\ sin\theta cos\varphi\ \widetilde{u_x} + r\ sin\theta sin\varphi\ \widetilde{u_y} + (r\ cos\theta + R)\ \widetilde{u_z}}{\left(\sqrt{r^2 sin^2\theta cos^2\varphi + r^2 sin^2\theta sin^2\varphi + (r\ cos\theta + R\ )^2}\right)^3} \right) \quad (15)$$

$$\vec{F}_{att\_z} = (\vec{F}_{attraction} \cdot \widetilde{u_z})\ \widetilde{u_z} \quad (16)$$

$$\vec{F}_{att\_z} = -\frac{1}{4\pi\varepsilon_0} qQ \frac{(r\ cos\theta + R)\ \widetilde{u_z}}{(r^2 sin^2\theta + (r\ cos\theta + R\ )^2)^{\frac{3}{2}}} \quad (17)$$

- Neglecting $r^2 sin^2\theta$ with respect to $(r\ cos\theta + R\ )^2$:

$$\vec{F}_{att\_z} \cong -\frac{1}{4\pi\varepsilon_0} qQ \frac{(r\ cos\theta + R)\ \widetilde{u_z}}{((r\ cos\theta + R\ )^2)^{\frac{3}{2}}} \quad (18)$$

$$\vec{F}_{att\_z} \cong -\frac{1}{4\pi\varepsilon_0} qQ \frac{1}{(r\ cos\theta + R\ )^2} \widetilde{u_z} \quad (19)$$

$$\vec{F}_{g\_inst} = \vec{F}_{rep} + \vec{F}_{att\_z} \quad (20)$$

$$\vec{F}_{g\_inst} = \frac{1}{4\pi\varepsilon_0} \frac{qQ}{R^2} \widetilde{u_z} - \frac{1}{4\pi\varepsilon_0} qQ \frac{1}{(r\ cos\theta + R\ )^2} \widetilde{u_z} \quad (21)$$

$$F_g = \frac{1}{area_{\ orb}} \iint F_{g\_inst} . dS_{orb} \quad (22)$$

$$area_{orb} = 4.\pi.r^2 \quad (23)$$

$$dS_{orb} = r^2 sin\theta d\theta d\varphi \quad \text{(as per figure 3)} \quad (24)$$

$$F_g = \frac{1}{4\pi r^2} \iint \frac{1}{4\pi\varepsilon_0} qQ \left(\frac{1}{R^2} - \frac{1}{(r\ cos\theta + R\ )^2}\right) r^2 sin\theta d\theta d\varphi \quad (25)$$

$$F_g = \frac{qQ}{4\pi\varepsilon_0} \frac{r^2}{4\pi r^2} \int_0^{2\pi} d\varphi \int_0^{\pi} \left(\frac{1}{R^2} - \frac{1}{(r\ cos\theta + R\ )^2}\right) sin\theta d\theta \quad (26)$$

- $\int_0^{2\pi} d\varphi = \varphi_0^{2\pi} = (2\pi - 0) = 2\pi$

$$F_g = \underbrace{\frac{1}{4\pi\varepsilon_0} \frac{qQ}{R^2}}_{F_{Coulomb}} . \frac{1}{2} \int_0^{\pi} \left(sin\theta d\theta - \frac{R^2 sin\theta d\theta}{(r\ cos\theta + R\ )^2}\right) \quad (27)$$

$$F_{Coulomb} = \frac{1}{4\pi\varepsilon_0} \frac{qQ}{R^2}$$

$$F_g = F_{Coulomb} . \frac{1}{2} \int_0^{\pi} \left(sin\theta d\theta - \frac{R^2 sin\theta d\theta}{(r\ cos\theta + R\ )^2}\right) \quad (28)$$

$$F_g = F_{Coulomb} . \frac{1}{2} \left(-cos\theta_0^{\pi} - R^2 \left(\int_0^{\pi} \frac{-dU}{r.U^2}\right)\right) \quad (29)$$

U= $r\ cos\theta + R$
dU=-r $sin\theta d\theta$

$$F_g = F_{Coulomb} \left(1 + \frac{R^2}{2\ r} \left(\frac{-1}{r\ cos\theta + R}\right)_0^{\pi}\right) \quad (30)$$

- $\left(\frac{-1}{r\ cos\theta + R}\right)_0^{\pi} = -\left(\frac{1}{-r+R} - \frac{1}{r+R}\right) = -\frac{R+r-(R-r)}{R^2-r^2} = -\frac{2\ r}{R^2-r^2}$

$$F_g = F_{Coulomb} \left(1 + \left(\frac{R^2}{2\ r}\left(-\frac{2\ r}{R^2-r^2}\right)\right)\right) \quad (31)$$

$$F_g = F_{Coulomb} \left(1 - \frac{R^2}{R^2-r^2}\right) \quad (32)$$

$$F_g = F_{Coulomb} \left(\frac{R^2-r^2-R^2}{R^2-r^2}\right) = F_{Coulomb} \frac{-r^2}{R^2-r^2} \quad (33)$$

- Neglecting r^2 with respect to R^2:

$$F_g \cong F_{Coul} \frac{-r^2}{R^2} = F_{Coul} \frac{-(0.0529\ nm\ )^2}{(6378\ km\ )^2} = -F_{Coul}\ 6.879\ x\ 10^{-35} \quad (34)$$

- Minus sign indicates attraction *towards* Earth ($-\widetilde{u_z}$)

Table 1: magnitudes of constants

Name	*Definition*	*Magnitude*
r	First radius of Bohr used as orbital's radius	0.0529 nm
R	Radius of the Earth	6378 km

2.5 Discussion

The objectives of this research were to establish a relation between the gravitational force and the electrical force. Our conceptual model in Figure 4 along with the solution of equation (4) show the relationship we expected to observe, and equation (34) summarizes the test of the hypothesized relationship as the obtained coefficient $6.879\ x\ 10^{-35}$ almost cancels the factor $1.24\ x\ 10^{36}$ by which the electrical force exceeded the gravitational force. Our results show that it is possible to derive the gravitational force from the electrical force.

3. Conclusion

Our finding that gravitational force possibly derives from electrical force leads to important implications because it simplifies the laws of Nature; there is an integration in which everything is pulled together in a unification turning out to be simpler than it looked before [9].

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Author Profile

Alejandro Schaller graduated as Electrical Engineer at Bahia Blanca's Regional College (FRBB) of the National Technological University (UTN) in 2008. During 2004 and 2005 he was appointed Head of the Research Department at the Officers' School of the Argentine Navy (ESOA). He was designated Assistant Professor in Physics at (FRBB) in 2011 and Assistant Professor in Theory of the Fields in 2019. He is still teaching both subjects.