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Classical Equation of Gravity to Quantum Limit

By Shantilal Goradia
Senior Engineer,
Nuclear Engineering Organization, American Electric Power
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3003 Royal Huntsman Court
South Bend, IN 46637-5044

Introduction: The fact that mass has an effect on surrounding space is the first essential element of general relativity. This paper unifies this mass/space distinction of general relativity with Newtonian gravity at a subatomic scale and with reported experimental findings of the last century. The subatomic distinction of mass concentration mainly in nucleons surrounded by empty space as we know it now was not known when the general relativity was written. The author uses this distinction to set forth a consistent classical equation of gravity valid to the Planck length and peeps into the quantum world. It is difficult to exaggerate the importance of fundamental nuclear theory for the understanding of matter in the universe and its cosmological evaluation, and also for the inclusion of gravity in the unified family of all four forces.

See equations **(1)** and **(2)**. The notation **D** in the denominator in Newtons equation **(1)** of the gravitational force denotes the separating distance between the centers of mass of the particles in question. Validity of equation **(1)** has been verified for distances as low as few centimeters. Its validity is not verified when subatomic separating distance between nuclei of atoms is a few femtometers (**fm's**). Newtons equation is an approximation that explains macroscopic observations. It does not express the measured force of attraction between nucleons at short range. My assertion is that its failure is a result of implicit assumption in Newtonian gravitys formation: that gravity originates at a point. Newtonian physics implies point masses and action between points. A point has no mass. I am asserting that, instead, the gravitation field originates at the surfaces of elementary particles, not at a central point within the elementary particles. The associated deviation from inverse square logic is insignificant and consistent with general relativity. The consequences of this distinction are enormous and unexplored. Newtons equation needs replacement by equation **(2)** for all microscopic distances. The correction is the injection of $\mathbf{d_n}$. The notation $\mathbf{d_n}$ in Equation **(2)** is the diameter of the nucleons in question. Equation **(2)** is good for all distances greater than Planck Length ($\mathbf{10^{-35}}$ **meters =** $\mathbf{10^{-20}}$ **fms)**. I require the Planck length as a lower bound so as to include the dominant, first order, quantum effect in this semi-classical model.

Newtonian $\quad \mathbf{F_N = G m_1 x m_2 / D^2} \quad$ **(1)**

Proposed $\quad \mathbf{F_P = G m_1 x m_2 / (D - d_n)^2} \quad$ **(2)**

The relative strength of the proposed equation is (2) divided by (1)

The Ratio $\quad \mathbf{F_P / F_N = D^2 / (D - d_n)^2}$

Strength of Gravity at Short Range per equation (2)

When **D** is very large compared to $\mathbf{d_n}$, $\mathbf{D^2}$ is almost equal to $\mathbf{(D\text{-}d_n)^2}$. The diameter of atoms is hundreds of millions of times greater than the diameter of nucleons located at the center of atoms. The force of gravitation calculated by these two equations between the nucleons of two adjoining atoms is practically the same, because the ratio $\mathbf{D^2 / (D\text{-}d_n)^2}$ is almost equal to one. When **D** is small compared to $\mathbf{d_n}$, the force of attraction calculated by equation **(2)** will be significantly greater than that calculated by equation **(1)**. The following results bring home the concept.

If we call the force of gravitation calculated by equation **(1) "g"**, the force of gravitation calculated by equation **(2)** would be higher by the ratio $\mathbf{D^2 / (D - d_n)^2}$. When **D** exceeds $\mathbf{d_n}$, by Planck length ($\mathbf{10^{-20}}$ **fms)**, the ratio:

$$D^2/(D-d_n)^2 = (d_n + \text{Planck length})^2/(\text{Planck length})^2$$ (All lengths in femtometers)

$$= (1 + 10^{-20}) / (10^{-20})^2$$ **(d_n = 1 femtometer)**

$$= 10^{40}$$

Multiplying this by "**g**" to get the force of attraction between two nucleons per equation **(2),** we get $\mathbf{F_P = 10^{40} g}$

Comparison to Observed Data

The order of magnitude of the force between two adjoining nucleons as derived from scattering experiments is $\mathbf{10^{40} g}$. No other formula predicts the short range strong force to any degree close to this prediction.

Yukawa potential is too weak to explain the nuclear force. Also, the rest energy of pion was predicted as 100 MeV based on range of the nuclear force equal to one femtometer. The range of nuclear force is reported several times higher depending upon which article one reads. Since the rest energy of a particle is inversely proportional to the range of nuclear force, the pion does not adequately describe the nuclear force. The proposed equation explains the higher range of the nuclear force.

Natures Intervention at Planck Length

Nature guards against conversion of physical quantity to either zero or infinity in ways hard to verbalize. Accordingly, before the force of gravitational attraction between nucleon masses increases to infinity, Nature must be intervening at Planck length with its mysterious and quantum mechanical tools.

Quark Confinement

This is an attempt for a qualitative explanation. The proposed equation can be looked as stating that the gravitational force between two particles is proportional to the mass effect divided by the space effect. In the absence of any space effect between quarks, the force between quarks is infinity-like. The mass effect between quarks increases with increasing separating distance between quarks, consistent with the camouflage effect of QCD.

Classical Unification

If equation **(2)** is correct, then the nuclear force between nucleons which is recognized as the secondary effect of the strong force (or resulting from the leakage of the strong force) or color force between the quarks is clearly at unity with gravity semi-classical way.

Prediction

The proposed equation predicts that at a surface to surface separation of 3 fm's and 4 fm's, the force of attraction between two nucleons would be 1.77 and 1.56 times the gravitational force for these distances respectively and gradually diminish to gravitational values at larger subatomic distances. There is no feature of nuclear force that distinguishes it from gravitation. No experiment will find any distinguishing feature between the two. The range of the nuclear force is limited due to the accuracy with which miniscule gravitational forces between tiny nucleons can be measured. Higher accuracy will measure higher range.

Conclusion

Newtons equation of gravitation is a macroscopic approximation. Equation **(2)** in the above text must be the general semi-classical equation of gravity for distances greater than Planck lengths. The nuclear force creates steep microscopic dents in the curvature of spacetime.

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For questions and comments for further development of the theory, please E-mail the author at shantilalg@juno.com

Shantilal Goradia

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1. Unification of Strong and Gravitational Forces.
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