

DO WORMHOLES FIX the COUPLING CONSTANTS?

S.G. Goradia

Gravity Research Institute, Inc. South Bend, Indiana 46637, USA
sg@gravityresearchinstitute.org

If Newtonian gravitation is modified to use surface-to-surface separation between particles, it can have the strength of nuclear force between nucleons. This may be justified by possible existence of quantum wormholes in particles. All gravitational interactions would be between coupled wormholes, emitting graviton flux in proportional to particle size, allowing for the point-like treatment above. When the wormholes are 1 Planck length apart, the resultant force is 10^{40} times the normal gravitational strength for nucleons.

1 Introduction

Newtonian gravity encounters issues for microscopic dimensions and cannot explain the nuclear binding force. Experimentalists and string theorists face a yet incomplete task of detecting and incorporating the spin 2 graviton into a fully quantized and renormalized theory. If we use the surface-to-surface separation between these particles to quantify the gravitational attraction instead of the center-to-center separation, at small separations relative to the particle radii the force between these particles grows much larger than classical gravity, and may resolve the above issues.

2 Modification of the Inverse Square Law

As an example, for two coupled nucleons (Fig. 1a), I chose the Planck length $L = (Gh/c^3)^{0.5}$ as the surface separation, as it is the minimum possible spatial distance that makes any sense in physics. Assuming zero separation distance would imply that the two particles are joined to form one particle, losing their distinctions as separate particles. The diameter of the nucleon is about 1 fm (10^{-15} meters). The Newtonian gravitational force is then $F_N = Gm^2/D^2$, where D is the center-to-center distance, ~ 1 fm. If we select the surface-to-surface separation instead, the force would become $F_P = Gm^2/d^2$, with $d = L = 10^{-20}$ fm. The ratio of these two forces is $D^2/d^2 = 10^{40}$, which is also the strength of the proposed gravity relative to Newtonian gravity. As the nucleons are separated, D/d shrinks, and F_P rapidly approaches F_N [1]. A similar analysis can be made of the quark-lepton interaction (Fig. 1b).

Nucleons are responsible for over 99 percent of gravity, therefore they are the primary focus of this paper. For nucleons, I recover Newtonian gravity at 1000 fm. This modification yields a force with high intensity at short range, rapidly falling off to a very low intensity at long range.

The values of a field and its rate of change with time are like the position and velocity of a particle. This modification meets the uncertainty principle requirement that the field can never be measured to be precisely zero.

Einstein, in a paper written in 1919, attempted to demonstrate that his gravitational fields play an important role in the structure and stability of elementary particles. His hypothesis was not accepted because of gravity's extreme weakness [2]. While Einstein's attempt is worth mentioning, it is not the foundation of my theory. Einstein could be wrong, but it seems he may not be. It has been proposed that the gravitational constant inside a hadron is very large, $\sim 10^{38}$ times the Newtonian G [2]. This "strong gravity" inside the hadron is similar to my proposed modification, but in my modification, instead of needing to change G itself, I change the distance measurement and get the same result. My theory does not create a conflict with the color force theory either. Strong gravity is consistent with string theory [1]. The short range forces are weakened at long range

by a high order of magnitude. This makes other attributes of the short range forces, infinitesimal at long range.

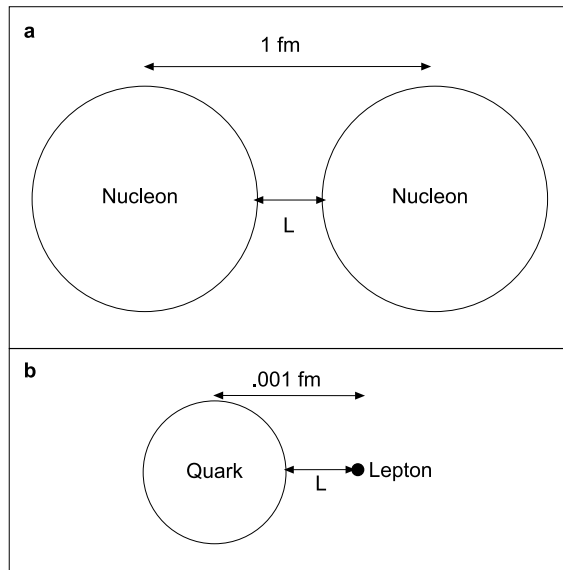


Fig. 1. Pictorial view of gravitational interaction showing surface and center separations (not to scale). L is the Planck length, 10^{-20} fm. **a**, Two nucleons at minimum separation; **b**, A quark and a lepton, also at minimum separation. The standard inverse-square law would use the center-to-center distances to calculate the force between the particles; using the surface-to-surface distance yields a much stronger force for these separations, equal to the relative strengths of the strong and weak nuclear forces, respectively.

One may question the mathematically simple application of the Planck scale to a problem where the relevant distances seem to be fm. Frank Wilczek has written a series of articles [3], explaining how these scales can be reconciled and provided responses. While this may seem simplistic, it seems to be mathematically valid, and frequently significant problems can be solved simply in the end, as also illustrated by Morris and Thorne [4]. Complexity in physics lies in the abstraction of simplicity. Classical centers of shapes and therefore surfaces, though used here only for intuitive reasoning are invoked in nuclear coupling constants by implicit comparison to Newtonian gravity and in other descriptions in modern physics. My model is very consistent and therefore suggestive, however it does not reconcile the fact that nucleons overlap. Thanks are due to Dr. G.'t Hooft for this comment. Quantum wormholes, as currently theorized, may resolve this issue and give a mathematical foundation to my model.

3 Quantum Wormhole Connection

I postulate that each particle is associated with a Planck length size wormhole. The wormhole's exit mouth then represents the entire mass of the particle and propagates its $1/r$ potential to the rest of the universe. All gravitational interactions become interactions between these wormholes. Radiation by particles would consist of energy being absorbed by one mouth of the associated wormhole and emitted by the other mouth. This would justify the use of point-like gravity. The mouth emitting the gravitational radiations does not have to be at the surface, allowing the nucleons to overlap. This may sound like a radical approach, but it is not. The direction of my proposal coincides with that in the particle related article by Einstein and Rosen [5], introducing what is now known as Einstein-Rosen bridges. The abundance of Planck-length size wormholes required could have evolved from perturbations in the initial big-bang density.

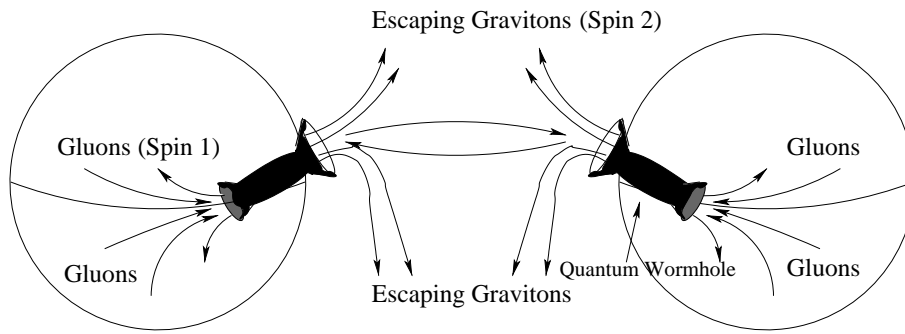


Fig. 2. Mental image of nuclear interactions via quantum wormholes. The graviton flux would be proportional to the mass of the interacting particle, yielding couplings of 10^{40} for nucleons, 10^{34} for lighter quark-lepton pairs and ~ 1 for point-like leptons.

Stable wormholes require “exotic”, negative energy matter “... it is not possible to rule out the existence of such material; and quantum field theory gives tantalizing hints that such material might, if fact, be possible” [4]. The stability of wormholes is on firmer grounds now. “...the theoretical analysis of Lorentzian wormholes is “merely” an extension of *known physics*-no new physical principle or fundamentally new physical theories are involved” [6]. Literature search reveals no detection of any central force within nucleons, raising a question about the existence of gravitons within nucleons. Fig. 2 shows the mental picture of the graviton flux from nucleons with some background data. Richard Feynman seems to have investigated transfusion of two particles into gravitons [7], but not in this context. The structure of the quantum space-time is foamy [8]. The potential conversion of two gluons into one graviton and vice versa would be debatable. Such foamy structure may give green light for some form of particle transfusion.

All long range forces are potentially simple, cumulative long range manifestations of their short range counter parts and vice versa with their intermediate range immeasurable by microscopic or macroscopic means. Since the spin-dependent nuclear force can be negative, my theory suggests investigation of photons instead of gravitons as the mediators of gravity. My model showing the strong gravity as a function of D^2 instead of particle mass (logical function of D^3) may point to holographic principle. Mach principle may imply that the universe spinning in the reference frame of nucleons may subject the nucleons to some form of gravity, not residual color force. So long as the observable characteristics of proposed wormholes are stable, their stability and types are of secondary importance because the coupling constants are averages of observations. The understanding of the coupling constants lies at the heart of our understanding other important issues. Using the concept of strong gravity, one can show the stability and structure of elementary particles, which could not be achieved by weak gravity [2].

4 Prediction

My model provides a consistent, intuitive and simplistic, but mathematical explanation of the observed relative values of coupling constants, something no other theory has done. Experimentally, my theory may be explored by a careful examination of the nuclear force at distances above 10 fm. Recently published test results verified the gravitational inverse square law down to $218\mu\text{m}$ [9]. The test results do not verify the higher dimensional theories that motivated the test, but they are not in conflict with my theory, as at these separations my modified force should be indistinguishable from Newtonian gravity. Spin-zero pions are potentially pushing the nucleons apart to prevent the collapse of nuclei and not pulling them together as theorized. Their range matching the size of nuclei gives a green light for such an investigation.

5 Conclusion

In summary, in the early part of last century, when the nuclear force was declared to be a separate force, the Planck length and its implications were not well understood. Planck's system of fundamental units was considered heretical until came the proposal by Peres and Rosen [10]. The weakness of gravity was unquestioned. Therefore, it was impossible to explain strong gravity force in terms of Newtonian gravity and Einstein's view was undermined. In light of my article this issue needs to be revisited. My consistent results show that strong gravity creates an illusion of a different force between nucleons. Mathematically, the strong force coupling constant $C_s = D^2$, where $D =$ nucleon diameter in Planck lengths.

Acknowledgments

I thank the staff at the Physics Department, University of Notre Dame for comments.

References

- [1] S. G. Goradia, physics/0210040.
- [2] S. K. Shrivastava, *Aspects of Gravitational Interactions* (Nova Science Publishers, Commack, 1998), p. 90.
- [3] F. Wilczek, *Physics Today* **54**, 12 (2001).
- [4] M. S. Morris and K. S. Thorne, *Am. J. Phys.* **56**, 395 (1988).
- [5] A. Einstein and N. Rosen, *Phys. Rev.* **48**, 73 (1935).
- [6] M. Visser, *Lorentzian Wormholes, From Einstein to Hawking* (Springer-Verlag, New York, 1996), p. 369.
- [7] R. Feynman, *Acta Phys. Pol.* **24**, 697 (1963).
- [8] S. W. Hawking, *Phys. Rev.* **D46**, 603 (1992).
- [9] C. D. Hoyle *et al.*, *Phys. Rev. Lett.* **86**, 1418 (2001).
- [10] A. Peres and N. Rosen, *Phys. Rev.* **118**, 335 (1960).