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Gravity and Strong Force: Potentially Linked by Quantum Wormholes

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Abstract: 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. Additionally, the invisible quantum wormholes may form binary effects imparting wave properties to all particles.

INTRODUCTION

Newtonian gravity encounters issues for microscopic dimensions and cannot explain the nuclear binding force. Physicists have attempted to explain the nuclear force in terms of perturbations to classical gravity [1]. However, in the end they concluded that a different force, the strong nuclear force, is responsible for nuclear binding. Quantum Chromodynamics was developed, following the form of Quantum Electrodynamics, to quantify the strong nuclear force. Experimentalists and string theorists faced a yet incomplete task of detecting and incorporating the spin 2 graviton into a fully quantized and renormalized theory.

We can follow the lead of those who try to explain the strong nuclear force in terms of gravity by attempting to modify the classical Newtonian theory of gravity in the case of small particles. If we use the surface-to-surface separation between these particles to quantify the gravitational attraction instead of the center-to-center separation, we find that the force between these microscopic particles is the same as before in the limit of large separations relative to the particle radii. At small separations relative to the particle radii the force between these particles grows much larger than classical gravity.

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 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, $\sim$ 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 force is $D^2/d^2 = 10^{40}$, which is also the strength of the nuclear force relative to gravitation, derived in a natural way by using the value of Planck curvature. As the nucleons are separated, D/d shrinks, and F_P rapidly approaches F_N (Fig. 2).

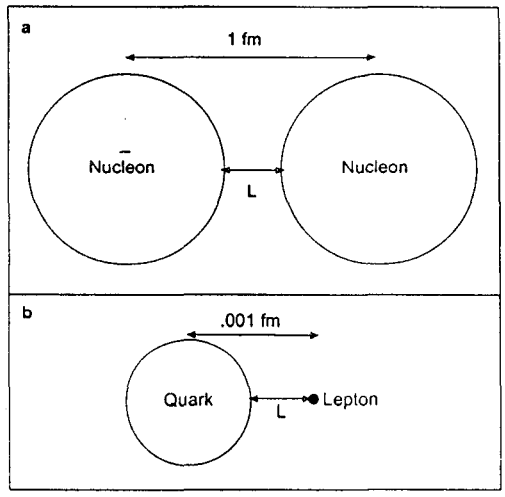

FIGURE 1. Pictorial view of gravitational interaction, showing surface and center separations (not to scale). L is the Planck length, 10^{-20} fm. **a**, Two nucleons at minimum separation; **b**, A quark and a lepton, also at minimum separation. The standard inverse-square law would use the center-to-center 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.

I recover Newtonian gravity at 1000 fm (about the radius of an atom). This modification yields a force with high intensity at short range, rapidly falling off to a very low intensity at long range. It naturally presents a smooth, curvilinear connection between the strong nuclear force and gravity in terms of the Planck curvature. 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. It also meets the boundary values of both gravitation and the nuclear force, and suggests that they could be the same interaction. A similar analysis can be made of the quark-lepton interaction (Fig. 1b), yielding the weak nuclear coupling constant 10^{34}.

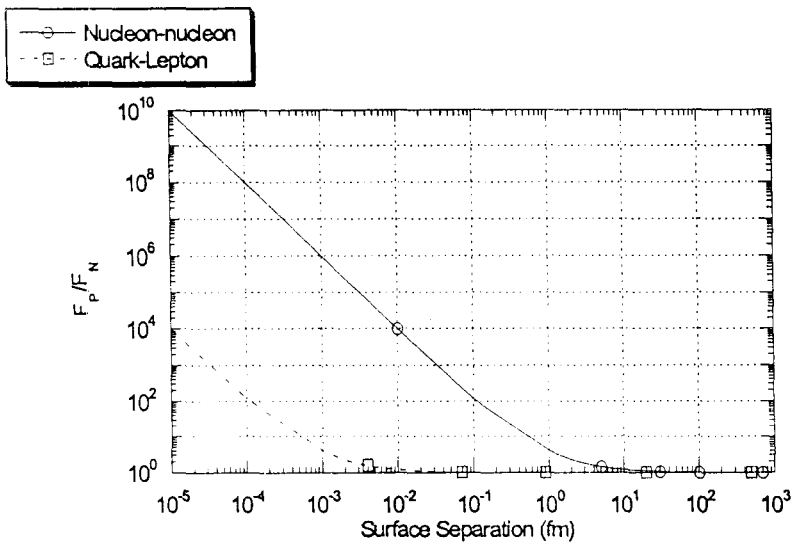

FIGURE 2. Ratio of modified force to Newtonian gravitation as a function of surface separation for nucleon-nucleon and quark-lepton interactions. The ratio approaches unity at large surface separations in both cases. Also, for both interactions the ratio becomes quite large for short separations, reaching 10^{40} for the nucleon-nucleon interaction and 10^{34} for the quark-lepton interaction in the Planck length separation limit of 10^{-20} fm.

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. Strong gravity is consistent with string theory. Einstein's explanation of nuclear force in terms of gravity [2], while worth mentioning, is not meant to be the foundation of my theory. Einstein could be wrong, but it seems he may not be. The nuclear forces are weakened at long range by a high order of magnitude. This makes other attributes of the color force, infinitesimal at long range.

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.

QUANTUM WORMHOLE CONNECTION

A possibility is 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.

Think of two identical balloons pressurized with air. The more they are subjected to pressure, the bigger they will grow. Upon releasing the mouths, they will experience reaction force such that the bigger balloon will experience higher force if the mouths are the same size. (The mouth size in my theory is Planck length where Compton wavelength equals gravitational radius.) If the balloons contained supercritical water, their mouths would transform water into steam, more noticeable as a mixture at close range and as steam at high range. Likewise nucleons will eject a graviton flux creating a force as a function of the size of nucleons. My geometrical model implies that the gravitational potential of a particle is proportional to its diameter, while my quantum wormhole injection implies it is proportional to the graviton flux. A potential proportionality of the diameter and the graviton flux to the surface tension would reconcile the issue.

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 theoretical analysis of Lorentzian wormholes is "merely" an extension of known physics-no new physical principle or fundamentally new physical theories are involved" [6]. This exotic matter may mask the necessary Planck mass of the wormhole, leaving a resultant effect at a point-like mass, equal to that of the associated particle. Controversies surrounding the large-scale negative energy for cosmic wormholes may not apply to tiny and harmless earthly quantum wormholes. Casimir effect is an example of negative energy observed on earth. The time travel may simply imply that an imaginary traveller on his/her journey to the quarks would see imaginary local clocks going backwards in time. My hypothesis characterizes gravity as long-range nuclear force. Literature search reveals no detection of any central force. The prevailing view is that the nuclear force is a secondary effect of the color force, raising a question about the existence of gravitons within nucleons. Fig. 3 shows the mental picture of the graviton flux, as if it is a product of "evaporation" . Richard Feynman seems to have investigated transfusion of two particles into gravitons [7], but not in this context. The potential conversion of two gluons into one graviton and vice versa would be debatable. The figure is drawn to show just the graviton flux at this stage with some background

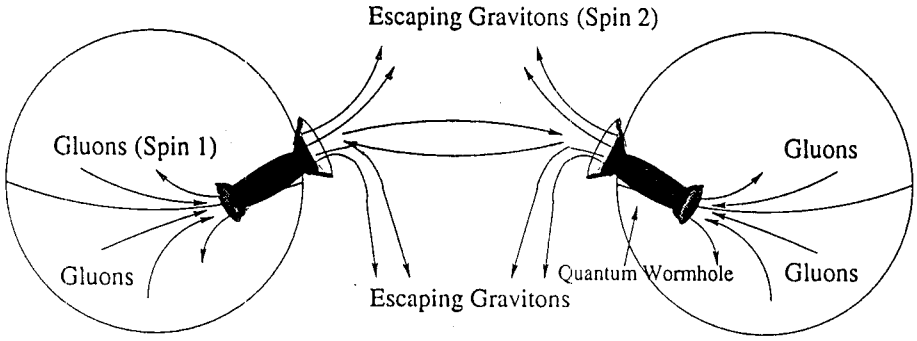

FIGURE 3. Mental image of nuclear interactions via quantum wormholes. The graviton flux would be proportional to the mass of the interacting particle, yielding couplings of 10^{40} for nucleons, 10^{34} for lighter quark-lepton pairs and ~ 1 for point-like leptons.

picture.

The proposed wormholes might form a binary system with their particles, potentially explaining the wave properties of particles. The structure of the quantum space-time is foamy [8]. Introduction of this two way foamy structure connecting the islands of particles with the normal space-time may impact some unsettled issues. My modification does not impact the second law of thermodynamics.

My potential link between nuclear force and gravity may be a typical simpler example of other such links in nature. All long-range forces are potentially simple, cumulative long-range manifestations of their short-range counter parts and visa versa with their intermediate range immeasurable by microscopic or macroscopic means.

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 can be explored by a careful examination of the nuclear force at distances of 1–10 fm. Recently published test results verified the gravitational inverse square law down to 218μm [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.

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 nuclear force in terms of gravity and Einstein's view was undermined. In light of my article this issue needs to be revisited. My consistent results show nuclear force and gravitation are synonymous. Quantum curvature, 10^{-40} fm, is a common denominator for coupling strengths, linking high-intensity, short-range forces with low intensity long-range forces. There is no compelling evidence to distinguish nuclear force from gravitation. My potential link between nuclear force and gravity may be a typical simpler example of other such links in nature.

ACKNOWLEDGEMENTS

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