The origin of gravity

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Abstract

Modern physics is facing a profound conundrum. Gravity is a fundamental force of nature, nevertheless, there is no theory, among many proposed, that can explain satisfactorily the origin of gravity. In addition, there are two major theories in modern physics: general relativity and quantum physics. Each of these theories has been proven to be correct with high confidence. Yet, no theory which combines both has been found. Specifically, quantum physics does not relate to gravity, whereas gravity is a profound parameter in general relativity. A theory that tries to unify the theories is quantum gravity. Quantum gravity hypothesizes that gravity may arise from quantum phenomena. However, there is no accepted answer.

I claim that gravity is the residual (or leftover) of the strong force that is confined inside nucleons. In other words, gravity originates from the strong force. In my answer I relate also to the profound open question: Why is gravity, which is involved in the structure of our entire universe, so much weaker than the other fundamental forces?

The origin of gravity

Modern physics is facing a profound conundrum. There are two major theories in physics: general relativity and quantum physics. Each of these theories has been proven to be correct with high confidence. Yet, no theory combines both. Specifically, quantum physics does not relate to gravity, whereas gravity is a profound parameter in general relativity.

I claim that the origin of gravity in the universe is the residual strong nuclear force. The strong nuclear force is one of the four fundamental forces of nature, along with gravity, electromagnetism, and the weak force. It's the strongest of the four, but it also has the shortest range, meaning it only acts over extremely small distances, like within the nucleus of an atom. The strong force holds the nucleus together: Protons are positively charged, and like charges repel. The strong force overcomes this electromagnetic repulsion, keeping the protons and neutrons tightly bound within the atomic nucleus. Studies show that although the strong force acts mainly between quarks within the nucleus (protons and neutrons), some of it spills over outside the nucleus. This leftover is designated the “residual strong force”. The magnitude of this force changes considerably as a function of the distances between nucleons.

The first scientist who suggested the equation of the strong force was Yukawa. He proposed the idea of mesons as the mediators of the strong force between nucleons (protons and neutrons). Yukawa in 1949 received the Nobel Prize for developing his theory of mesons.

$$F_Y = -g_y{}^2 \cdot (\frac{1}{r^2} - \frac{1}{r_1 \cdot r}) \cdot e^{-\frac{r}{r_1}} \qquad \text{(A.1)}$$

Where:

F_Y …is the force between nucleons (in Newtons) according to Yukawa

r …is the distance between nucleon centers.

$r_1 = 10^{-13} cm$ …is the Yukawa radius.

g_y …is the Yukawa's nucleon interaction constant. (1)

e …is the base of the nature logarithm.

(1) The value of the scaling constant "g" in the Yukawa model is not a fixed constant. It depends on the specific interaction being modeled. In the standard model – for fermions, ~ $g_y{}^2 = 1\frac{kg \cdot m^3}{s^2}$

Yukawa's formula indicates that:

1) The strong nucleon force between two nucleons is always attractive.
2) The strong nuclear force exists only in a small range of 0.5x10^-13cm and smoothly decays with distance. For example, at a distance of 100cm between nucleons the value is. $F_Y \rightarrow 0.0N$

However, in 1968, Reid experimentally showed that the strong force is attractive and repulsive depending on the distance between nucleons, rather than being attractive at all ranges as suggested by Yukawa. Reid model is described in Nuclear force [1].

My hypothesis of the origin of gravity is based on the work done by Ma & Wang "Duality Theory of Strong Interaction" [2]. They developed formulas based on field theory. The formulas they developed relate to the strong force interaction between quarks, nucleons, and atoms. They modified the Yukawa potential equation (A1) to resemble the Reid experimental results.

According to Ma & Wang, the strong interaction is short-ranged with different strengths at different levels. For example, in the quark level, strong interaction confines quarks inside hadrons, in the nucleon level, strong interaction bounds nucleons inside atoms, and in the atom and molecule level, strong interaction almost diminishes. **In particular, beyond the molecular level, the strong interaction diminishes significantly.**

Ma & Wang note that the value of the strong interaction (or coupling) varies considerably according to the range. The value inside the nucleon is the strong coupling is:

$$g_s{}^2 = 0.5 \cdot 10^{25} \cdot \hbar \cdot C = 0.158 \frac{kg \cdot m^3}{s^2}$$

The value between nucleons in a molecule is:

$$g^2 = 10 \cdot \hbar \cdot C = 3.153 \cdot 10^{-25} \frac{kg \cdot m^3}{s^2}.$$

However, Ma & Wang do not relate to the case when the distance between the nucleons is at cosmic distance, because they assumed that at cosmic distances the force is approaching zero.

In the following paragraph, I suggest a way to calculate the coupling constant for nucleons at cosmic distances.

Ma & Wang modified the strong force between two nucleons F_n (in Newtons) in the range of the atom radius is described by formula (6..12) in their paper [2] and is plotted in Fig. 1.

$$F_n = g^2 \cdot \left(\frac{1}{4 \cdot \sqrt{e}} \cdot \frac{1}{r^2} - \frac{2 \cdot r}{r_1^3} \cdot e^{-\frac{r}{r_1}}\right) \qquad \text{(A.2)}$$

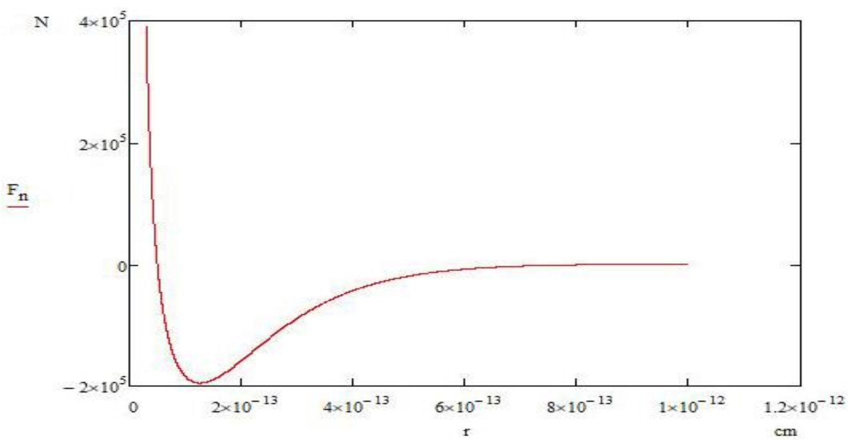

Fig. 1 – Ma &Wang force between two nucleons as a function of the distance between them.

Figure 1 is in good agreement with the measurements. From the graph, it is also clear that the residual strong force is reduced substantially as the distance between nucleons grows. For example, at a distance of one hundred centimeters between nucleons, the attractive force is $4.8 \cdot 10^{-26} N$, dropping substantially from the maximum force $2 \cdot 10^{5} N$ at a distance $1.3 \cdot 10^{-13} cm$. Here, **I postulate that although the force between nucleons on cosmological scale is extremely small, there is nevertheless, a significant attraction force between celestial bodies in the universe because each of them contains an enormous number of nucleons.**

Examining equation (A.2) shows that $\frac{1}{4 \cdot \sqrt{e} \cdot r^2} \gg \frac{2 \cdot r}{r_1^3} \cdot e^{-\frac{r}{r_1}}$ when the distance between nucleons increases. The meaning of this is that at cosmic distances the second part of the equation (A.2) can be discarded and the attraction force between nucleons can be written as:

$$F_n = g^2 \cdot \frac{1}{4 \cdot \sqrt{e}} \cdot \frac{1}{r^2} \qquad \text{(A.3)}$$

Considering the force between two celestial bodies one having mass M_1 and the second M_2. The number of nucleons (Note: Mass of nucleon = mass proton =~ mass of neutron) in the first body is: $N_1 = \frac{M_1}{m_{nucleon}}$. The number of nucleons in the second body is $N_2 = \frac{M_2}{m_{nucleon}}$

The force between the two bodies each of them containing many nucleons:

$$F_{\Sigma n} = g^2 \cdot N_1 \cdot N_2 \cdot \frac{1}{4 \cdot \sqrt{e}} \cdot \frac{1}{r^2} = g^2 \cdot \frac{1}{m_{nucleon}{}^2} \cdot \frac{1}{4 \cdot \sqrt{e}} \cdot \frac{M_1 \cdot M_2}{r^2} \qquad \text{(A.4)}$$

On the other hand, according to Newton's gravitational law, the force between two bodies is given by:

$$F_G = G \cdot \frac{M_1 \cdot M_2}{r^2} \qquad \text{(A.5)}$$

where $G = 6.67 \cdot 10^{-11} \frac{m^3}{kg \cdot s^2}$ ….is the universal gravitational constant.

By equating $F_{\Sigma n}$ (A.4) and F_G (A.5) I suggest a value of the cosmological coupling constant between nucleons $g_{nuecleon}$. Its value is calculated by:

$$G = g_{nucleon} \cdot \frac{1}{m_{proton}{}^2} \cdot \frac{1}{4 \cdot \sqrt{e}} \quad \rightarrow \quad g_{nucleon} = G \cdot m_{nucleon}{}^2 \cdot 4 \cdot \sqrt{e} = 1.232 \cdot 10^{-63} \frac{kg \cdot m^3}{s^2} \qquad \text{(A.6)}$$

To sum up:

Equation (A.6) shows the dependence of the cosmological coupling constant of the nucleons, $g_{nucleon}$, to the mass of the nucleon, and Newton's gravitational constant. Thus, it unifies quantum physics, Newton's gravitational law, and GR.

Example: Gravitational force between Sun and Earth

1) Newton's gravitational law

$M_{Sun} = 1.989 \cdot 10^{30} kg$ ...Sun mass

$M_{Earth} = 5.9 \cdot 10^{24} kg$ ...Earth mass

$R = 150 \cdot 10^{6} km..$ ...Sun-Earth distance

$$G = 6.67 \cdot 10^{-11} \frac{m^3}{kg \cdot s^2}$$

$$F_G = G \cdot \frac{M_{Sun} \cdot M_{Earth}}{R^2} = 3.5 \cdot 10^{22} N$$ ... Newtons gravitational force

2) Nucleons residual force

$$g_{nucleon} = 1.232 \cdot 10^{-63} \frac{kg \cdot m^3}{s^2} \quad \text{(A.6)}$$

$m_{nucleon} = 1.6726 \cdot 10^{-27} kg$ ...Nuecleon (proton or neutron) mass

$$N_{Sun} = \frac{M_{Sun}}{m_{nucleon}} = 1.195 \cdot 10^{57}$$ ...Number of nucleons in the Sun

$$N_{Earth} = \frac{M_{Earth}}{m_{nucleon}} = 3.527 \cdot 10^{51}$$ ...Number of nucleons in the Earth

$$F_{nucleon} = g_{nucleon} \cdot \frac{1}{4 \cdot e^{0.5} \cdot R^2} = 8.302 \cdot 10^{-87} N$$

$$F_{\sum nucleon} = F_{nucleon} \cdot N_{Sun} \cdot N_{Earth} = 3.5 \cdot 10^{22} N$$ ... Nucleons gravitational force

$$\therefore \quad F_G = F_{\sum nucleon}$$

References

1. Wikipedia Nuclear force Nuclear force - Wikipedia
2. Ma and Wang "Duality Theory of Strong Interaction" https://inspirehep.net/files/6c6e09f5bdbc35670f295ee771afdd56