Microscopic theory of Gravitation

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Abstract

The source of gravitation may come from the virtual electron-positron pairs generated by vacuum polarization and the force carrier particles would be pairs of virtual photons generated by the virtual electron-positron pair that travels in unison, and the origin of gravitation would be electron-positron pair that exchanges virtual photons. Based on this assumption, we establish a theory to describe gravitation. We discuss Barnett effect [1].

Key words
Gravitation, Vacuum polarization, Force carrier particle, Barnett effect.

Introduction

Newton proposed that there is an interaction between any two objects in universe, in the form below:

$$\mathbf{F} = G\frac{M_1M_2}{r^3}\mathbf{r} \qquad (1)$$

Where G is the Newton universal gravitational constant, G $=6.67\times10^{-11}\ \mathrm{m^3{\cdot}s^{-2}}$, M1 and M2 are gravitational masses of two objects and r is the distance between them.

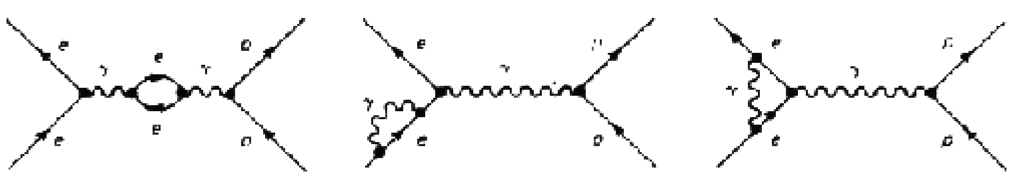
Along with Gravitation there are 3 other fundamental interaction forces: Strong, Weak and electromagnetism. There is a force carrier particle for each of those 3 fundamental interactions and there is a Microscopic theory to describe how each force be created by exchanging its carrier particle.

Gravitation is an exception as we don't know which parts of object exchanges gravitons, nor do we know its detailed process.

The new theory of gravitation: Two-photon theory of gravitation

We assume that the force carrier particle of gravitation is a particle that has a stationary mass of zero, and a spin of 2. We also assume that the force carrier particle is exchanged by independent pairs of virtual electron and positron that are produced in vacuum polarization.

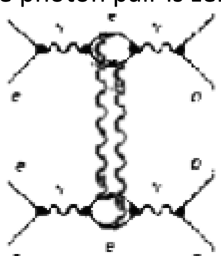
Quantum electrodynamics (QED) accurately describes the behaviour of photons and electrons. Let's consider one of the three high-order processes in following pictures: QED vacuum polarization. The virtual photon produces virtual electron-positron pair and then the electron-positron pair annihilates into a virtual photon.



Vacuum polarization Electron mass renormalization Anomalous magnetic moment

Further considering the next order process of vacuum polarization, virtual electron and virtual positron emits one photon respectively before annihilating into a virtual photon. Of those photon pair emitted by electron and its counterpart positron, few pairs has the following property: the momentum of one photon is linear to the momentum of its pairing photon. In other words, the pair moves together like a single particle once they are emitted. Photon pairs that satisfy the above properties can be obtained by other electron-positron pairs. This type of exchange between positron-electron pairs is similar to the Electromagnetic interaction which exchanges a single virtual photon.

The photon pair is zero mass and its spin is 2. See following pictures:



We call the virtual electron-positron pair as Q-PAIR and photon pair as queton. Two Q-pairs interact with each other by exchanging a queton and in this case the queton is the force carrier particle which is zero-mass and spin-2.

We assume that electron-positron pair (Q-PAIR) is the source of gravitation. Gravitational force carrier particle is a virtual photon pair (queton), spin 2, zero stationary mass. This means that Gravitation force is essentially Electromagnetic force, but instead of a photon, we have a queton as force carrier particle. Instead of charges, we have Q-PAIRs as force sources. A stationary electron cannot interact with a queton since there are two photons in one queton. Gravitation force can be completely described by QED in certain ways.

Despite that Gravitation force essentially is the electromagnetic force, we can still derive the gravitational field theory.

The force in stationary state between two Q-PAIRs is similar to Coulomb's interaction:

$$F = \mathrm{k}_e \frac{Q_{e1} \cdot Q_{e2}}{r^2} \qquad (2)$$

Where Q_e is gravitational charge of a body similar to electronic charge and k_e is Coulomb constant.

The interactions may also be repulsive. However, the system of two attracting Q-PAIRs has a lower energy level than the system of two repulsing Q-PAIRs. Hence, the interaction is normally an attraction.

Let's discuss gravitational charge Q_e .

for two charges system, its Q_e is proportional to A∗ f(α, μ). Where A is the strength of electromagnetic field between two charges, which generates vacuum polarization. α is the fine-structure constant. μ is probability by which two photons are emitted by a virtual positron-electron pair that moves together like a single particle. Not all photons omitted by two virtual vacuum polarization Q-PAIRs can be queton. Only very small amount of photons can be formed queton, which should be moving together at all times. We expect that for a single Q-PAIRs its probability of forming queton for all photons is a constant and its value should be very small.

The force two Q-PAIRs exchanging a queton (force carrier) will be transferred to their original generator (two charges system) and the transformation depends on the strength of electromagnetic field between two charges A. Therefore Q_e is proportional to A.

If the strength of electromagnetic field between two real charges is changed, the number of virtual photons exchanged between two real charges will be changed. The stronger electromagnetic field between two real charges, the more number of virtual photons exchanged between two real charges and as the results, the more number of Q-PAIR and quetons and the stronger gravitation force.

Q-PAIR will be generated wherever electromagnetic force exists. It is well known that normal substances consists of atoms, atoms consists of a nuclei and orbiting electrons, nucleus consists of neutrons and protons, both of which consists of Quarks and Quark has charge. The strongest electromagnetic fields are between Quarks inside of neutrons and protons. The second strongest electromagnetic field happens inside of the nucleus, generated between protons inside the nucleus. The weakest one is between nucleus and the orbiting electrons. This directly correlates the number of Q-pairs generated, as Q-pair generation is positively correlated with the strength of the electromagnetic field. If any electromagnetic structure is changed, then the total number of Q-PAIRs will change, which results in a change of the gravitational force. For example, if the orbiting electrons of a atom is forced further away from the nuclei, then the electromagnetic field between the electron and nuclei will weaken, which causes a decrease in the rate of Q-pair generation, which will weaken gravitational forces. The change in gravitational force would be extremely small, and would require very accurate equipment to measure.

As a direct corollary, if a substance is heated, the electromagnetic field between the nuclei and orbiting electron will weaken, as orbiting electrons are forced away from nuclei and will jump to higher energy levels. The result is the weakening of the gravity of the substance.

Some experiments[3][4] have shown that this is indeed the correlation between the temperature of substances and its gravity. If adding heat to a body its weight will be decreased.

let's discuss the experiment result more detail.

Adding heat to a body, the body obtains energy and its total energy will be increased. According to Einstein mass-energy formula: $\Delta E = \Delta MC^2$ the inertial mass of the body will be increased. According to equivalence principle of the inertial mass and gravitational mass, its gravitational mass will be increased and therefore its weight should be increased. However the experiments has shown that the weight actually decreases.

At normal temperature T, the number of lattice n with thermal vibration energy ϵ is $\sim e^{-\frac{\varepsilon}{k_b T}}$, where k_b Boltzmann constant. Part of energy ϵ will be transferred to electrons moving around nucleus in the lattice. When the energy electrons got is bigger enough, the electrons will be apart from nucleus which causes the reduction of gravity. Total mass reduction $\Delta M \sim n \sim e^{-\frac{\varepsilon}{k_b T}}$. And if the electrons around nuclei can be easily moving away from the nuclei by disturbing energy, for an example of metal or large Atomic Number materials, the material will be more mass reduction when adding heat. for examples of lead and ceramic, there will be more mass reduction for lead than for ceramic.

To generalize, we predict that any action that weaken the electromagnetic field between the nuclei and orbiting electrons will also weaken the gravity of the atom.

We have similar equations like electromagnetic field theory to describe gravity:

$$\varphi(x, t) = k_e \int \frac{\rho(x', t - \frac{r}{c})}{r} \, dV' \quad (3)$$

$$\mathbf{A}(x, t) = k_e \int \frac{J(x', t - \frac{r}{c})}{r} \, dV' \quad (4)$$

$$\mathbf{E} = -\nabla\varphi - \frac{\partial \mathbf{A}}{\partial t} \quad (5)$$

$$\mathbf{B} = \nabla \times A \quad (6)$$

For stationary field, we have

$$\varphi = k_e \frac{Q_g}{r} \quad (7)$$

$$\mathbf{E} = -\nabla\varphi = k_e \frac{Q_g}{r^3}\mathbf{r} \quad (8)$$

Despite that Gravitation force essentially is the electromagnetic force, Newton universal gravitation law is still roughly correct.

$$\mathbf{F} = G\frac{M_1 M_2}{r^3}\mathbf{r} \tag{9}$$

Thus we have relation between gravitational mass and gravitational charge:

$$Q_e = M\sqrt{\frac{G}{k_e}} \tag{10}$$

There is gravitational magnetic effect which is similar to the electromagnetic field theory. Due to $\frac{\sqrt{G}}{\sqrt{k_e}} \approx 10^{-10}$, corresponding gravity change Q_e of mass M is very small and therefore its gravitational magnetic effect can be observed only for huge bodied.

The gravity force can be only applied to Q-PAIR and has no effective on electrons. But gravitational magnetic field will be same magnetic field as electromagnetic case.

Barnett Effect

Barnett, S.J[1] conducted a series of experiments: An uncharged object rotating with angular velocity ω tends to spontaneously magnetize, with a magnetization given by:

$$M = \frac{x\,\omega}{\gamma} \tag{11}$$

Where γ is gyromagnetic ratio for the material, χ is magnetic susceptibility. The phenomenon is referred as Barnett Effect.

There are some researches on Barnett Effect[5][6]. From our theory points of view, Barnett Effect is a very clear evidence to demonstrate that there are relations between gravitational and electromagnetic forces: when rotating, gravitational charge and electronic charge generate same results: magnetization or magnetic field. Since essentially gravitational force is electromagnetic force, when rotating gravitational charge and electronic charge follow similar rules and therefore generate similar results. Why a stationary gravitational charge doesn't show electronic force like a stationary electronic charge and cannot interact with electrons? Since stationary Q-PAIRs can only interact with Q-PAIRs, not stationary electrons.

When a body of mass M spins around a fixed axis with angular velocity ω, the angular momentum of its microelement Δm is:

$$\Delta U = \omega r^2 \Delta m \tag{12}$$

Where r is the distance from microelement Δm to the rotation axis.

If charge ΔQ_g rotates, its Magnetic dipole moment is:

$$\Delta P = \frac{\omega}{2} r^2 \Delta Q_g \tag{13}$$

Supposed that the Inertia mass roughly equals gravitational mass and according to (5), we have:

$$\Delta P = \frac{\Delta Q_g}{2\Delta M}\Delta U \tag{14}$$

then $$\Delta P = \frac{1}{2}\frac{\sqrt{G}}{\sqrt{k_e}}\Delta U \tag{15}$$

and $$P = \frac{1}{2}\frac{\sqrt{G}}{\sqrt{k_e}}U = \frac{1}{2}\frac{\sqrt{G}}{\sqrt{k_e}}\,\omega r^2 M \tag{16}$$

Formula (16) conforms to Barnett experiment result (11).

Especially (11) is the special case of Blackett effect[3].

In 1947, P. M. S. Blackett[2] proposed that a rotating body should generate a magnetic field proportional to its angular momentum.

$$P = \beta\frac{\sqrt{G}}{2\sqrt{k_e}}U \tag{17}$$

Where G is gravitational constant, P is magnetic dipole moment, U is angular momentum, k_e is Coulomb constant and β is dimensionless constant and in order of unity.

Barnett effect could be base of Blackett's hypothesis.

Formula (16) is Formula (17) when β = 1.

Blackett found that there are 3 stars meeting the formula. Though Blackett himself rejected the hypothesis, later data shows that there is indeed a linear correlation between the magnetic field and the angular momentum of stars. See diagram below:

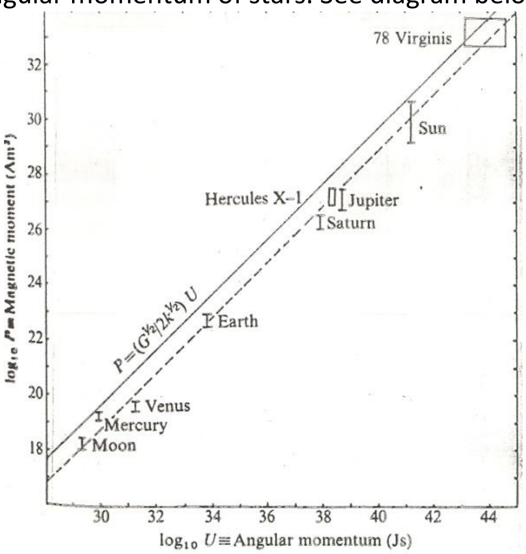


Fig. 1 Magnetic moment/angular momentum diagram. Comparison of gravi-magnetic hypothesis line, $P=(G^{1/2}/2k^{1/2})\,U$, with P and U for massive rotating bodies. The dotted line is the regression line for the data. In $\log_{10}$ form, and in SI units: $G^{1/2}/2k^{1/2} = -10.37$; the mean P/U is -11.13 ± 0.42.

Source: http://www.kokus.net/magnetism

Discussion

The experiments of temperature-mass negative correlation and Barnett effect very clearly demonstrate the relations between gravitational and electromagnetic forces. Our theory is trying to theoretically figure out the relations.

We are expecting that any processes forcing electrons around nuclei move away from the nuclei will cause measurable mass reduction. There are more experiments could be recommended to confirm the relations:

1. Charging electronic capacitor could reduce the mass of the capacitor.
2. Magnetizing material could reduce the mass of the material.
3. Putting two magnets together repulsively the total mass of two magnets could be reduced.
4. Repeating Barnett experiment to verify that uncharged object rotating with angular velocity ω its magnetic dipole moment P conforms Blackett effect formula P = $\beta\frac{\sqrt{G}}{2\sqrt{k_e}}U$.

We are expecting that there more evidences in astronomy to demonstrate Barnett and Blackett effects.

Reference

[1] *Barnett, S. J. Magnetization by Rotation. Physical Review.* ***6*** *(4): 239–270 (1915)*
[2] P. M. S. Blackett . The magnetic field of massive rotating bodies, *Nature* **159**, #4046 (May 17, 1947), pp. 658-666
[3] Wuqing Liu, ENGINEERING SCIENCES. 2010,12(2):9~11
[4] Alexander L. Dmitriev , World Academy of Science, Engineering and Technology Vol:7 2013-07-24
[5] S. P. Heims. Reviews of Modern Physics, Vol. 34, No. 2, 143-165, April, 1962.
[6] C. J. de Matos.Gravitomagnetic Barnett Effect. https://arxiv.org/abs/gr-qc/0012091