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# Gravitational Force is a Type of Physical Interaction between Gluon Fields: Molecular Motions of Gases

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***Author's contribution***

*The sole author designed, analyzed, interpreted and prepared the manuscript.*

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## ABSTRACT

This study presents a Gluon Gravity Model, to explain the mechanism of gravity. With the development of quantum chromodynamics since 1970, Newton's law of universal gravitation and Einstein's theory of general relativity need to be reinterpreted. Like an electric charge causes an electric field, the color charges in quantum chromodynamics were introduced into the gravitational field. The gluons mediating strong force can bring about a new color field around the strong force field owing to their color charges. This new color field of charges becomes a gravitational field in Gluon Gravity Model. This model is supported by the facts that most of the atomic mass is composed of the gluon field energy and the similarity between the two formulas of Coulomb's law and Newton's laws of universal gravitation. Additionally, it is possible to explain the gas molecular motions by applying the Gluon Gravity Model to the gluon fields within a proton.

*Keywords: gluon field; gravity; color charge; gas molecular motions; vacuum polarization; proton acceleration; quantum fluctuation.*

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## 1. INTRODUCTION

According to Newton's law of universal gravitation and Einstein's theory of general relativity [1], the most trusted theories of gravity, gravity is expressed as an interaction between masses. However, advances in quantum chromodynamics since the 1970s have provided more accurate information about mass. The quark particles account for less than 5% of the proton mass, and most of the mass is composed of the energy of the gluon fields [2-4]. Now, gravity, the interaction between masses, can be seen as an interaction between gluon fields in quantum mechanics. In addition, quantum vacuum was proposed by Paul Dirac in 1927 [5-7]. The vacuum is not a space that contains nothing but is filled with quantum fluctuations in which virtual particles and anti-particles are instantaneously constantly produced and annihilated [8-12].

After the development of quantum chromodynamics, Chen and Mageshwaran et al. argued that mass absorbs vacuum energy to create gravity [13,14]. As early as Nikola Tesla (10 July 1856 – 7 January 1943) said that gravity is created by the charge of mass [15]. However, Chen and Mageshwaran et al could not explain the mechanism by which mass absorbs vacuum energy, and Nikola Tesla also failed to explain why mass is an electric charge, so their theories were not well-received at the time.

Why and how mass absorbs vacuum energy is an important issue in finding the cause of gravity in quantum mechanics. In this study, a Gluon Gravity Model is proposed to explain the mechanism of how mass absorbs vacuum energy and creates gravity. Additionally, the Gluon Gravity Model is applied to the gluon fields within a proton to explain the cause of gas molecular motions.

## 2. METHODOLOGY

### 2.1 Gluon Gravity Model

#### 2.1.1 Comparisons of electric and gravitational fields in quantum vacuum

*2.1.1.1 Electric field*

An electric charge causes a vacuum polarization around it. In normal state of quantum vacuum, the virtual $e^+e^-$ pairs are in quantum fluctuations [8, 9, 12], but when vacuum polarization occurs, the virtual $e^+e^-$ pairs are rearranged in a certain direction according to the inverse square law of distance around the point charge. As shown in fig.1, the virtual $e^+e^-$ pairs are forcibly rearranged.

Here, the density of the arranged virtual $e^+e^-$ pair is equal to the density of virtual photons in Feynman Diagram, and which becomes the strength of the electric field.

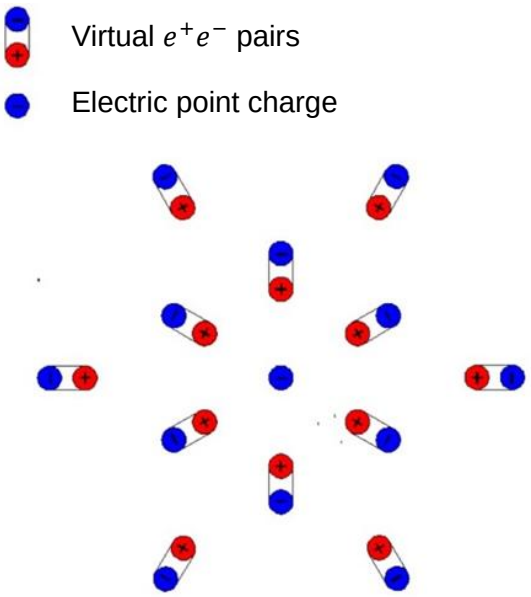



**Fig. 1. Conceptual diagram of vacuum polarization by an electric point charge**

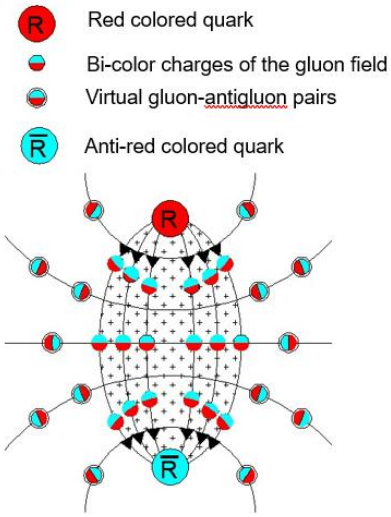



**Fig. 2. Conceptual diagram of "gravitational color field" by a strong force field**

### 2.1.2 Gravitational field

The gluon fields are formed around quarks and between quarks and antiquarks [16]. A gluon particle is a gauge boson that mediates a strong force like a photon mediating electromagnetic force. However, unlike a photon, a gluon has color charges. Therefore, a gluon field causes a vacuum polarization in the surrounding.

Let's look at the vacuum polarization by a strong force field created between the red colored quark and the anti-red colored quark in Fig. 2. The gluons mediating strong force have charges. Thus, a strong force field can act as a new source of color field. This new color field of charges is not a color field within the strong force, but it is defined as a "gravitational color field" because it creates gravity. The "gravitational color field" is not a static field because the colors of the charge in the gluon field are continuously changing. Nevertheless, the density of the virtual gluon-antigluon pairs depends on the strength of the gluon field energy, which is ultimately expressed as the strength of the gravitational field.

In Gluon Gravity Model, a strong force field produce a "gravitational color field" around the gluon field with the virtual gluon-antigluon pairs.

### 2.1.3 Similarity between the formulas of the electric and gravitational fields

Equations (1) and (2) represent the strength of the electric and gravitational field, respectively.

$$E(r) = k_e \frac{q}{r^2} \tag{1}$$

Here, $E(r)$ is electric field strength
$q$ is the quantity of electric charge.
$k_e$ is Coulomb's constant.
$r$ is the distance

$$g(r) = G \frac{m}{r^2} \tag{2}$$

Here, $g(r)$ is gravitational field strength.
$m$ is mass.
$G$ is universal gravitational constant.
$r$ is the distance

It is important to note the similarity between the two expressions. In particular, the field strength of the two equations obeys the inverse square law of distance. This similarity shows the possibility that the mass $m$ of Equation (2) is also a certain quantity of charge as in the quantity of electric charge $q$ of Equation (1). However, the fact that mass is the gluon field energy of color charges is only after the development of quantum chromodynamics in the late 1970s [17]. Therefore, it is now possible to recognize the fact that mass can also cause vacuum polarization.

## 2.2 Rigidification of Quantum Fluctuation

Vacuum energy or quantum fluctuation energy comes from the fluctuations of virtual particle-antiparticle pairs. When an electric or a gravitational field is created to force the rearrangement of virtual particle-antiparticle pairs

in a quantum vacuum, this eventually weakens the quantum fluctuation energy. The weaken quantum fluctuation energy by mass cause an imbalance of the vacuum energy in space. This imbalance cause gravity.

When Einstein's theory of general relativity came out, Nikola Tesla did not trust Einstein's theory, saying that mass is an electric charge and that gravity is created by the rigidification of the vacuum [15,18]. Now that quantum mechanics has advanced, it is possible to reinterpret that mass is an energy of color charge field, and that the rigidification of the vacuum is due to the forced arrangement of virtual particle-antiparticle pairs by the color charge of the gluon fields. Accordingly, the reduction in vacuum energy due to the mass causes imbalance with the surrounding normal state of vacuum. Gravity appears to resolve this imbalance of vacuum energy [13,14].

The rigidification of the vacuum by an electric charge brings about an electric force, but the rigidification of the vacuum by a color charge brings about a gravitational force. What the two forces have in common is that the force is produced by the rigidification of the vacuum.

Let's consider that attraction and repulsion can both be possible in the two electric fields, whereas only attraction appears in the two gravitational fields. First, when the two electric fields are nearby, the virtual $e^+e^-$ pairs in the quantum vacuum overlap. Since there are two types of electric charges, there are only two cases of arrangement in superposition. One is the case when different charges are nearby, the virtual $e^+e^-$ pairs overlap with same directions. Here, a virtual $e^+e^-$ pair meets a virtual $e^+e^-$ pair at the same place. In this case, the virtual $e^+e^-$ pairs are strengthened by the principle of superposition. The other is the case when same charges are nearby, the virtual $e^+e^-$ pairs overlap with opposite directions. Here, a virtual $e^+e^-$ pair meets a virtual $e^-e^+$ pair at the same place. In this case, the virtual $e^+e^-$ pair is forcibly annihilated [19].

When the virtual $e^+e^-$ pair arrangement is strengthened, it means that the rigidity is severe, and the vacuum energy reduction is further increased. Therefore, attractive force is generated. When the virtual $e^+e^-$ pairs arrangement is forcibly annihilated, the vacuum energy increases due to the increase in the activity of quantum fluctuations and repulsive force is generated [19].

While there are two types of electric charge, color charges have three types of colors and the gluons in gluon fields are made from the combination of eight types of color charges. Therefore, when two gluon fields are nearby, there is little chance that virtual gluon-antigluon pairs overlap with opposite directions each other. It means there is no forced annihilations of virtual gluon-antigluon pairs. In other words, it means there is no repulsive force in universal gravitation. Rather, various combinations of gluons create various virtual gluon-antigluon pairs, which increases the density of virtual gluon-antigluon pairs, thereby increasing the rigidity of the vacuum. Finally, only attraction force is created in the gravitational field.

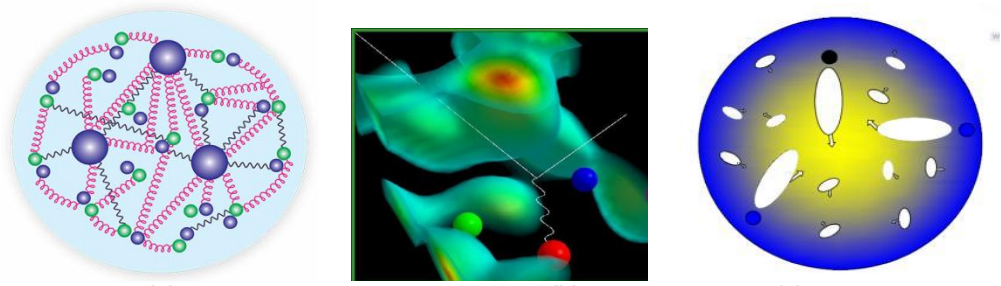
## 3. THE ACCELERATION OF A PROTON

### 3.1 Asymmetric Universal Gravitation

In the 2000s, with the development of deep inelastic scattering (DIS), it became possible to see the inside of protons accurately. Thus, it was possible to obtain the three-dimensional shapes for the gluon fields in a proton. The shape of the gluon field is changing every moment, and it never takes the shape of a spherical body. Instead, it has an aspherical shape like a tube [20-24]. In the gravitational interaction between these aspherical gluon fields, the universal gravitation longer maintains mutual symmetry [25]. In Ref [25], the formula for the generation of asymmetric gravitational force in an aspherical body was developed. Because the shape of the gluon field is aspherical, the gravitational attraction force between the gluon fields in the proton creates an asymmetric attraction.

### 3.2 The Acceleration of a Proton

Fig. 3(a) shows gluon fields connected to three quarks inside the neutron and proton [13]. Fig. 3(b) shows the three-dimensional shape of the gluon fields containing three quarks in the proton [2]. Gluon Gravity Model has been applied to the aspherical gluon fields of the proton. Fig. 3(c) shows the conceptual diagram of the asymmetrical gravitational attractions of the gluon fields in a proton [25].



(a) (b) (c)

**Fig. 3. Quark-Gluon model and Gluon field's acceleration vectors**
**(a)The neutron and proton, in addition to having three valence quarks (larger balls), are filled with a virtual sea of gluons (red springs) and quark (purple)–antiquark (green) pairs [16]. (b) 3D visualization of the proton. The red, green and blue spheres are quarks, confined by the gluon field to form a proton. The pair of green and magenta (anti-green) sphere is a quark-antiquark pair, forming a meson. The quarks only make up 3% of the proton's mass, and the gluon field makes up 97% by Einstein's equation m = E/$c^2$. Hence, the majority of all mass originates in gluon interactions [2]. (c) Gluon field's acceleration vectors obtained from asymmetric gravitational attraction between gluon fields [25]**

Moreover, since these gluon fields are bound to each other, and the total gravitational force vector of a proton can be obtained by summing the asymmetric attraction vectors of $f_i$. The total gravitational force vector of a proton $F$ in equation (3) will not be zero and a proton necessarily has an acceleration [25]. If the value of instantaneous acceleration of a proton is greater than the value of gravitational acceleration, a molecule of hydrogen gas will fly freely.

$$F = \sum_{i=1}^{n} - f_i \quad (i = 1, \ldots n) \tag{3}$$

$$= m a \tag{4}$$

$F$ is the total gravitational force vector of a proton.

n is the number of gluon field within a proton.

$f_i$ is a shielded gravitational force vector for the *i*-th gluon field.

$m$ is the mass of a proton.

$a$ is the acceleration vector of a proton.

A molecule of hydrogen is a form in which two protons with independent accelerations are covalently bonded. Therefore, the motions of a molecule of hydrogen gas are possible in translation, reciprocation, and rotation. The shape of the aspherical gluon field changes every moment inside the proton, which causes random motion of gas molecules. In addition, it is known that the amplitude of the atomic vibration increases with an increase in temperature. As the temperature increases, the asphericity of the gluon field's shape increases, thereby increasing the asymmetric attractions of the gluon fields. This is the reason for increasing acceleration of the proton. Therefore, as in Charles' law, the temperature and the volume of the gas have a proportional relationship. Particularly, at absolute zero, the vibration of atoms stops. It is shown that the gluon fields inside the proton are in a static state of a nearly spherical shape. At this time, the symmetry of the gravitational force is restored, the acceleration of the proton converges to zero and the motions of the gas molecules disappears.

## 4. RESULTS AND DISCUSSION

Gluon fields energy account for most of the atomic mass in quantum mechanics, the gravitational field now should be made by the gluon field, not by the mass. This is the basis of Gluon Gravity Model. In Gluon Gravity Model, a strong force field creates a "gravitational color field" around it due to the color charges of mediator gluons. The proposed Gluon Gravity Model can explain why the formula of Newton's law of universal gravitation is similar to Coulomb's law. And by applying the Gluon Gravity Model to the gluon fields within a proton, it is possible to explain the causes of gas molecular motions.

The electric or the magnetic fields cannot induce a new second-order field around them. This is because the photons have no charge. On the

other hand, the gluon that mediates the strong force have color charges. Therefore, strong force field can induce a new field around it. Of course, this new field is the gravitational field in Gluon Gravity Model.

In Einstein's theory of general relativity, the curvature of space is observed as the path of light, possibly due to changes in the permittivity or permeability of the vacuum around the mass.

In the conventional gravitational theory, mass serves as the cause of gravitational interaction. However, according to the suggested Gluon Gravity Model, particles without color charges such as neutrinos or electrons will not produce gravitational fields. They will be weightless on the Earth.

## 5. CONCLUSION

The Gluon Gravity Model presents that a strong force field can act as a new source of color field due to the color charges of the mediator gluons, and the generated color field of charges by the new source is defined by a “gravitational color field”. The quantity of color charges contained in the strong force field plays the role of mass in Newton's law of universal gravitation, just like the quantity of electric charges in Coulomb's law. The "gravitational color field" is strengthened by the principle of superposition. Expanding into the macro world, universal gravitational force is the result of physical interactions between the gluon fields. The Gluon Gravity Model is supported by several scientific basis. First, the similarity between the two formulas of Coulomb's law and Newton's laws of universal gravitation. Second, most of the atomic mass is composed of gluon field energy in quantum mechanics. Additionally, by applying the Gluon Gravity Model to the gluon fields within a proton, it is possible to explain the molecular motions of gases.

According to the Gluon Gravity Model, electrons or neutrinos having no color charges will be weightless particles like photons, although they have masses.

## COMPETING INTERESTS

Author has declared that no competing interests exist.

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