Journal of High Energy Physics, Gravitation and Cosmology, 2022, 8, 417-431
https://www.scirp.org/journal/jhepgc
ISSN Online: 2380-4335
ISSN Print: 2380-4327

Four Kinds of Potential Mass-Energy Space-Time Distribution Unified by a Dynamical Approach

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How to cite this paper: Qian, W.H. (2022) Four Kinds of Potential Mass-Energy Space-Time Distribution Unified by a Dynamical Approach. *Journal of High Energy Physics, Gravitation and Cosmology*, **8**, 417-431.
https://doi.org/10.4236/jhepgc.2022.82032

Received: March 7, 2022
Accepted: April 17, 2022
Published: April 20, 2022

Abstract

The unification of gravity and electricity since the early 20th century and the unification of four fundamental forces since the 1970s have become a mainstream of physical study by using different theories and methods. This paper introduces a dynamical approach to respectively reveal the physical natures of gravity and electricity as well as strong and weak forces. The results showed that the nature of gravity is associated with dynamical product of mass-energy linear distributions between two adjacent objects and the nature of electricity is associated with a dynamical product of mass-energy linear distributions between two adjacent unlike charges. Potential nuclear energies are mathematically shown by the products of mass-energy linear distributions between proton-neutron particles as well as hadron-lepton particles, which are also initially generated through external perpendicular forces with the maximum efficiency. Thus, four kinds of potential mass-energy space-time distribution rather than four long- and short-range forces showed a common mathematical expression or similarity among them by using this approach.

Keywords

Gravity, Electricity, Strong-Weak Forces, Potential Energy, Unification

1. Introduction

A mainstream of thoughts or a goal in physical study is the unification of all natural forces by one theory since the 1970s [1]-[8]. Historically, the first unification was done by Newton, who unified the celestial and terrestrial gravity in 1687 [9]. The second unification was done by Maxwell, who unified electricity and magnetism as electromagnetism in 1865 [10] [11]. After the invention of general relativity in 1916, Einstein's remaining goal was to find a good unification theory to possibly combine gravity and electricity together [12]. He spent decades of his life on this goal and hoped to solve all mysteries of quantum effects and elementary particles [13].

Following the work of Einstein, many physical scientists focus on the search of this goal using different theories and methods. Among them, higher dimensional space-time field equations [6] [14] [15], geometric approaches [3] [13] [16], entropic concept [7] [8] [17] and others have been developed for this goal's study. Currently used theories and methods are relatively more complex than the traditional Newton and Coulomb's methods. Originally, the gravitational force was described by Newton's law in 1687 [9] while the electric force was illustrated by Coulomb's law in 1783 [18].

Newton's law of gravity stated that any particle of matter in the universe attracts any other with a force varying directly as the product of the masses and inversely as the square of the distance between them. In symbols, the magnitude of the attractive force $F_{A,B}^{m}$ is equal to the gravitational constant G which is a universal constant multiplied by the product of two masses (m_A and m_B) and divided by the square of the distance r.

$$F_{A,B}^{m} = G\frac{m_A \cdot m_B}{r_{A,B}^{2}}. \tag{1}$$

Newton used it to explain the observed motions of the planets and their moons, which had been reduced to mathematical form by Kepler early in the 17th century.

Coulomb's law stated that the electric force ($F_{A,B}^{q}$) between two charges is proportional to the product of both charges (q_A and q_B) and inversely proportional to the square ($r_{A,B}^{2}$) of the distance between them [18].

$$F_{A,B}^{q} = k\frac{q_A \cdot q_B}{r_{A,B}^{2}}, \tag{2}$$

where, $k = \frac{1}{4\pi\varepsilon_0}$ is the Coulomb's constant and ε_0 is the vacuum permittivity. The electric law was considered to be analogous to Newton's inverse square law of gravity. It means that Equation (2) is similar to Equation (1) but they have not been unified by any theory or method.

The word of strong force was first recorded during the 1960s, which stated that the strong short-range attractive force between baryons holds together the nucleus of the atom [19] [20] [21]. The strong force was considered as a fundamental interaction that acts between subatomic particles of matter and binds quarks together in clusters to make more-familiar subatomic particles, such as protons and neutrons.

The weak force was supposed as another fundamental force that governs weak interactions between hadrons and leptons and is responsible for particle decay processes such as beta decay of unstable subatomic particles in radioactivity [22].

The weak force is 10^{-5} times the strength of the strong force and acts over distance smaller than those between nucleons in an atomic nucleus. Particles interact through the weak interactions by exchanging force-carrier particles known as the W and Z particles. The word of weak nuclear force or weak interactions was firstly recorded from the 1950s-1960s [22] [23] [24] [25].

The gravitational force and the electric force belonged to the long-range forces that can be macroscopically observed in daily life [20] [26]. Two short-range strong and weak forces cannot be observed in daily life because they microscopically exist at the subatomic particles. The gravitational force and the electric force were statistically formulated by Newton's law and Coulomb's law because the two forces have different empirical constants. However, there are no similar laws to statistically or dynamically describe the strong and weak forces so far. Among the four forces, some exchanging force-carrier particles have mass or have no mass while massless gravitons have not been detected for the gravitational force [27]. As connected by Li [28], all the fundamental interactions have the same origin. For this origin, a theory or a method should be simply formulated like Newton's law or Coulomb's law but it must be developed to have the basic principle of mathematical physics. First, the goal of this paper is to construct a dynamical formulation. This formulation can describe the following two situations: either two actual forces act on an object to separate it into two parts or contrarily the two actual forces act on the two separated objects to combine them together. Then, the dynamical formulation is mathematically simplified to describe the four kinds of potential mass-energy space-time distribution instead of the four fundamental forces.

2. A Dynamical Approach

According to Equation (1), the gravitational force formulated is a relation of action between two adjacent objects separated by a distance in the macroscopic world. How to explain the interaction between them? If there is only one object in the world, gravity does not exist for the case of an object entirely and initially. If two external forces $\boldsymbol{F}_A$ and $\boldsymbol{F}_B$ act on an initial object (A_{t1} + B_{t1}) to split it apart, the world will have at least two separated objects (A_{t2} and B_{t2}) in **Figure 1**. On the other hand, there are initially two separated objects A_{t1} and B_{t1} in the world as shown in **Figure 2**. Then, two external forces $\boldsymbol{F}_A$ and $\boldsymbol{F}_B$ act on two objects (A_{t1} and B_{t1}) and combine them together (A_{t2} + B_{t2}). Either the separation process in **Figure 1** or the combination process in **Figure 2**, two external forces are

$$\boldsymbol{F}_A = \frac{m_A}{r} v_A^2 \boldsymbol{n}_A + m_A a_A \boldsymbol{k}_A, \tag{3}$$

$$\boldsymbol{F}_B = \frac{m_B}{r} v_B^2 \boldsymbol{n}_B + m_B a_B \boldsymbol{k}_B. \tag{4}$$

Where, the term $\frac{m}{r} v^2 \boldsymbol{n}$ is a mass centripetal force with mass m and velocity or

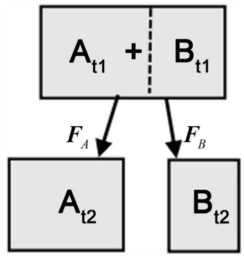

Figure 1. The two external forces $\boldsymbol{F}_A$ and $\boldsymbol{F}_B$ split an object (A_{t1} + B_{t1}) into two separated parts (A_{t2} and B_{t2}) with their masses m_A and m_B.

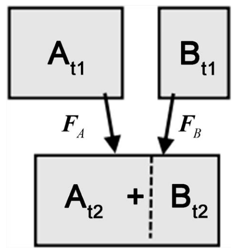

Figure 2. The two external forces $\boldsymbol{F}_A$ and $\boldsymbol{F}_B$ combine two separated parts (A_{t1} and B_{t1}) as an object (A_{t2} + B_{t2}) together.

speed v at the $\boldsymbol{n}$ direction and the term $ma\boldsymbol{k}$ is a force of mass acceleration ma at the $\boldsymbol{k}$ direction.

The cross product $\boldsymbol{F}_A \times \boldsymbol{F}_B$ of two external forces acting on the one object (A_{t1} + B_{t1}) in Figure 1 or the two objects (A_{t1} and B_{t1}) in Figure 2 is a stress of vector format

$$\boldsymbol{\tau}_X^{+i,-j} = \left(q_A^+ \frac{m_A}{r} v_A^2 \boldsymbol{n}_A + q_A^+ m_A a_A \boldsymbol{k}_A \right) \times \left(q_B^- \frac{m_B}{r} v_B^2 \boldsymbol{n}_B + q_B^- m_B a_B \boldsymbol{k}_B \right). \tag{5}$$

Where, the stress $\boldsymbol{\tau}_X^{+i,-j}$ is a result of two external forces acting, the letter X represents types of result or product, the letters i and j denote different kinds of object (or particle) or different objects (or particles) for a macroscopic (or microscopic) world, and the signs + and − indicate different charges of object (or particle) in different worlds hereafter.

This stress in Equation (5) is like a description of mass-energy metric tensor and the evolutional tendency of object (or particle) motions with space and time because the term $ma\boldsymbol{k} = m\frac{\mathrm{d}v_k}{\mathrm{d}t}\boldsymbol{k}$ spatially shows expansion and contraction of objects (or particles) with time. It can be expanded into four terms of vector format,

$$\begin{aligned} \boldsymbol{\tau}_X^{+i,-j} &= \left(q_A^+ \frac{m_A}{r} v_A^2 \right) \cdot \left(q_B^- \frac{m_B}{r} v_B^2 \right) \cdot \left(\boldsymbol{n}_A \times \boldsymbol{n}_B \right) && \text{(a)} \\ &+ \left(q_A^+ \frac{m_A}{r} v_A^2 \right) \cdot \left(q_B^- m_B a_B \right) \cdot \left(\boldsymbol{n}_A \times \boldsymbol{k}_B \right) && \text{(b)} \\ &+ \left(q_B^- \frac{m_B}{r} v_B^2 \right) \cdot \left(q_A^+ m_A a_A \right) \cdot \left(\boldsymbol{n}_B \times \boldsymbol{k}_A \right) && \text{(c)} \\ &+ \left(q_A^+ m_A a_A \right) \cdot \left(q_B^- m_B a_B \right) \cdot \left(\boldsymbol{k}_A \times \boldsymbol{k}_B \right) && \text{(d)} \end{aligned} \tag{6}$$

If only considering the second term (b) on the right side of Equation (6),

$$\boldsymbol{\tau}_{(b)}^{+i,-j} = \left(q_A^{+}\frac{m_A}{r}v_A^2\right)\cdot\left(q_B^{-}m_B a_B\right)\cdot\left(\boldsymbol{n}_A \times \boldsymbol{k}_B\right). \tag{7}$$

It means that the object A has an action of centripetal force turning along the direction $\boldsymbol{n}_A$, while the object B has an action traveling toward (or away from) the object A along the direction $\boldsymbol{k}_B$ for an expanding (or contracting) world.

For an extreme case, the two vectors ($\boldsymbol{n}_A$ and $\boldsymbol{k}_B$) are perpendicular to each other (Figure 3 or Figure 4), so the stress has its maximum in scalar format,

$$\tau_{(b)}^{+i,-j} = \left(q_A^{+}\frac{m_A}{r}v_A^2\right)\cdot\left(q_B^{-}m_B a_B\right) = \left(q_A^{+}\cdot q_B^{-}\right)\cdot\left(\frac{m_A v_A^2}{r}\right)\cdot\left(\frac{\mathrm{d}P_B}{\mathrm{d}t}\right). \tag{8}$$

Where, the term $\frac{m_A v_A^2}{r}$ is the mass-energy linear distribution of object (or particle) A related its rotation center, the term $P_B = m_B v_B$ is the momentum of object (or particle) B so the term $\frac{\mathrm{d}P_B}{\mathrm{d}t}$ is the momentum change of object (or particle) B with time, and the term $q_A^{+}\cdot q_B^{-}$ denotes the unlike charges signed by object (or particle) A and object (or particle) B respectively. If the force $\boldsymbol{F}_B \to \max$ (maximum), the mass of particle B will have $m_B \to \min$ (minimum) and the speed $v_B \to \max$, which suggests that the universe $\tau_{(b)}^{+i,-j}$ of two particles will have large amounts of energy. If $m_B \to fin$ (finite) with a determined speed v_B, the two groups of particles can be seen as two separate pieces of cumulonimbus cloud with unlike charges so that a lightning can happen between them. This process shows a release of electric energy.

The third term (c) on the right-hand side of Equation (6) has a similar result as the second term. In the nature, the condition $ma_A\boldsymbol{k}_A > 0$ or $ma_A\boldsymbol{k}_A < 0$ can exist at different space-time points. For a formation of tropical cyclone over an open

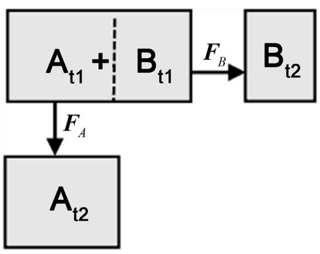

Figure 3. The two external forces $\boldsymbol{F}_A$ and $\boldsymbol{F}_B$ are perpendicular to each other and separate an object ($A_{t1} + B_{t1}$) into two parts (A_{t2} and B_{t2}) at a space-time point.

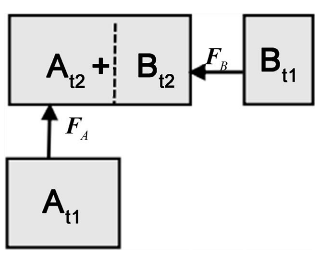

Figure 4. The two external forces $\boldsymbol{F}_A$ and $\boldsymbol{F}_B$ are perpendicular to each other and combine two objects (A_{t1} and B_{t1}) into one part ($A_{t2} + B_{t2}$) together.

ocean, the two force terms $\frac{m_A}{r}v_A^2$ and $m_B a_B$ in the cyclone can locally act on an air mass to split it into two parts from moment to moment and from place to place with $a_B < 0$ when the cyclone converges and strengthens with up-welling motion $v_A > 0$, while $a_B > 0$ when the cyclone diverges and weakens with down-welling motion $v_A < 0$. It means that the two forces are perpendicular to each other, namely $a_B < 0$ and $v_A > 0$ or $a_B > 0$ and $v_A < 0$. Perpendicular cases of particle forces occur much less frequently than other type of cases in practice.

For the fourth term (d) in Equation (6), $a_A \boldsymbol{k}_A$ and $a_B \boldsymbol{k}_B$ have various directions, showing a world of expansion and contraction locally. Here, only perpendicular direction between them is considered with the maximum product value.

$$\tau_{(d)}^{+i,-j} = \left(q_A^+ m_A a_A\right) \cdot \left(q_B^- m_B a_B\right) = \left(q_A^+ \cdot q_B^-\right) \cdot \frac{\mathrm{d}P_A}{\mathrm{d}t} \cdot \frac{\mathrm{d}P_B}{\mathrm{d}t}. \tag{9}$$

Naturally, there are two situations: two objects (or particles) move closer to each other or travel apart. In a low-speed motion, unlike charges can be accumulated through the interaction of different particles and then lightning or discharge can happen between two unlike charges. For high-speed motion, high-energy collisions can occur during this process under suitable materials and conditions.

The universe formulated by Equation (5) or Equation (6) is rather complex. There are four terms of interacting, expanding, and contracting with space and time for the universe. Hereafter, we only use the first term of Equation (6) to understand the physical nature of the four fundamental forces as proposed in many previous studies.

3. Long-Range Forces

Gravity and electricity are believed to have the same feature that belongs to long-range forces moving at the speed of light and acting on an infinite distance. The unification of gravitation and electromagnetism is still a hot topic of physical study [13] [14] [15] [29]. The dynamical natures of these two long-range forces proposed in previous studies will be respectively examined in this section.

3.1. Gravitational Force

For two objects such as the Earth m_A and the Moon m_B (or an apple on a tree), gravity formulated by Equation (1) exists between them although they are separated by a vacuum distance. As an extreme, gravity will suddenly disappear from an infinity when the apple naturally falls down to the Earth's surface. Gravity will not work if their distance is too far away or too close to each other (in zero distance). The exchanging force-carrier particles are still unknown.

Physically, gravity is a quantitative description of the moving mass inertia of all objects preserved since their astronomical evolution started, rather than their interaction [30]. This nature can be extracted from Equation (6) and physically described from the first term (a) as

$$\boldsymbol{\tau}_G^{A,B}=\left(\frac{m_A}{r}v_A^2\right)\cdot\left(\frac{m_B}{r}v_B^2\right)\cdot\left(\boldsymbol{n}_A\times\boldsymbol{n}_B\right). \tag{10}$$

Where, the term $\boldsymbol{\tau}_G^{A,B}$ indicates the gravitational stress acted by two external forces ($\boldsymbol{F}_A$ and $\boldsymbol{F}_B$) on two objects (A and B). At this moment, unlike charges ($q_A^+\cdot q_B^-=0$) and mass accelerations ($a_A=a_B=0$) are not considered in Equation (6).

If the two external forces are perpendicular to each other, the stress reaches its maximum in the scalar format.

$$\tau_G^{A,B}=\left(\frac{m_A v_A^2}{r}\right)\cdot\left(\frac{m_B v_B^2}{r}\right)=\left(v_A^2\cdot v_B^2\right)\frac{m_A m_B}{r^2}=gravity. \tag{11}$$

$$\tau_G^{A,B}=\left(v_A^2\cdot v_B^2/G\right)\left[G\frac{m_A m_B}{r^2}\right]=\left(v_A^2\cdot v_B^2/G\right)\cdot F_{A,B}^m \tag{11'}$$

When comparing Equation (11') and Equation (1), it can be identified that the physical nature of gravity is not a force but associated with the product of mass-energy linear distributions between two adjacent objects. It is interesting to note that Equation (1) is a statistical form formulated by Newton's law, while Equation (11) is a dynamical form. Equation (11) showed that the mass-energy linear distributions can be viewed as simplified Einstein equations under the weak field approximation.

3.2. Electric Force

From Equation (5), only the terms of two unlike charges are considered here

$$\boldsymbol{\tau}_e^{+,-}=\left(q_A^+\frac{m_A}{r}v_A^2\boldsymbol{n}_A+q_A^+m_A a_A\boldsymbol{k}_A\right)\times\left(q_B^-\frac{m_B}{r}v_B^2\boldsymbol{n}_B+q_B^-m_B a_B\boldsymbol{k}_B\right). \tag{12}$$

This stress $\boldsymbol{\tau}_e^{+,-}$ is like a description of mass-energy (m and v^2) space-time metric tensor with different electric charges (q_A^+ and q_B^-). The complexity can be derived after expanding into four terms as shown in Equation (6). If there is no acceleration ($a_A=a_B=0$, neither expanding nor contracting) and the two vectors ($\boldsymbol{n}_A$ and $\boldsymbol{n}_B$) are perpendicular to each other, the result can be simplified as the scalar format

$$\boldsymbol{\tau}_e^{+,-}=4\left[\left(q_A^+\frac{1}{2}m_A v_A^2\right)\Big/r\cdot\left(q_B^-\frac{1}{2}m_B v_B^2\right)\Big/r\right]. \tag{13}$$

The stress is a product of the kinetic energy linear distributions along the distance r between two unlike charges (q_A^+ and q_B^-). It can also be written to associate with Equation (2),

$$\boldsymbol{\tau}_e^{+,-}=4\left[\left(\frac{m_A v_A^2}{2r}\right)\cdot\left(\frac{m_B v_B^2}{2r}\right)\right]\left(q_A^+\cdot q_B^-\right)=\left[\left(m_A\cdot m_B\right)\cdot\left(v_A\cdot v_B\right)^2\right]\frac{q_A^+\cdot q_B^-}{r^2}. \tag{14}$$

$$\boldsymbol{\tau}_e^{+,-}=\left[\left(m_A\cdot m_B\right)\cdot\left(v_A\cdot v_B\right)^2/k\right]\cdot F_{A,B}^q \tag{14'}$$

Equation (2) is a statistical form formulated by Coulomb's law, while Equation (14) is a dynamical form associated with electricity. The former is an empirical expression, while the latter has sound physical meaning describing how two unlike charges are produced through perpendicular relative motion of particles. In Equation (14), the term $\frac{1}{2}m_A v_A^2/r$ and the term $\frac{1}{2}m_B v_B^2/r$ are kinetic energy linear distribution of the two particle parts (m_A and m_B) while the q_A^+ and q_B^- are two unlike charges.

Equation (14) can be further written as

$$\boldsymbol{\tau}_e^{+,-} = \frac{4}{r^2}\left(E_A q_A^+\right)\cdot\left(E_B q_B^-\right). \tag{15}$$

Where, $E = \frac{mv^2}{2}$ denotes kinetic energy. The kinetic energy $E_A q_A^+$ and the kinetic energy $E_B q_B^-$ have different properties with positive and negative charges, respectively. If a friction with perpendicular relative motion happens between two particle parts of material, the larger mass with faster velocity and shorter distance of charged particles will occupy more electric energy. Thus, the letter $\boldsymbol{\tau}_e^{+,-}$ is a potential energy produced by perpendicular frictional forces. In some studies, the interaction of various molecular charges was considered as that a long-ranged attractive force or electronic friction forces on molecules moving near metals [31]. The physical nature showed that Coulomb's law empirically or statistically formulated by Equation (2) is not an electric force but associated with the product of two kinetic energies of a pair of unlike charges. It must be distributed along a line with a distance between two unlike charges, so it can be regarded as a potential electric energy.

The potential electric energy can exist when a negative charge q_B^- moves for a longer distance r related to a positive charge q_A^+, while the potential electric energy $\tau^{+-} \to 0$ when $r \to \infty$. Equations (14) and (15) should have a wide range of applications in electric energy's generation, storage and transmission. Two unlike charges with higher kinetic energies can be released at a shorter distance, which results in lightning between two charged particle parts. This type of potential energy is an electric energy because they have unlike charges. These electric phenomena can be macroscopically observed, and it has been widely used in daily life.

From Equation (11) and Equation (14), we can write the potential electric energy as

$$\boldsymbol{\tau}_e^{+,-} = \left(q_A^+ \cdot q_B^-\right)\cdot\left(v_A^2 \cdot v_B^2/G\right)\cdot F_{A,B}^m \tag{16}$$

Equation (16) has mathematically connected the electricity and gravity together, which may be the Einstein's remained goal. Thus, the physical nature of Coulomb's law can be viewed as the unlike-charge's potential electric energy rather than electric force. It is noted that the Equivalence Principle can be observed in Equations (11) and (14) rather than in Equations (1) and (2).

4. Short-Range Forces

Strong force and weak force are two fundamental nuclear forces proposed in previous studies, which cannot be observed in daily life but nuclear energy exists and has been widely used. Many approaches have been developed to try to unify gravity and electricity with strong-weak interactions [8] [16] [17]. In this section, the dynamical natures of these two short-range forces will be respectively examined by a simple dynamical approach.

4.1. Strong Force

Equation (11) macroscopically describes the product of mass-energy linear distributions between two adjacent objects. However, Equation (14) or Equation (15) microscopically illustrates the unlike-charge's potential energy between two adjacent parts of particle, which can be made by human beings or by natural perpendicular forces. Naturally, due to the relative motion between different particle parts of rain or ice-crystal drops, a cloud can produce or separate positive charge (q_A^+) from negative charge (q_B^-). As a result, lightning can happen between them of positive and negative charges. Friction electrification has been identified and used by the ancients to make fire. The separated unlike charges by natural perpendicular forces or human beings must have relative motion from some kinds of matter (material or medium).

Strong force happens between subatomic particles of matter and binds quarks together in clusters to make more-familiar subatomic particles, such as protons and neutrons. This is a micro interaction located inside a nucleus through relative motion between protons and neutrons. For all glowing stars such as the Sun, the relative motion with high speed happens between different inner spheres, so that the light produced by the relative motion with perpendicular interactions has a speed limit of photon escaping the mass inertia of a star [30]. The relative motion also happens from the inner core and the asthenosphere of the Earth, so the geomagnetic field can be measured. The Moon's magnetic field cannot be measured because no relative motion happens now between its inner spheres.

Human can make a device by using some kinds of matter to produce relative motion of micro particles. Equation (5) can be written as the strong interactions between protons and neutrons as

$$\boldsymbol{\tau}_S^{p,n} = \left(\frac{m_p}{r} v_p^2 \boldsymbol{n}_p + m_p a_p \boldsymbol{k}_p \right) \times \left(\frac{m_n}{r} v_n^2 \boldsymbol{n}_n + m_n a_n \boldsymbol{k}_n \right). \tag{17}$$

Equation (17) includes four terms of interactions and can also be expanded like as Equation (6). But only the perpendicular interactions are listed below.

$$\tau_{S(b)}^{p,n} = \left(\frac{m_p v_p^2}{r} \right) \cdot \left(\frac{\mathrm{d}P_n}{\mathrm{d}t} \right), \tag{18}$$

$$\tau_{S(c)}^{p,n} = \left(\frac{m_n v_n^2}{r} \right) \cdot \left(\frac{\mathrm{d}P_p}{\mathrm{d}t} \right), \tag{19}$$

$$\tau_{S(d)}^{p,n} = \frac{\mathrm{d}P_p}{\mathrm{d}t} \cdot \frac{\mathrm{d}P_n}{\mathrm{d}t}. \tag{20}$$

The above three equations indicate the mass-energy linear distribution between two adjacent particles and particle momentum change with space and time. These interactions can happen in subatomic particles, such as protons and neutrons.

From Equation (17) and Equation (6), its first term under the perpendicular interactions can be written as

$$\tau_{S(a)}^{p,n} = 4\left[\left(\frac{m_p v_p^2}{2r}\right)\cdot\left(\frac{m_n v_n^2}{2r}\right)\right] = \left(v_p \cdot v_n\right)^2 \frac{\left(m_p \cdot m_n\right)}{r^2}. \tag{21}$$

It indicates that the potential nuclear energy is produced from subatomic particles such as protons and neutrons. The dynamical expression of Equation (21) is similar as the dynamical Equation (11) and the dynamical Equation (14).

4.2. Weak Force

The weak force is referred as another fundamental force that governs weak interactions between hadrons and leptons and responsible for particle decay processes. Human can also make a device by using some kinds of matter to produce relative motion of micro particles. Equation (5) can also be written as the weak interactions between particles of hadrons and leptons as

$$\boldsymbol{\tau}_W^{h,l} = \left(\frac{m_h}{r} v_h^2 \boldsymbol{n}_h + m_h a_h \boldsymbol{k}_h\right) \times \left(\frac{m_l}{r} v_l^2 \boldsymbol{n}_l + m_l a_l \boldsymbol{k}_l\right). \tag{22}$$

Equation (22) can be expanded into four terms like Equation (6), which only the perpendicular interactions are listed below.

$$\tau_{W(b)}^{h,l} = \left(\frac{m_h v_h^2}{r}\right)\cdot\left(\frac{\mathrm{d}P_l}{\mathrm{d}t}\right), \tag{23}$$

$$\tau_{W(c)}^{h,l} = \left(\frac{m_l v_l^2}{r}\right)\cdot\left(\frac{\mathrm{d}P_h}{\mathrm{d}t}\right), \tag{24}$$

$$\tau_{W(d)}^{h,l} = \frac{\mathrm{d}P_h}{\mathrm{d}t}\cdot\frac{\mathrm{d}P_l}{\mathrm{d}t}. \tag{25}$$

Equation (23) and Equation (24) express the mass-energy linear distribution between two adjacent decay particles and particle momentum change with space and time. Equation (25) indicates the momentum changes of two decay particles with space and time.

From Equation (22) and Equation (6), its first term under the perpendicular interactions can be written as

$$\tau_{W(a)}^{h,l} = 4\left[\left(\frac{m_h v_h^2}{2r}\right)\cdot\left(\frac{m_l v_l^2}{2r}\right)\right] = \left(v_h \cdot v_l\right)^2 \frac{\left(m_h \cdot m_l\right)}{r^2}. \tag{26}$$

It also indicates that the potential nuclear energy is produced only by decay particles from hadrons and leptons. The dynamical expression of Equation (26) is similar as the dynamical Equation (11), the dynamical Equation (14), and the dynamical Equation (21). All the four expressions of Equation (11), Equation

(14), Equation (21) and Equation (26) are from the simplification of Equation (5). Thus, the four potential particle energies are only simplified from a stress equation under the perpendicular interactions but not directly associated with the four fundamental forces.

5. Conclusions and Discussion

The unification of the four fundamental forces including two long-range forces of gravity and electricity as well as two short-range strong and weak forces has long been a goal of the mainstream study of theoretical physics. However, this study developed a dynamical approach and identified that they are not real forces but associated with potential particle energies which are produced by external perpendicular forces initially acted on materials. The dynamical approach used two forces acting on an object or same medium to separate two particle parts and then explore the stress of two external forces. Conversely, two external forces could act on two adjacent objects to combine them together. Changes in their mass-energy distribution and mass-energy tendency can be explored from this approach. Physically, the potential energy produced by two external forces is a product of mass-energy linear distributions between two adjacent particles. Mathematically, the maximum potential particle energy reaches at the moment when two external forces acting on particles are perpendicular to each other.

Regionally, gravity is associated with the product of mass-energy linear distribution between two adjacent objects or a local interaction of two adjacent objects to overcome their inherent mass inertias [30]. But gravity had been statistically formulated by Newton's law. Globally, gravity presents the space-time curvature characteristics nested by multi-level rotating structures as described by Einstein's equation [12]. As an example, a process described that an apple storing the potential and biological energies naturally grows and hangs up a tree. It has been given a description following three sentences in three seasons [30]. Under the sunlight acting, molecules of water and nutrient rise from the root along the trunk and branches to blossoms during spring. The apple grows up under the photosynthesis in summer months. And the ripening apple in autumn falls naturally with the inertial acceleration from the branches to the ground at the moment due to the inherent inertia of all molecules of the apple. Similarly, potential particle energy between the Sun and the Earth or between the Earth and the Moon has formed since their evolution started.

Electricity is a product of mass-energy linear distributions between two adjacent unlike-charges produced by external forces. But it was statistically formulated by Coulomb's law. Two external forces can act on a medium to separate it into two particle parts with opposite charges. Thus, potential electric energy has stored in two particle parts with unlike charges. External forces can produce relative motion which is a fundamental cause for generating potential electric energy. The phenomenon of electrification by friction can be found in daily life. Mathematically, relative motion acted by perpendicular forces can generate potential electric energy with the maximum efficiency by using many natural materials.

Potential nuclear energy can be produced by the relative motion of subatomic particles, such as protons and neutrons as well as hadrons and leptons. Potential nuclear energy generated by the relative motion of protons and neutrons can be seen as the action of strong forces, while potential nuclear energy generated by the relative motion of hadrons and leptons can be seen as the action of weak forces. The difference is only from particle decay processes for the latter. These particles that can be used to generate potential nuclear energy are some nuclear raw materials which cannot be naturally produced like as electrification by friction using ordinary materials. But their basic principles for generating potential particle energy are similar. For example, generated potential nuclear energy needs relative motion of nuclear raw materials or different particles under a nuclear device. After the initial action of external perpendicular forces, large amounts of energy can be released and then concomitantly released through reacting to generate different subatomic particles and changing in mass or momentum of different subatomic particles.

Two external perpendicular forces can initially lead particles to produce relative motion. This relative motion can form potential particle energy including potential object energy, potential electromagnetic energy, and potential nuclear energy. The physical nature of all potential particle energies is the product of mass-energy linear distributions between two particles with or without unlike charges only depending on the macroscopic and microscopic properties of particle. The unified all potential particle energies with and without charges can be mathematically written as

$$\tau_X^{+\alpha,-\beta} = \left(q_\alpha^+ \cdot q_\beta^-\right) \cdot \left(v_\alpha \cdot v_\beta\right)^2 \frac{\left(m_\alpha \cdot m_\beta\right)}{r^2}. \quad (27)$$

Where, letters α and β denote two objects (or particles). Equation (27) can be seen as a standard model summarized from Equation (11), Equation (14), Equation (21), and Equation (26). In Equation (27), the unified potential particle energy shows the maximum value because external forces are taken as perpendicular to each other at that space-time point. Four kinds of potential mass-energy space-time distribution have a same common mathematical form under the Equivalence Principle but have different mass-energy properties. However, Equation (5) and Equation (6) show the complex form with different interactions in various directions. Frequency of perpendicular interactions to each other is very low. This feature should be considered in the device for making nuclear reactions and large electron-positron colliders to obtain the maximum energy.

This unification shows that all particles including protons, neutrons, hadrons, leptons and photons produced by stars have very light masses. Physically, if a particle has the faster speed, it must have the lighter mass acted by the stronger force to escape its star. In Newton's law, the gravity is not a force between two adjacent objects but associated with the potential object energy stored since the formation of the objects. In Coulomb's law, the magnitude and sign of the electric force are directly associated with electric charges, rather than material masses. Coulomb's law explained that attraction exists between two unlike charges and repulsion exists between two like charges. If there is repulsion between two like charges, there should have been the lightning between two clouds with like positive charges or like negative charges. However, this type of lightning has never been observed. Today's widely used energy is unlike-charged electric energy without other two types of like-charged electric energy.

Acknowledgements

The author wishes to thank Dr. Du J. for improving this paper's expression and the anonymous reviewers for their constructive suggestions which have improved the paper. This work was supported by the innovative R&D project in Guangdong Province in China (2019ZT08G669) and the National Natural Science Foundation of China (Grant Number: 41775067).

Conflicts of Interest

The author declares no conflicts of interest regarding the publication of this paper.

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