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Origins and Unifying of Four Fundament Forces of Nature

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Abstract Four fundamental forces of nature are too important to say because they dominate the formation and evolution of the universe. However, until now, their origins and physical essences have not been answered with wide acceptations. This paper gives new explanations for the origins and essences of these four forces based on different understandings, which can easily explain that all of the four fundamental forces of nature are originated from the electric force only and so can be unified to be one force. First of all, the gravitational force is a synthesized electric force produced by a huge number of electric charges via particular movements and distributions. Depending on inference of nuclear structure, which has strong supports by observed phenomena, the strong and weak forces are deduced to be electric forces too. The introduced new understandings can explain observed confusing phenomena simply and effectively, such as "galaxy shape", "dark matter", "dark energy", "gamma-ray bursts" in nuclear fission or fusion and from black holes, and so on. The author wrote this paper is for helping to find the natural truth earlier.

Keywords: gravitational force; strong force; weak force; origins of the four fundament forces

1. Introduction

According to current standard theory, there are four fundamental forces in the universe. In order of increasing strength, they are gravitational interaction force, weak interaction force, electromagnetic interaction force and strong interaction force. The intrinsic qualities of these four forces are different. They have different origins, different interaction strengths and different effective distances. These four forces are fundamentally important because they dominate the formation and evolution of the universe.

However, what are origins and physical essences of these four forces? Where do they come from? How do they work? Until now, these questions still have not been answered with wide acceptations. For a long time, many attempts have been made for trying to explain these questions. However, although various inferences and hypotheses have been proposed, some observed phenomena still have not been explained satisfactorily. At present, the standard answer to these questions is simply that these four fundamental forces are special forces. They are different from each other. This answer can't give real essential nature of these four forces, but it is written in the school textbooks in the world.

For helping to find the nature truth earlier, new understandings about these four fundamental forces are introduced here.

Now, the author has realized that all of these four fundamental forces are just originated from the electric force. But, some of them are originated from the electric force simply, and some of them are originated from the electric force complexly.

The magnetic force is originated from the electric force simply. But, for example, the gravitational force is originated from the electric force complexly. The gravitational force is a synthesized electric force produced by a huge number of electric charges via charge particular movements and distributions.

The author has also deduced that the strong interaction force is originated from the electric force too. This deduction is based on the suppositions of the exceptional neutron and proton structures, that is, the exceptional nuclear structure. With such structures, multiple protons and neutrons can be

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kept together only by the electric force. Thus, the special strong interaction force is not needed for explain that the multiple protons can be kept in the nucleus.

In the similar way, the special weak interaction force is also not needed to explain the radioactive decay rays emitted from the atoms with high atomic numbers. With increase of the protons and neutrons in the nucleus, more collisions, which are performed all by the electric force, will happen in the atoms. Thus, some photons, electrons and small groups of bound protons with neutrons go out from the atoms to form gamma, beta and alpha decay rays.

The supposed proton and neutron structures are strongly supported by observed phenomena including gamma-ray bursts in nuclear fission and fusion reactions, photon appearing after electron-positron annihilation, photon splitting into electron and positron in high-energy collision, and even the gamma-ray bursts from black holes.

Thus, the four fundamental interaction forces of nature have a same origin and can be unified to be only one force, that is, the electric force.

Although these new understandings are now just inferences and have no experimental evidences, a few inferences have been confirmed indirectly by astronomical and experimental observations.

2. Gravitational Interaction Force

First of all, what is the gravitational force? This question is particularly difficult to answer because of strange and mysterious behaviors of the gravitational force. Many people including famous scientists have made great efforts to find the answer, but without satisfied result.

The gravitational force is too important to say, it is the foundation of all things in the universe. Without the gravitational force, there are no earth and universe. From microscopic particles to macroscopic galaxies, all things are moving, gathering, bursting and so evolving under the gravitational force.

According to new understanding, the gravitational force is the synthesized electric force produced by a huge number of electric charges via charge particular movements and distributions. In fact, the origin of the gravitational force is not very complicated. However, the insight is needed to find the truth through confusing appearances.

2.1. Observation of Gravitational Force

In the textbook of physics, there is a description of the early discovery of the electric charge and the attractive and repulsive forces between two charges [1]. As early as 600 BC, the ancient Greeks discovered that if amber was rubbed, the amber would attract other light objects, such as the wool. Today we know that the amber has acquired a net electric charge, or has become “charged”. And then the net charge on the amber would attract the wool. When we comb dry hair with comb, rub plastic rod with fur, and rub glass rod with silk, you can find that the rubbed comb, rubbed plastic rod and rubbed glass rod all have become “charged”, and then they can attract other light objects.

To do the experiments of rubbing plastic rod with fur and rubbing glass rod with silk, we can see that the plastic rod can be attracted by the glass rod. But, the two plastic rods rubbed with fur, or the two glass rods rubbed with silk are repelled to each other. Today we know that there are two kinds of electric charges. They are negative and positive, respectively, and are produced by rubbing the plastic rod with the fur and rubbing the glass rod with the silk. After rubbing, the rubbed fur and rubbed silk have also become “charged”. When signs of two net charges on rods are same, two rods repel each other. When signs of two net charges on rods are opposite, two rods attract each other. Today we know that the signs of the net charges on the rubbed plastic rod and silk are negative. The signs of the net charges on the rubbed glass rod and fur are positive.

When you see the wool is attracted by the “charged” amber, you need to think more: wool is not rubbed with any material, thus the wool has not acquired any net charge, that is, has neither negative charge nor positive charge. An “uncharged” object should be electrical neutral, and so should not be attracted or repelled by another “charged” object, no matter that “charged” object has negative or positive charges. Thus, why does the “charged” amber attract the “uncharged” wool?

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Here, the generation and influence of the induced electric charge are referred. In an object, there are free electric charges. These free charges can move easily from one region to another region in the object. If an external electric field exerts force on an object, the free charges in the object will move, and thereby changing the distribution of the total charges in the object. The change of the distribution of the total charges will change the distributions of the electric fields in and out the object, because the electric field generated by the electric charges in the object can extend force out of the object. Thus, the regional distribution of the electric charges in the object and the spatial distribution of the electric field out the object will affect each other and the last equilibrium of the charge and field distributions will be determined by both of the electric charges and electric field.

The free electric charges in an object emerge from some atoms having less attractions to their electrons, thus these electrons may escape easier from the atoms. In addition, there are polar molecules in many objects. These molecules have equal amounts of positive and negative charges but a lopsided distribution. In these molecules, excess positive and negative charges are concentrated on two different sides. Such an arrangement makes an electric dipole and such a molecular is called a polar molecular. The dipole moment direction of the polar molecule may change with the external electric field. In the object, there are also un-polar molecules. Under the external electric field, the positive and negative charge centers of these un-polar molecules may change from concentric status to un-concentric status, and thus these un-polar molecules become induced polar molecules. In addition, the electrical neutral atoms in the object will also produce atomic polarization under the external electric field, that is, the positive and negative charge centers of the atoms are changed from the concentric status to the un-concentric status too.

The moving of the free charges, the dipole moment direction changes of the polar molecules, and emergences of induced polar molecules and atoms will form the induced electric charges in the object. These induced charges will change the regional distribution of the electric charges in the object and the spatial distributions of the electric fields inside and outside the object.

The amount of the induced electric charges depends on the number of molecules and atoms in the object, thus general speaking, the more the number of the molecules and atoms in an object, that is, the more the mass of the object, the more the induced electric charges.

Under the external electric field, the distribution change of the electric charges including free and induced electric charges in the object is the key reason that the “charged” amber can attract the “uncharged” wool. Because no matter an object is electrical neutral, or has been “charged” to have net positive or net negative charges, as long as under the external electric field, the electric charge distribution in this object will be changed.

Suppose that the “charged” amber is close to the “uncharged” wool. If the amber has net positive charges, it will exert a positive electric field on the wool, and the free negative charges in the wool will be attracted to the amber side and will stay close to the amber. Since the amounts of the positive and negative charges in the electrical neutral wool are equal because of conservation of the electric charge, the amount of the net negative charges increased in the region close to the amber would be equal to the amount of the net positive charges increased in the region far from the amber. Because the net negative charges are closer to the amber than the net positive charges, the amber attractive force to the net negative charges is slightly greater than the amber repulsive force to the net positive charges. Thus, the net force of the amber exerting on the wool is attractive. This net force is much smaller than the real attractive force or repulsive force of the amber on the wool, but it is enough to pick up light object such as the wool.

At the same time, the polar molecules and the induced polar molecules and atoms in the wool will produce two kinds of induced net charges too. Under positive electric field of the amber, the center of all induced net negative charges will be close to the amber, and the center of all induced net positive charges will be far from the amber. The location difference between two charge centers will make amber attractive force slightly larger than amber repulsive force to the wool too, which will help to pick up the wool.

The produced attractive force between the amber and wool is synthetically electric interaction force produced by a huge number of the electric charges in both of the amber and wool. Though the

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wool is small, it is enough to contain a huge number of molecules and atoms, and so a huge number of electric charges.

If the amber is replaced by a negatively "charged" plastic rod, the plastic rod can pick up the "uncharged" wool too. In this case, the plastic rod will exert a negative electric field on the wool. The negative field will attract net free positive charges close to the rod, and will push net free negative charges far from the rod. Because the amounts of two kinds of the net free charges in their stay regions in wool are equal, but the region distances from the rod are different, the net force of the plastic rod to the wool will be a small attraction force, which is enough to pick up the light wool. The two kinds of the induced net electric charges in the wool will produce a similar small attractive force between the plastic rod and the wool, which will help to pick up the wool too. Thus, whether an object has net positive charges or net negative charges, the "uncharged" wool will always be attracted by the "charged" object.

Author answered why a small "uncharged" paper piece can be attracted by a "charged" object in the electromagnetism examination in the university with such a detailed explanation when young, but did not think further at that time, and so was unaware that understanding such a phenomenon had approached realizing the origin of the gravitational force.

2.2. Origin of Gravitational Force

Now, the author has realized that the attractive force of the "charged" object exerting on the "uncharged" object is not only the electric force, but also the gravitational force too. Of course, to affirm this recognition, some additional mystifications must be overcome.

From the understanding that a "charged" object can attract an "uncharged" object to the realizing that the gravitational force can originate spontaneously between two "uncharged" objects, the key step is to realize that the non-uniform distribution of the electric charges, and so the regions with net positive and net negative electric charges can emerge spontaneously in an "uncharged" object, that is, in an initially electrical neutral object.

In an object which is electrical neutral, due to various reasons, an initial variation of the electric charge distribution will break the uniform charge distribution, and causes appearance of net positive or negative electric charge(s) at a site in that object. There are many possible reasons to cause such an initial variation, such as different movements of the free electric charges, different thermal vibrations of the polar molecules and un-polar molecules and atoms, different densities of the polar molecules and un-polar molecules and atoms, different physical and chemical characteristics of the different regions in the object, which include material compositions, forms, states, temperatures, pressures, electric and thermal conductivities and so on. Because the reasons causing an initial variation are too much, the existence of the net electric charge(s) at a site and at a moment in an object is normal.

When two objects approach each other, if the first object has a region having net electric charge(s), its net charge(s) will produce a net electric field and will exert on the second object. Such an external electric field, even it is weak, will make the electric charge distribution in the second object change from initially possible uniform to non-uniform, and even it is small. The non-uniform distribution of the electric charges in the second object will produce new electric field and will exert back on the first object. Then, the changed electric field with increased strength in the first object will affect the second object again. In this way, the non-uniform distributions of the electric charges in two objects will become larger and larger, which will make more and more net electric charges appear in some regions in two objects, and so the produced electric fields in and out two objects will become stronger and stronger.

Thus, the produced electric interaction forces between two objects can start from nothing, and can increase from weak to strong.

However, there are limitations for the increases. Because the net negative charges located in one or some region(s) will be attracted by the net positive charges located in another or some other region(s) in both objects. With continuously moving of the free charges in two objects, the amounts of the net positive and net negative charges all increase in different regions, which will produce stronger attractive forces to both of the net positive and net negative charges. It will reduce the

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moving of the free charges gradually in two objects. There are similar limitations for two kinds of the induced net electric charges from polar molecules, un-polar molecules and un-polar atoms in two objects. Therefore, all of these increases will eventually go to equilibriums of the net electric charge distribution and electric field distribution in and between two objects. Thus, the increase of the electrical attractive force between two objects will stop with a last balanced value, which is determined by the specific situation depending upon the two objects.

Such produced electrical force can make two objects attract each other even the two objects are initially electrical neutral. These two objects which are initially electrical neutral may be any object in the universe. These objects can have different shapes, states, compositions, densities, pressures, temperatures, electric and thermal conductivities, and so on. These objects can be as small as atoms and molecules, and as large as galaxies and galaxy clusters. Such electrical attractive force is just the gravitational force exactly, which is the origin of the gravitational force.

It may be hard to understand that the net electric field and so the net electric force can be produced from nothing at the start and increased from weak to strong between two initially electrical neutral objects. However, if the net electric field can be produced in the initially electrical neutral wool by an external electric field, why can't the net electric field be produced in other initially electrical neutral object by an external electric field even the external electric field is weak at the start? Furthermore, why can't a weak electric field be produced by net electric charge(s) caused by an inevitable variation of the electric charge distribution in an initially electrical neutral object?

In fact, it is very easy and common that a little net electric charge(s), and so a weak net electric field can appear spontaneously in an initially electrical neutral object. Please pay special attention here, just this mystification has prevented people from realizing the origin of the gravitational force for a long time.

For example, the earth is a typical object with non-uniform distributions of the electric charges and fields, and these non-uniform distributions should be generated spontaneously. In the earth interior, there are various compositions with different physical and chemical characteristics, such as different shapes, sizes, states, densities, temperatures, pressures, fluidities, electric or thermal conductivities and so on. These differences inevitably cause non-uniform distributions of the electric charges and fields. Furthermore, these non-uniform distributions change continuously. The earth magnetic field is just caused by continuous flowing of a huge number of the electric charges. The measurements have also shown that the earth has complicated non-uniform electric field distribution on the ground, which can be used as the map for ground navigation. This map maybe is more reliable than the GPS system as it can't be destroyed.

Please note that the things happened on the earth may happen on the other celestial bodies too. In addition, the things happened on the object with large size, such as the earth, may happen on the other object with small size, such as the wool too. For the free electrons, polar molecules, un-polar molecules and atoms, the objects with small sizes, such as the wool, are large enough.

The electric interactional force between two initially electrical neutral objects can be generated spontaneously from nothing, from weak to strong, and reach the balanced value lastly. These changes can't be seen visibly because that the movements of the free electric charges and the polarizations of the polar molecules, un-polar molecules and atoms are the movements of the electrons and the shifts of the electric charge centers. In addition, these movements and shifts have very fast speeds which maybe are close to the light speed. Therefore, because these processes can start from nothing, grow and finish instantly and can't be seen visibly, which are the reasons why the gravitational force is strange and mysterious.

In the interactions participated by a huge number of positive and negative electric charges, the most electrical attractive forces are cancelled by the electrical repulsive forces as the electric charges have opposite signs. Thus, the net electrical interaction force is weak, and so though the gravitational force is the electric force, the gravitational force strength is much smaller than the electric force. It is the reason that the strength of the gravitational force is about 37 orders of magnitude smaller than the electric force, but both have the same extremely long interaction distances. It is another confusing difficulty for many people to understand the gravitational force.

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As described above, the more the number of the atoms or the molecules in the object, the more the free and induced electric charges in the object, the stronger the generated net electric field. The stronger net electric field will produce larger gravitational force. It is the reason why the object having more mass can produce larger gravitational force.

At present, what is the mass? It has not been explained clearly too. In physics, the mass concept has two meanings: one is gravitational mass and another is inertial mass. Based on the new understanding about the gravitational force, the object gravitational mass expresses the net attractive force strength exerting on the object by synthesized electric field of total earth electric charges when the object is motionless relative to the earth. The object inertial mass expresses the net attractive force strength exerting on the object by synthesized electric field of total electric charges distributing in a space in which the object is moving. The new understanding about the mass can explain the real physical nature of the Einstein mass-energy conservation law:

$$E = mC^2. \tag{1}$$

Because the gravitational mass and the inertial mass all are the expressions of the interaction force strengths, the energy change caused by interaction force and motion will naturally bring so-called mass to change.

In fact, the electromagnetic theory, and especially the modern electromagnetic theory developed in more than two hundred years since Coulomb has strongly hinted that the gravitational force is the electric force. Compare the famous Newton's law of the gravitational force F_G:

$$F_G = G\frac{m_1 m_2}{R^2}, \tag{2}$$

and the famous Coulomb law of the electric force F_E:

$$F_E = K\frac{q_1 q_2}{R^2}. \tag{3}$$

We can see that their expressions are very similar. Eq. (2) expresses the attractive gravitational force generated by two point-like objects with masses of m_1 and m_2. Eq. (3) expresses the attractive electric force generated by two point electric charges of q_1 and q_2. *G* and *K* are proportionality constants whose numerical values depend on the system of the used units. *R* is the distance between two mass centers or two charge centers. If two masses in Eq. (2) are replaced by two charges in Eq. (3) without considering the difference of the dimensions of two constants *G* and *K*, then Eq. (2) becomes Eq. (3). Because m_1 and m_2 are mass, and q_1 and q_2 are electric charges, the dimensions of the constants *G* and *K* are different naturally. Considering that the gravitational force is generated by a huge number of electric charges, and that the most of the electric forces produced by the electric charges with opposite signs have been cancelled, the values of the constants *G* and *K* have large difference naturally.

Another hint indicating that the gravitational force is the electric force is that the so-called gravitational wave propagation speed equals to the light speed. It is known that the light speed is the speed of the electromagnetic wave propagation. Therefore, since the gravitational force is the electric force, the gravitational wave propagation speed is equal to the light speed naturally.

If the natures of two physical forces are different, the expressions of these two forces will be significantly different as they have different characteristics. However, except the gravitational force and electric force, where to find two different physical forces have such similar theoretical expressions?

2.3. Calculation of Gravitational Force

As described above, the gravitational force is generated by non-uniform distribution of the electric charges in an object. The non-uniform distribution of the charges in an object may be very complicated, which will make the analysis and calculation of the produced electric fields become difficult. In order to simplify the analysis and calculation, the concept of “mass center” used in mechanics calculations is simulated.

Every object is composed of a lot of small regions and each region is exerted by a gravitational force. If all of the gravitational forces exerted on all small regions are synthesized to become a synthetic gravitational force, then the point of the synthetic gravitational force exerted at is the “mass

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center" of that object. The concepts of two net "charge centers" may be defined in the similar way. They are used to describe the distribution of the net electric charges in an object.

In an object, regardless of the complexity of the distributions of the net positive and net negative charges, all electric forces generated by all net positive charges can be synthesized to become a synthetic net positive electric force, the point that the synthetic net positive electric force is based on for exerting the force on other object is the net positive "charge center" of that object. In the same way, the net negative "charge center" of that object is defined.

Under such simplification, any object with non-uniform charge distributions can be regarded as having a net "positive charge center" and a net "negative charge center". All net positive charges in the object are regarded as concentrated in its "positive charge center", and all net negative charges in the object are regarded as concentrated in its "negative charge center". Thus, any object with non-uniform charge distribution can be regarded as an electric dipole.

The theoretical electric dipole is a pair of two point electric charges with equal magnitude and opposite signs (a positive charge q and a negative charge $-q$). A small distance $\boldsymbol{l}$ is between two point charges. The electric dipole moment $\vec{\boldsymbol{p}}$ is the product of the distance $\boldsymbol{l}$ and the charge q.

$$\vec{\boldsymbol{p}} = q\vec{\boldsymbol{l}}. \tag{4}$$

where $\vec{\boldsymbol{P}}$ and $\vec{\boldsymbol{l}}$ are vectors. The direction of the electric dipole moment $\vec{\boldsymbol{P}}$ is from the negative point charge to the positive point charge.

When the object with non-uniform charge distribution is regarded as an electric dipole, q is absolute value of the total net positive charges or the total net negative charges in the object. In addition, in the object, the distance between the net "positive charge center" and the net "negative charge center" may not be small. However, if the size of the object is much smaller than the scale related to the considered problem, such as considering the attraction between a planet and a star in the universe, the size and shape of the object are less important. Thus, the distance between the net positive and net negative "charge centers" in an object may be treated as small, so the object with non-uniform charge distribution may be regarded as an electric dipole reasonably.

The electrical field strength $\vec{\boldsymbol{E}}$ of the electric dipole at the distance of R is [2]

$$\vec{\boldsymbol{E}} = \frac{1}{4\pi\epsilon_0 R^3}[3(\vec{\boldsymbol{P}}\cdot\vec{\boldsymbol{R}})\vec{\boldsymbol{R}} - \vec{\boldsymbol{P}}]. \tag{5}$$

In Eq. (5), $\vec{\boldsymbol{R}}$ is unit distance vector along R direction. From Eq. (5), we know that when the direction of the vector $\vec{\boldsymbol{R}}$ changes, the electric field strength $\vec{\boldsymbol{E}}$ changes too. When the direction of $\vec{\boldsymbol{P}}$ is the same as or opposite to the direction of $\vec{\boldsymbol{R}}$, the electric field strength $\vec{\boldsymbol{E}}$ becomes E_S or E_O,

$$E_S = \frac{2P}{4\pi\varepsilon_0 R^3} \tag{6}$$

$$E_O = \frac{-2P}{4\pi\varepsilon_0 R^3} \tag{7}$$

The E_S in Eq. (6) is positive, which expresses a repulsive force away from the dipole to a positive point charge. The E_O in Eq. (7) is negative, which expresses an attractive force towards the dipole to a positive point charge. And when the direction of the dipole moment is perpendicular to the direction of $\vec{\boldsymbol{R}}$, the electric field strength $\vec{\boldsymbol{E}}$ becomes E_P.

$$E_P = \frac{-P}{4\pi\varepsilon_0 R^3}, \tag{8}$$

the E_P in Eq. (8) is negative. Please note that E_P is a deflective force, because the direction of E_P is perpendicular to the R direction.

Then a puzzle appears. If the electric field strength of the object with non-uniform electric charge distribution is not isotropic, why haven't we seen that the gravitational force changes with the relative direction between two attractive objects obviously? For example, many planet orbits around stars are circles in the universe.

The reason is that although the electric field of the electric dipole may exert repulsive, or attractive, or deflective force on another electric dipole, but in the most cases, the repulsive and deflective forces will change to the attractive force lastly. Because when the interaction force between two electric dipoles is repulsive force, both electric dipoles will stay in the states with highest electric potential energies. Such states are unstable. Any change of the electric charge distribution in one of

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two objects will produce a deflective force between these two electric diploes. That deflective force will rotate these two electric dipoles.

Supposing there are two objects, that is, two electric dipoles. The first electric dipole moment is $\vec{P}_1$, and the second electric dipole moment is $\vec{P}_2$. Two electric dipoles will produce a rotating torque $\vec{\tau}$ to each other [3]

$$\vec{\tau} = \frac{-1}{4\pi\varepsilon_0 R^3}[3(\vec{P}_1 \cdot \vec{R})(\vec{P}_2 \cdot \vec{R}) - \vec{P}_1 \cdot \vec{P}_2]. \quad (9)$$

In Eq. (9), R is connecting distance between two electric dipole centers, and $\vec{R}$ is unit distance vector of R. Because of the rotating torque, two electric dipoles rotate until the two dipole moments have the same directions. When two electric dipoles have the same directions, the rotating torque $\vec{\tau}$ has its minimum value τ_{MIN}

$$\tau_{MIN} = \frac{-2P_1P_2}{4\pi\varepsilon_0 R^3}. \quad (10)$$

Please note that, τ_{MIN} becomes a pure attractive force between two electric dipoles.

Of course, in some cases, the gravitational force between two attractive objects still changes with their relative direction, which is the reason that some planet orbits around the stars are elliptic.

Below, the interaction forces between two electric dipoles are calculated further. First, supposing the directions of two electric dipole moments are the same. In Figure 1, the first electric dipole moment $\vec{P}_1$ consists of positive pinot charge q_{1+} and negative point charge q_{1-}. The second electric dipole moment $\vec{P}_2$ consists of positive pinot charge q_{2+} and negative point charge q_{2-}. The distance between the positive and negative point charges of the first dipole moment $\vec{P}_1$ is r_1. The distance between the positive and negative point charges of the second dipole moment $\vec{P}_2$ is r_2. The distance between the centers of two electric dipoles is R.

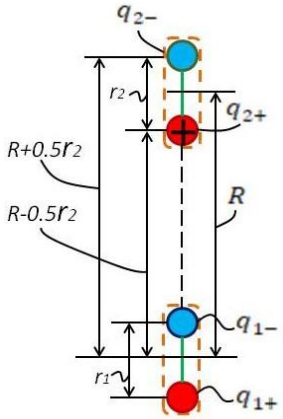

Figure 1. Interaction forces between two electric dipoles when dipole moment directions are same.

From Eq. (5), the first electric dipole will produce the electrical field $\vec{E}_1$ at the distance R from its center

$$\vec{E}_1 = \frac{1}{4\pi\varepsilon_0 R^3}[3(\vec{P}_1 \cdot \vec{R})\vec{R} - \vec{P}_1], \quad (11)$$

In Eq. (11), $\vec{R}$ is unit distance vector along R direction. In the electrical field $\vec{E}_1$, the positive point charge q_{2+} of the second electric dipole will feel a force $\vec{F}_{q2+}$ as

$$\vec{F}_{q2+} = q_{2+}\vec{E}_1 = \frac{2q_{2+}\vec{P}_1}{4\pi\varepsilon_0(R-0.5r_2)^3}, \quad (12)$$

the direction of force $\vec{F}_{q2+}$ is along the direction of $\vec{R}$. The negative point charge q_{2-} of the second electric dipole will feel a force $\vec{F}_{q2-}$ as

$$\vec{F}_{q2-} = q_{2-}\vec{E}_1 = \frac{2q_{2-}\vec{P}_1}{4\pi\varepsilon_0(R+0.5r_2)^3}. \quad (13)$$

The direction of force $\vec{F}_{q2-}$ is also along the direction of $\vec{R}$. Because the absolute values of q_{1+} and q_{1-} are equal, and the absolute values of q_{2+} and q_{2-} are also equal, when $R \gg r_1$ and $R \gg r_2$, the approximately total force felt by the second electric dipole in the electric field $\vec{E}_1$ is $\vec{F}_T$

$$\vec{F}_T = \vec{F}_{q2+} + \vec{F}_{q2-} \doteq \frac{6r_1r_2}{R^2}\frac{1}{4\pi\varepsilon_0}\frac{q_1q_2}{R^2}\vec{R}, \quad (14)$$

where $\vec{R}$ is unit distance vector along R direction.

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In Eq. (14), if $\frac{6r_1r_2q_1}{R^2}$ is replaced by m_1, $\frac{6r_1r_2q_2}{R^2}$ is replaced by m_2, and $\frac{1}{4\pi\varepsilon_0}$ is replaced by gravitational constant G, then Eq. (14) becomes Newton's gravitational law

$$\vec{\boldsymbol{F}}_{\boldsymbol{G}} = G\frac{m_1m_2}{R^2}\vec{\boldsymbol{R}}. \tag{15}$$

We can see that the physical essence of the mysterious mass is just the electric charges. In other words, the mass is another expression of the amount of the electric charges.

Eq. (14) expresses the interaction force between two electric dipoles when two dipoles have the same directions. This interaction electric force is just the gravitational force between two objects for the most common situations. According to Eq. (14), the gravitational force has the following properties:

First, since the gravitational force is produced by electric charges q_1 and q_2, the gravitational field is the electric field.

Second, the gravitational force strength depends upon the force direction, that is, the gravitational force is anisotropic.

Third, if replacing $\frac{6r_1r_2q_1}{R^2}$ by m_1 and replacing $\frac{6r_1r_2q_2}{R^2}$ by m_2, because in the most cases, $R \gg r_1$ and $R \gg r_2$, the magnitudes of m_1 and m_2 are much smaller than the magnitudes of q_1 and q_2. It is the reason that although the gravitational force is electric force, the strength of the gravitational force is much smaller than the strength of the electric force.

Fourth, the values of r_1 and r_2 in Eq. (14) are not fixed because they depend upon the electric charge distributions in two objects. Since the variations of the charge distributions in two objects can change the values of r_1 and r_2, the gravitational force between two objects is not fixed even their net electric charges q_1 and q_2 don't change, that is, even their masses don't change.

These properties make the gravitational force have strange and mysterious behaviors.

Eq. (14) also hints us to consider an important problem. Newton's law expresses the change rate of the gravitational force expanded with the distance from the point mass center. Because the gravitational force is expanded from a point mass center towards all directions in the three-dimensional space, according to energy conservation law, the total force distributing on every spatial sphere with different radiuses from the mass center should be equal. Since the area of every spatial sphere is proportional to the cube of its radius, thus, the strength change of the gravitational force in any direction should be inversely proportional to the cube of the distance R from the mass center. Such cognition can consistent with the physical intuition. However, now that the gravitational force is the force expanding in the three-dimensional space from a point mass center, how can Newton's law have a two-dimensional expansion rate of $\frac{1}{R^2}$?

Newton's law has been verified countless times, thereupon, how to explain the incompatibility between the practical observations and the physical intuition? Now, this incompatibility can be explained by the new understanding of the gravitational force easily. The key is that the real gravitational force is not isotropic and just expands in two-dimensional plane mainly. From the Eqs. (6), (7) and (8), we can see that the electric force of the electric dipole is anisotropic and is effective mainly in the directions parallel to the dipole moment. Thus, the gravitational force of an object expands just in a thin spheric space like a discus, that is, in an approximately two-dimensional circular plane with the rotation of the dipole moment.

In fact, because Newton's law has implied anisotropic property of the gravitational force, the gravitational force can be described by Newton's law well.

Even though the difference between Eq. (14) and Newton's law is not large for many applications, especially for those on the earth, such difference now still has caused inaccuracy for advanced engineering calculations, such as for spacecraft flying. Further, some astronomical observations can't be explained by Newton's law, which will be discussed below.

In addition, Coulomb's law, which describes the attractive electric force between two point charges, should also be mentioned here. According to the explanations given above, the electric force produced by a point electric charge should expend in the tree-dimensionally spherical space uniformly, that is, the electric field distribution of a point charge should be isotropic. However, in

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Coulomb's law, the expansion rate of the electric force of a point charge in the three-dimensional space is two-dimensional too.

Coulomb established his law in 1784. At that time, Newton's (1642-1727) law of the gravitational force had been known to European physics community. Was Coulomb influenced by Newton when establishing his law?

Coulomb's law has also been tested countless times. How to explain the incompatibility between the actual measurements and the physical intuition? The possible reason might come from the Coulomb experiment. In the experiment, two big metal balls were used in torsion balance test for electric force strength measurements. Thus, the distributions of the net electric charges in two big metal balls are more like two electric dipoles than two point electric charges. Thus, the measured rate of the electric field change agrees with the change rate of the electric dipole electric field.

Therefore, to express the change of the electric field of a real point electric charge, Coulomb's law should be revised as

$$\vec{\boldsymbol{E}} = \frac{1}{4\pi\varepsilon_0'}\frac{q}{R^3}\vec{\boldsymbol{R}}. \tag{16}$$

In Eq. (16), $\vec{\boldsymbol{R}}$ is unit distance vector along the distance R direction. q is the amount of the point electric charge. ε_0' is revised electric constant.

Eqs. (5), (6), (7), (8) and (14) are deduced from Coulomb's law. When using revised Coulomb's law, Eqs. (5), (6), (7), (8) and (14) become below Eqs. (17), (18), (19), (20) and (21), respectively

$$\vec{\boldsymbol{E}} = \frac{1}{4\pi\varepsilon_0' R^4}[3(\vec{\boldsymbol{P}}\cdot\vec{\boldsymbol{R}})\vec{\boldsymbol{R}} - \vec{\boldsymbol{P}}], \tag{17}$$

$$E_S = \frac{2P}{4\pi\varepsilon_0' R^4}, \tag{18}$$

$$E_O = \frac{-2P}{4\pi\varepsilon_0' R^4}, \tag{19}$$

$$E_P = \frac{-P}{4\pi\varepsilon_0' R^4}, \tag{20}$$

$$\vec{\boldsymbol{F}} = \frac{8r_1 r_2}{R^2}\frac{1}{4\pi\varepsilon_0'}\frac{q_1 q_2}{R^3}\vec{\boldsymbol{R}}. \tag{21}$$

Please note that although the change rate of the gravitational force becomes $\frac{1}{R^3}$ in Eq. (21) base on the revised Coulomb's law, the gravitational force is still an anisotropic force because of the Eqs. (17), (18), (19) and (20). But the force strength reduces with distance more quickly.

Without any doubt, Newton and Coulomb are greatest scientists in history. They made great contributions to the human being. Here, author just discusses the pure scientific problems, which doesn't reduce author's great respect to them.

Below, the forces between two electric dipoles when their moment directions are different are analyzed. First, see Figure 2, the case of the directions of two electric dipoles being perpendicular to each other is considered.

In Figure 2, the first electric dipole moment $\vec{\boldsymbol{P}}_{\boldsymbol{1}}$ consists of positive and negative point charges q_{1+} and q_{1-}, and the second electric dipole moment $\vec{\boldsymbol{P}}_{\boldsymbol{2}}$ consists of positive and negative point charge q_{2+} and q_{2-}. The distances between the positive point charge q_{2+} and the positive and negative point charges q_{1+} and q_{1-} are R'. The distances between the negative point charge q_{2-} and the positive and negative point charges q_{1+} and q_{1-} are $R' + r'$ approximately.

The positive point charge q_{1+} and negative point charge q_{1-} produce repulsive force $\vec{a}$ and attractive force $\vec{b}$ to the positive point charge q_{2+}. The synthesized force of $\vec{a}$ and $\vec{b}$ is $\vec{c}$. The positive point charge q_{1+} and negative point charge q_{1-} produce attractive force $\vec{a'}$ and repulsive force $\vec{b'}$ to the negative point charge q_{2-}. The synthesized force of $\vec{a'}$ and $\vec{b'}$ is $\vec{c'}$. Note that $\vec{a}$, $\vec{b}$, $\vec{c}$, $\vec{a'}$, $\vec{b'}$ and $\vec{c'}$ all are vectors. The components along the x-axis of two synthesized forces $\vec{c}$ and $\vec{c'}$ are x_+ and x_-, and the components along the y-axis of two synthesized forces $\vec{c}$ and $\vec{c'}$ are y_+ and y_-. Since two components y_+ and y_- have equal magnitudes with opposite directions, they are cancelled. Two components x_+ and x_- are added to each other since they have equal magnitudes and same directions. Therefore, the electric field of the first electric dipole $\vec{\boldsymbol{P}}_{\boldsymbol{1}}$ exerts a net deflective force on the second electric dipole $\vec{\boldsymbol{P}}_{\boldsymbol{2}}$. Under this deflective force, the electric dipole $\vec{\boldsymbol{P}}_{\boldsymbol{1}}$ and electric dipole $\vec{\boldsymbol{P}}_{\boldsymbol{2}}$ will rotate to have the same directions.

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Actually, the directions of two interacting electric dipoles can't become perpendicular to each other for long time. As long as an electric dipole is affected by a deflective force, its dipole moment direction will rotate. The rotation of the electric dipole doesn't need the rotation of real object physical body. It only needs change of the distribution of the net electric charges including free and induced charges in the object. Such changes in the object are very fast and can't be seen visibly. Therefore, if only considering the gravitational force between two objects, because the directions of two electric dipoles are almost always the same, the gravitational force between the two objects can be expressed by Eq. (14) or (21) only.

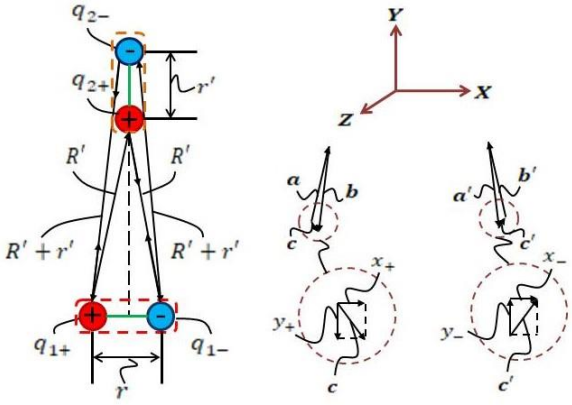

Figure 2. Interaction forces between two electric dipoles when dipole moment directions are perpendicular to each other.

When three objects interact to each other, the free and induced charges in each object are redistributed in response to the electric fields generated by two external objects. If each object is still simplified as an electric dipole, each object will interact with two external electric dipoles. Thus, the redistribution of the free and induced charges in each object may be regarded as forming two electric dipoles. Each of such an electric dipole in one object responds to an external electric dipole in one other object, and the problem becomes the analysis of the interactions among six electric dipoles. When more objects interact, the gravitational force analysis will become more complex. However, redistribution of electric charges in each object may still be regarded as forming multiple electric dipoles in principle, each of such an electric dipole responds to an external electrical dipole in one other object.

2.4. Truths of Some Confusing Phenomena

With new understanding about the gravitational force, the causes of some astronomical phenomena, which have confused people for a long time, can be explained simply and effectively. On the other hand, these phenomena may be regarded as indirect evidences for proving correctness of the introduced understanding.

2.4.1. Formation of Flat Spheric Shape of Galaxy

So far, almost all of the observed galaxies including solar system, galaxies, galaxy clusters have approximately flat spheric shape. As mentioned above, because most celestial bodies can be regarded as electric dipoles, and the electric force of the electric dipole is anisotropic, thus the electric force of the electric dipole is strongest in the direction of the dipole moment and is weakest (as being minus) in the opposite direction of the dipole moment. Therefore, the celestial bodies, no matter they are in the solar system, galaxies or galaxy clusters, are attracted more strongly in some special directions. These anisotropic attractive forces pull the celestial bodies to form flat spherically spatial distribution from previous random three-dimensional spatial distribution. It is the reason for the approximately flat spheric shape of the solar system, galaxies and galaxy clusters.

2.4.2. Rotation of Celestial Bodies and Galaxies

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Atoms consist of electrons, protons and neutrons, and the neutrons are also composed of an electron and a proton. All of these electrons, protons and neutrons have their rotational angular momentums and magnetic moments (In the following, the origins of the rotational angular momentums and magnetic moments of the electron, proton and neutron will be given). All the rotational angular momentums and magnetic moments of the electrons, protons and neutrons in an atom will compose a synthesized net rotational angular momentum and a net magnetic moment. Please note that the most of the rotational angular momentums and magnetic moments of the electrons, protons and neutrons in an atom will offset each other because of their opposite directions or signs.

Any celestial body is made up of the atoms, and so any celestial body will have a synthetic rotational angular momentum and a synthetic magnetic moment, which are the sums of the net rotational angular momentums and net magnetic moments of all atoms in that celestial body. Also, the most of the net rotational angular momentums and net magnetic moments of the atoms in that celestial body will offset each other too because of their opposite directions or signs. Since every celestial body has net rotational angular momentum, every celestial body rotates.

At the same time, as the celestial bodies have motion momentums, when two celestial bodies are attracted to close each other, as long as their motion momentum directions are different, the attractive force between them will change their moving directions, and so to make two bodies start to rotate around each other. When multiple celestial bodies are attracted to close their attractive center, they will rotate around that attractive center, which causes rotation of a star system. Many rotational star systems compose a rotational galaxy, and many rotational galaxies compose a rotational galaxy cluster.

2.4.3. No “Dark Matter” in the Universe

Astronomical observations show that the rotation-al speeds of the celestial bodies in the faraway edges of a giant galaxy grow with the distance increase from the galaxy center. The higher speeds require stronger attractive forces for the celestial bodies in the galaxy edges. Otherwise, the faraway spiral arms of the galaxy will collapse. According to current classical theory of the gravity, these celestial bodies must have much greater masses. However, other observations, such as the photometric mass observations, indicate that the visible masses of the celestial bodies including gases, dusts, planets and stars in the faraway spiral arms are much less than those for producing required strong attractive forces. Therefore, a large quantity of unseen “dark matter” must exist in the faraway spiral arms of the galaxy. However, no any sign for “dark matter” existence has been observed until now.

The new understanding about the gravitational force can eliminate the requirement for the “dark matter”. According to the electric dipole model described by Eq. (14) or (21), the attractive force between two objects can change with dipole moment lengths r_1 and r_2, and net electric charges q_1 and q_2. r_1 and r_2 values are determined by the distributions of the electric charges in two objects. The net electric charge amounts q_1 and q_2 are determined by external electric force strengths. All of these values and amounts are changeable. Thus, the values of the so-called object masses are variable.

The current common concept of the mass is just applicable to the Earth condition. The academic terminology “mass of a matter”, which is familiar to us, just means the weight of that matter on the Earth. Because of various reasons, such as substance form, state, density, temperature, pressure, conductivity, and so on, the objects including gases, dusts, planets and stars in the faraway spiral arms of the galaxy not only can have electric dipole like electric charge distribution, but also can produce much stronger attractive forces than the predicted gravitational forces depending on their mass amounts defined by current gravity theory suitable for the earth situation. Therefore, the faraway spiral arms of the galaxy can rotate at faster speeds with the whole galaxy without collapse. There is no requirement for existence of the “dark matter”.

2.4.4. No “Dark Energy” in the Universe

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Astronomical observations also found that the spectra of the faraway stars have "redshift", that is, the wavelengths of the light waves from the faraway stars increase. Depending on "Doppler shift" theory, it is proposed that the faraway stars are moving away from the Earth. Since the spectrum "redshift" has been found for the stars in different directions, and so all faraway stars are proposed being moving away from the Earth. Thus, many people believe that the universe is expanding continually now.

Actually, since the gravitational forces existing in the space are attractive, the expansion of the universe should be reduced. However, such deceleration was not seen. Furthermore, in observation of supernova explosion, it is found that such expansion is accelerated. For explaining the universe expansion, especially the expansion acceleration, huge "dark energy" is proposed existing in the universe.

Some scientists suppose that the gravitational force doesn't play the major role in the space, and a kind of "repulsive" force is the dominant role for universal accelerated expansion. The idea of such "dark energy" is extremely difficult to be understood.

In fact, we don't need to put ourselves into such a difficult status. The key support for universe expansion is star spectrum "redshift". However, the star spectrum "redshift" is not caused by star fast moving away from the Earth. A new understanding about light and photon is also introduced in a sisterly paper titled "Origin of Light" written by the author too. In that paper, the author introduced the microscopic structure of the photon in detail, and indicated that the photon has periodically vibrational electric field with short interaction distance. The spectrum "redshift" of the faraway stars is only the result of the speed reductions of the photon rotation and straight-line motion caused by interactions with other electric fields in the space.

Thus, the spectrum "redshift" of the faraway stars is essentially a phenomenon of photon rotation and motion energy reductions. It may be regarded as somewhat fatigue of the photon. The spectrum "redshift" can't be taken as the evidence for universe explosion. The universe expansion doesn't exist. The universe accelerated expansion doesn't exist too. For the phenomenon of universe accelerated expansion observed in the supernova explosion, since this phenomenon involves many possible causes and the obtained information is limited now, so no more discussions about it here.

Please note that saying that the stars are not moving away from the Earth doesn't mean that all stars are not moving away from the Earth, or that all stars are not moving away from each other. There are various star movements in the universe. The stars in the universe are moving with different speeds and different directions. Some stars are moving away from each other, and some stars are moving close to each other. However, this kind of diverse movements of the stars is different from the "universe expansion" completely.

3. Nature of Magnetic Force

It is known that the magnetic force is originated from the electric force. The magnetic force is produced by moving electric charge or a collection of moving electric charges, that is, by motion or rotation of the electric field. The magnetic and electric fields are almost always accompanied with each other.

In fact, the microscopic particles carrying electric charges are always moving and rotating. Apart from random thermal motions, electrons, positrons and even neutral neutrons all have magnetic moments. Although the magnetic moments of the electron, proton and neutron are observed in experiments, their genuine physical originations are not clear. Here, the author indicates that these magnetic moments are indeed produced by real rotations of the electric fields of the electron, protons and neutron. Please note that the neutron still has un-uniform electric field distribution in the extremely close vicinity of the neutron. More detailed descriptions about the structures of the photon and neutron are given in the paper titled "Origin of Light".

The magnetic field is just produced by the moving or rotating electric field, and so the magnetic force is originated from the electric field. The magnetic force and the electric force are the basic causes for forming the universe and driving its evolution.

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4. Origin of Strong Interaction Force

The strong interaction force is also considered as one of the four fundamental forces of nature, and its main role is to enable multiple protons to be assembled together in the tiny nucleus. The strength of the strong force is roughly 100 times as strong as the strength of the electromagnetic force. The effective interaction distance of the strong force is just about $1fm = 1 \times 10^{-15}m$. The strength of the strong force drops much quickly than the rate of $\frac{1}{R^2}$.

In the nucleus, the distances among the protons are very short. According to the current theory, the repulsive force between two protons can be as large as dozens of kilograms, and in more cases a proton may be repelled by dozens of protons. Thus, there must be a strong attractive force for avoiding nucleus collapse. The strong interaction force is very difficult to image.

In order to recognize the intrinsic quality of the strong interaction force, the microscopic structure of the atomic nucleus must be investigated further. One way of investigating the nuclear structure is to know what the nucleus is made of or what is stored in the nucleus.

4.1. Structure of Nucleus and Origin of Strong Interaction Force

It is known that any nuclear reaction, no matter it is nuclear fission or nuclear fusion, will produce extremely strong gamma-ray burst. The gamma-ray consists of high-energy photons. These phenomena strongly show that a lot of high-energy photons are stored in the nucleus. Here, the author should especially emphasize that the gamma-ray burst is not transferred from the mass of the nucleus. The abstract and professed concept of "mass-energy transfer" is not true, although many persons have been familiar with it and believed it. The gamma-ray burst is just the real substance release from the nucleuses directly because every nucleus consists of a lot of photons inherently. Another evidence of proving that the photon is the most basic building blocks for any substance is that almost all black holes in the universe emit extremely strong gamma-rays. It means that under the most ultimate conditions including extremely high pressure and temperature, any substance will be broken into its basic units, that is, the photons.

Any substance consists of the atoms, and every atom consists of the proton, neutron and electrons. Therefore, it is a reasonable deduction that the neutron consists of multiple photons, and the proton consists of multiple photons but lacking an electron which leaves the proton and still stays in the atom.

The author has inferred that the photon is just the extremely tiny electric dipole consisting of a pair of an electron and a positron. This inference is strongly supported by well-known phenomena of photon appearing after electron-positron annihilation, and photon splitting into electron and positron in high-energy collision. The detailed explanations about this inference are given in the paper titled "Origin of Light".

As an electric dipole, even it is extremely tiny, the net electric field of the photon is not zero within a very small range around the photon. However, because the sizes of the electron and positron are extremely tiny, and the distance r between the electron and positron is very short since they are bound tightly due to their strong electric fields with opposite signs. According to the Eqs. (5), (6), (7) and (8) or Eqs. (17), (18), (19) and (20), the net electric field of the photon is only effective in the small range around the photon, because the net electric field strength of the photon drops fast with the rate of $\frac{r}{R^3}$ or $\frac{r}{R^4}$. Therefore, for a distant observer, the photon is electrical neutral, that is, no net electric field.

But, for a nearby observer, the net electric field of the photon is not zero. In other words, every photon has its electric field within very short distance. Thus, multiple photons can be combined together within a tiny volume in the way that the positive end of each photon attracts the negative end of its adjacent photon in series or in parallel.

The calculations of the electric field strengths of the photon are described in detail in the paper titled "Origin of Light". The calculation results show that at the site with the distance of $R = 1fm$ from the photon center, the electric field strength is from $2.9\times10^{16}\frac{V}{m}$ to $2.9\times10^{19}\frac{V}{m}$ ($\frac{V}{m} = \frac{Volt}{meter}$) for photons with dipole moment lengths of $10zm$ ($1zm = 1 \times 10^{-21}m$) to $10am$ ($1am = 1 \times 10^{-18}m$).

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Please note that taking the photon dipole moment length with such large range (from $10zm$ to $10am$) is due to that the photon size can't be estimated accurately now. Such large electric field can bind the photons tightly within a small range certainly. With increase of the distance R, the electric field strength of the photon drops fast. At the site with the distance of $R = 1\mu m$ from the photon center, the electric field strength drops to from $2.9\times10^{-11}\frac{V}{m}$ to $2.9\times10^{-8}\frac{V}{m}$ for photons with dipole moment lengths of $10zm$ to $10am$. Therefore, to measure electric field strength of the photon is very difficult. It is the reason that the photon is regarded as no electric field. When using revised Coulomb's law to calculate the electric field strength of the photon, the electric field strength of the photon will drop faster.

These calculation results show that the author inference of the nuclear structure is reasonable, because the calculation results are consistent with the observation results, that is, why the effective interaction distance of the so-call strong force is about $1fm = 1\times10^{-15}m$ (Please note that when the multiple photons are bound together, their synthesized net electric strength is more weak and has shorter effective distance), and why the strength of the strong force drops much quickly than the rate of $\frac{1}{R^2}$.

The possible structures of the neutron and proton are that the multiple photons compose a photon sell or several photon shells with spherical shapes. The left section of Figure 3 shows the hypothetical photon distribution of a partial photon shell in the proton or neutron. In Figure 3, each photon is represented by an electric dipole consisting of a positron (small red circle) and an electron (small blue circle). In this section, the dipole moment directions of the photons are parallel to the shell surface. Supposing spherical shell has radius of r_p. The full structures of the proton and neutron, which describes the whole distributions of the photons in the proton and neutron, are not given now because of needing more nuclear information and analysis.

Since each neutron consists of multiple electric dipoles, although the sum of all electric dipole fields of the neutron is zero, in the vicinity very close to the neutron, the net electric field is not zero. For example, in the regions near the positrons, the net fields are positive, and in the regions near the electrons, the net fields are negative. Thus, to bind multiple neutrons one by one in the nucleus is possible and only needs the electric force. Here, it should be mentioned that, according to current theory, no answer to explain how to keep multiple neutrons in the nucleus because the neutrons are electrical neutral.

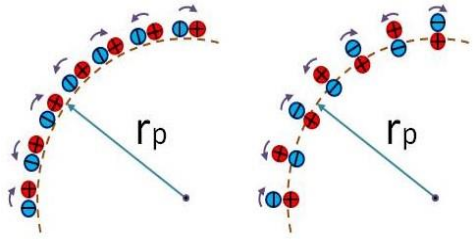

Figure 3. The left section shows that the photon dipole moment directions are parallel to the shell surface. The right section shows that the photon dipole moment directions rotate to perpendicular to the shell surface.

Compared with the neutron, each proton just loses an electron. Because the mass of a proton is 1836.5 times the mass of an electron, there should be several hundred photons, that is, several hundred electric dipoles in each proton. Therefore, in each proton, the sum of the positive electric fields of all positrons is only one in several hundred larger than the sum of the negative electric fields of all electrons. Such small difference between the positive and negative net electric fields in each proton can't create a force to repel another nearby proton strongly. Perhaps, the net positive electric force of each proton in the nucleus can only make the nucleus unstable when the number of the protons is large, which helps to cause emissions of the radioactive decay rays.

Furthermore, in the similar way as the neutron, because in the vicinity very close to the proton, the net electric field is not zero, the multiple protons can be bound with the neutrons in the nucleus. Therefore, the forces of binding the neutrons and protons in the nucleus can be only electric forces. It

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is not required to bring up the idea of a special strong interaction force for binding the protons in the nucleus.

The electron and positron all have rotation angular momentums and magnetic moments. Thus, the photon has angular momentum and magnetic moment too (detailed explanations about photon rotational angular momentum and magnetic moment are given in the paper titled "Origin of Light").

Thus, the dipole moment directions of the photons will rotate in the nucleus. The right section of Figure 3 and left and right sections of Figure 4 show the photon rotations from parallel to the photon shell surface, to perpendicular, then to parallel, and then to perpendicular to the shell surface in a rotational cycle.

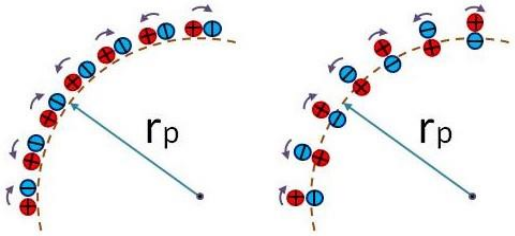

Figure 4. The photon dipole moment directions rotate from perpendicular to parallel, and then to perpendicular to the shell surface again.

4.2. Structures and Characteristics of Electron Shells

When a proton and an electron meet, as they have net electric charges with equal magnitude and opposite signs, they attract each other. If they are close enough, since the electron mass is much smaller than the proton, in most cases, the electron is bound by the proton and stays close to the proton. Thus, one proton and one electron compose the simplest atom with atomic number of 1.

When such an atom is formed, because the charge center of the electron does not coincide with the charge center of the proton, and the electric field distribution in the vicinity around the proton is not uniform as explained above, the negative electric field of the electron can't cancel the net positive field of the proton uniformly and completely, which will produce an un-uniform distribution of the synthetic electric field in the vicinity of the proton, that is, in the vicinity of the nucleus. Such an atom has relatively high chemical activity.

For the electron and proton, the effective interaction distances of their net electric fields are much larger than their physical sizes (the proton diameter is about $1 \times 10^{-15} m$, and the diameter of the electron is smaller further). Thus, even if the charge centers of the electron and proton don't coincide with each other, since the distance between charge centers of the electron and proton is small (the atom diameter is about $1 \times 10^{-10} m$), for a distant observer, the negative electric field of the electron can still cancel the net positive electric field of the proton almost completely. Therefore, the distant synthetic electric field strength of the atom is almost zero, and so such an atom can be considered as electrical neutral.

As mentioned above, in the proton the electric charge can't be stored within a point-like volume. Furthermore, the positive electric field distribution of the proton is un-uniform. For example, the proton has magnetic moment, which means that the proton electric field distribution has a centrally symmetric axis. Thus, the electron may stay in a small area near the proton where the proton net positive electric field is relatively high, and so the electron doesn't rotate around the proton. Of course, the electron can't be still in that small area and to cling to the proton. The inevitable thermal motion will make the electron move restlessly in that small area and keep a small distance from the proton. For an atom consisting of a proton and an electron (hydrogen), its distant electric field strength is zero. But, the electric field distribution in or near the atom is non-uniform. If closing the electron, the net electric field is negative, and if closing the nucleus (proton), the net electric field is positive.

It is very important that the electron can stay near the nucleus, and doesn't need to rotate fast around the nucleus. Thus, some confusion can be eliminated: 1. Since the electron doesn't rotate around the nucleus, so no continual electromagnetic radiation is emitted from the atom; 2. The

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electron electric field is around the nucleus because the electron is close to the nucleus, which makes the electron seem to exist at any position around the nucleus at any time. Thus, the seemingly strange behaviors of the electron, such as the electron exact position, don't need using wave function and probabilities to describe. Here, it should be emphasized that, in many cases, the detected thing is the electric field of the electron, not the electron (core) itself.

As described above, when a proton meets another proton including the proton attaching an electron, because the electric field distribution on each proton surface is not uniform because each proton consists of multiple photons, thus for example, the surface region of one proton with net positive electric field will attract the surface region of another proton with net negative electric field. In this way, two protons may bind each other with or without neutrons to compose a nucleus of two protons. Such a nucleus will bind two external electrons to form an atom with atomic number of 2.

Because the net electric forces of the protons in the nucleus to the electrons are attractive, two external electrons are attracted to the nucleus as close as possible. Meanwhile, because two electrons push each other as far as possible since they have same negative electric fields. Two electrons are not only attracted to be as close as possible, but also repel each other as far as possible, which results in that the two electrons are located at two sides of the nucleus with a suitable distance where the attractive forces and repulsive forces are balanced.

In Figure 5, the electric charge centers of two electrons are located on the x-axis with a distance of Λ. The diameter of the nucleus is η. Because the centers of the spherical electric fields of two electrons are not concentric, the synthetic negative electric field distribution of two electrons is ellipsoidal, which centrally symmetric axis is the x-axis. Although such a field distribution is ellipsoidal, it can approximately cover the spheric field distribution of the nucleus roughly. The two electrons outside the nucleus form the first electron shell.

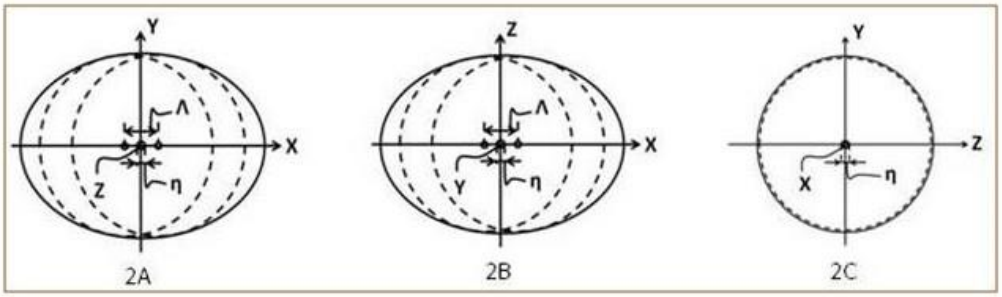

Figure 5. The electron positions on the first electron shell or the first electron sub-shell, the centers of two electrons are located on x-axis with a distance of Λ. The diameter of the nucleus is η.

The two electrons locating on both sides of the nucleus with a short distance between them will cause a very important result. The strongly repulsive force of each electron will exert on other electron, which will rotate the other electron with fast speed, because the electric field of one electron will produce strong tangent force to another electron. Thus, two electrons rotate on their own fast and in reverse directions. It is the physical origin of the electron rotational angular momentum and magnetic moment. The rotation directions of two electrons are opposite, and so their angular momentums and magnetic moments have opposite signs. The electron angular momentum and magnetic moment are extremely important. They are fundamental sources for creating rotational angular momentums and magnetic moments of the protons, neutrons and atoms.

When the protons in the nucleus increase to three, the electrons outside the nucleus also increase to three. Since an elliptic negative electric field produced by two electrons has approximately covered the spheric positive electric field produced by the nucleus almost completely, the attractive force of the nucleus to the electron is reduced. Thus, the third electron can't go close to the nucleus as the first and second electrons, so the third electron stays a little far from the nucleus to form a new electron shell.

When the protons in the nucleus increase to four, the electrons outside the nucleus will increase to four too. Since there is only one electron in the second electron shell, the second shell can't

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effectively cover the net positive electric field of the nucleus in all directions, the fourth electron need to stay in the second electron shell, and so the second ellipsoidal negative electric field is formed. The second ellipsoidal negative electric field produced by the second electron shell can also approximately cover the spheric positive field of the nucleus almost completely. In the second electron shell, the third and fourth electrons repel each other too by their electric forces, which also make the third and fourth electrons have rotational angular momentums and magnetic moments with opposite signs.

When the fifth electron comes, because of the similar reasons, the second completed electron shell will not allow the fifth electron to enter it, thus the fifth electron to form another electron shell. This new shell has a larger radius from the nucleus and larger shell area. In this shell, the distances between the electrons become larger with smaller mutually repulsive forces. Thus, this shell can hold more electrons than two electrons. It is the second sub-shell of the second shell.

The maximum number of the electrons allowed in a sub-shell depends on the following requirements: 1. The shell area should be occupied as even as possible by the electrons; 2. The repulsive forces between every two adjacent electrons should be as equal as possible; 3. The synthetic electric field generated by all electrons in the sub-shell should be symmetrical around a central axis, because the nuclear net positive electric field is symmetrical around a central axis due to the net magnetic moment of the nucleus; 4. In the sub-shell, the electron number in any plane parallel to the central axis should be zero or even, which is the requirement also for electron magnetic moment equilibrium; 5. If supposing the nucleus is at the center of the coordinate system and the central axis is the x-axis, the electron distribution in the sub-shell should be mirror image symmetrical to the xy-plane, xz-plane and yz-plane, which is also the requirement for electron magnetic moment equilibrium. The sub-shell is not always occupied fully by the electrons. The atoms in un-full sub-shell have relatively higher chemical activity, that is, such atoms are easy to capture or lost the electron. The total negative charge amount of all electrons in all shells of an atom is equal to the total net positive charge amount of all protons in the atom nucleus.

Following these rules, and since the areas of the first shell and the first sub-shell of the second shell are small, there are only two electrons in them, separately.

Beginning with the fifth electron, the second sub-shell of the second shell is gradually filled. According to above-described rules, when this sub-shell is full, the electron number should be 6. In this sub-shell, the distance between every two adjacent electrons should be as equal as possible, which is shown in the sections 6A, 6B and 6C in Figure 6. Such electron distribution is an approximate structure of octahedron. In the section 6A, six electrons produce a synthetic electric field around the x-axis. The x-axis is central axis of the ellipsoidal filed. Four electrons are in the xy-plane. Four electrons are in the xz-plane, and four electrons are in the yz-plane.

We know that regular octahedron has equal edge lengths, equal vertex angles and equal face areas [4], which satisfy the requirements for producing equal repulsive forces among six electrons. When the multiple electrons occupy all vertexes of the octahedron, because all vertex angles and all edge lengths of octahedron are equal, so all face areas of the octahedron are equal too. Then every electron will receive equal electrical repulsive force from each of its adjacent electrons.

There are only five regular polyhedrons in nature. They are tetrahedron, cube, octahedron, dodecahedron and icosahedrons. All of them have equal edge lengths, equal vertex angles and equal face areas. Although the structures of the tetrahedron and cube can meet requirements of equal electrical repulsive forces between any two adjacent electrons, the tetrahedron structure can't satisfy rotational symmetry around central axis, and the cube structure can't satisfy the mirror image symmetry. The octahedron structure can satisfy these three requirements, so it is the first existing sub-shell structure for containing the multiple electrons.

Of course, the increase of the electron number in the sub-shells is due to the increase of the photon number in the nucleus. In the second sub-shell of the second shell, the mutual electrical repulsive forces will make all electrons have rotational angular momentums and magnetic moments too.

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When the second sub-shell of the second shell is full, the newly captured electrons will begin to fill a new sub-shell. The new sub-shell is the first sub-shell of the third shell. The possible reason for forming a new shell is related to changes of the structure and the electric field distribution of the nucleus since the eleventh proton joins in the nucleus. The eleventh proton maybe increases anisotropy of the synthetic net positive electric field distribution of the nucleus, for example, increases the ellipticity of the net positive field distribution of the nucleus. Thus, newly captured eleventh electron needs to form a sub-shell consisting of two electrons which can have the most anisotropic negative field distribution to match the net positive field distribution of the nucleus.

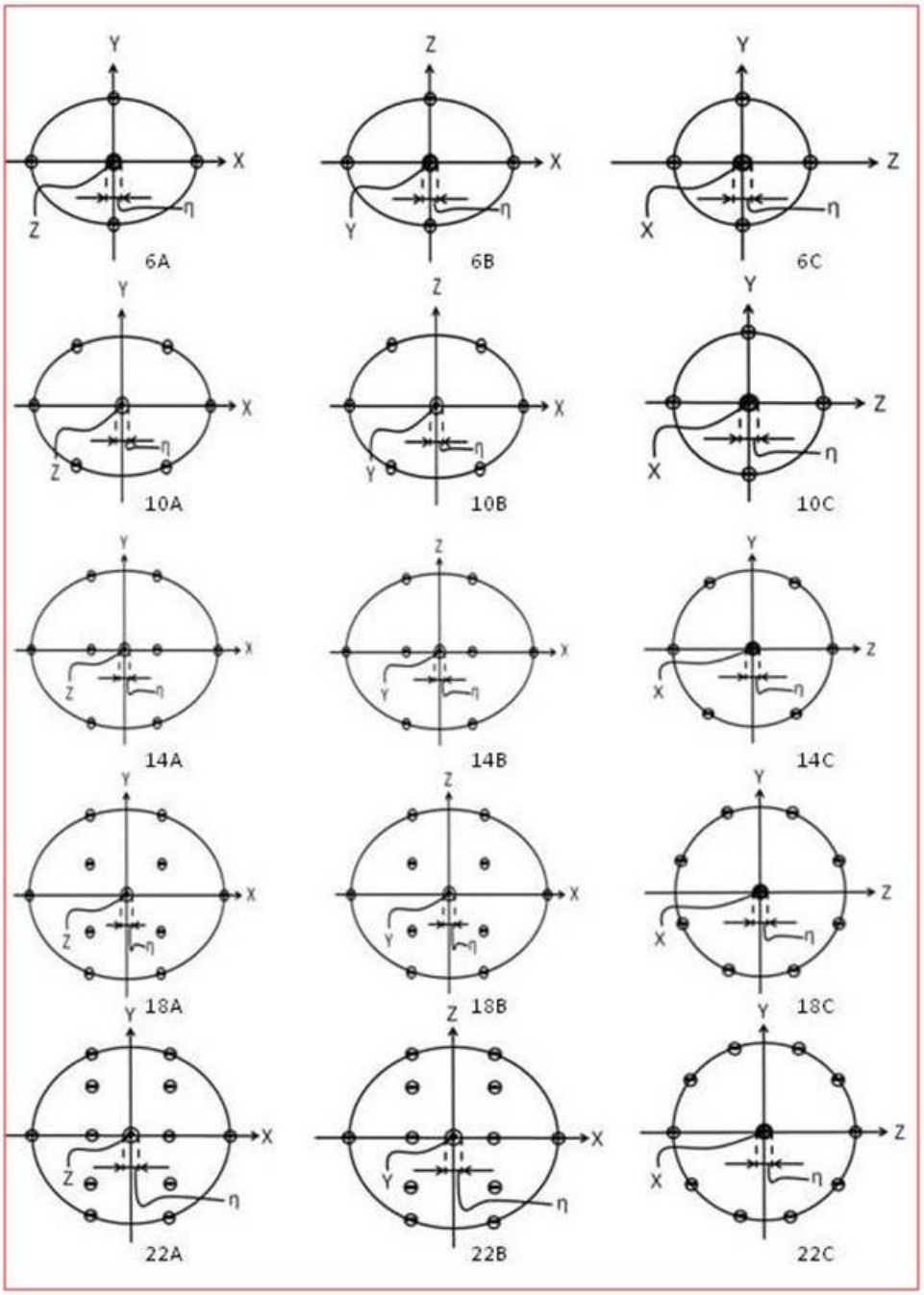

Figure 6. The electron positions on the second, third, fourth, fifth and sixth electron sub-shells, the electrons produce a synthetic ellipsoidal electric field rotated around x-axis.

Then, the second sub-shell of the third shell is formed in the similar way for formation of the second sub-shell of the second shell. It contains six electrons.

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With the nineteenth electron is captured, it also means that the proton in the nucleus increases to nineteen. Because the second sub-shell of the third shell is farther away from the nucleus, and the nineteenth proton maybe not increase the anisotropy of the synthetic net positive electric field of the nucleus, the nineteenth electron begins to fill the third sub-shell of the third shell.

The third sub-shell of the third shell has larger shell area, so this shell can contain more than six electrons. Because both of the dodecahedron and icosahedron structures can't meet mirror image symmetry, the permitted sub-shell structure is that which can contain ten electrons. Such electron sub-shell structure is shown in the sections 10A, 10B and 10C in Figure 6. The long axis of the synthetic ellipsoidal electric field of this sub-shell is also along the x-axis. The synthetic electric field is rotated symmetrically around the x-axis. Six electrons are located in the xy-plane. Six electrons are located in the xz-plane and four electrons are located in the yz-plane. The ten electrons in this sub-shell also have their angular momentums and magnetic moments.

With the twenty-ninth proton joins in the nuclear, the ellipticity of the synthetic net positive electric field distribution of the nucleus maybe is increases too, and so the fourth shell begins to be formed. As the fourth shell is farther away from the nucleus, the fourth shell can have more sub-shells. Apart from its first, second and third sub-shells, this shell will have its fourth sub-shell containing more than ten electrons. The electron number in the fourth sub-shell is 14. The electron distribution in the fourth sub-shell is shown in the sections 14A, 14B and 14C in Figure 6. The synthetic ellipsoidal electric field produced by fourteen electrons also rounds the x-axis. Eight electrons are in the xy-plane, eight electrons are in the xz-plane and six electrons are in the yz-plane.

The newly captured sixty-first electron begins to form the fifth shell. Apart from the first, second, third, and fourth sub-shell, this shell has its fifth sub-shell. The electron number in the fifth sub-shell is 18. The electron distribution of the fifth sub-shell is shown in the sections 18A, 18B and 18C in Figure 6. The synthetic ellipsoidal electric field of the eighteen electrons is also around the x-axis. Ten electrons are in the xy-plane, ten electrons are in the xz-plane and eight electrons are in the yz-plane.

Finally, the electron distribution of the sixth sub-shell of the sixth shell is given. It is shown in the sections 22A, 22B and 22C in Figure 6. The synthesizing ellipsoidal electric field of the electrons is also round the x-axis. Twelve electrons are in the xy-plane, twelve electrons are in the xz-plane, and ten electrons are in the yz-plane. When the sixth sub-shell of the sixth shell is full, the protons in the nucleus have exceeded 182, which is an extremely unstable atom that can't naturally exist.

As shown in Figure 6, with increase of the electrons in each sub-shell, the synthetic net electrical field distribution of the electron in each sub-shell becomes closer to the sphere gradually. Please note that all of the electrons in every sub-shell will have angular momentums and magnetic moments as they push each other by their electrical repulsive forces.

Of course, the electron sub-shell and shell formations described above are too simplified. The author just wants to explain the basic characteristics of the electron shells and sub-shells. These properties include 1. The electrons in the shells or sub-shells don't need to rotate around the nucleus; 2. The electrons in the shells or sub-shell all rotate on their own driven by the repulsive forces from adjacent electrons, and so have their spin angular momentums and magnetic moments with different values; 3. The maximum numbers of the electrons in each shell and sub-shell must follow the specific rules.

5. Origin of Weak Interaction Force

According to current theory, the weak interaction force is considered to play the main role in the radioactive decay emissions from the nucleus. The radioactive decays of sub-atomic particles produce alpha-ray, beta-ray and gamma-ray from the atomic nucleus with high atomic numbers. The alpha-ray is composed of helium nucleus consisting of two protons and two neutrons. The beta-ray is composed of high-energy electrons. The gamma-ray is composed of high-energy photons. The observations show that the atomic nucleuses of the atoms with high atomic numbers are unstable and produce the radioactive decay rays spontaneously.

According to the current theory, the photons are generated by the transitions of the electrons between the electron sub-shells or shells in the atom. And also based on the current theory, there are

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no electrons in the nucleus or very few positrons in the nucleus since each proton has only one positron. Therefore, the beta-ray and gamma-ray can't be emitted out from the nucleus. Thus, the beta-ray and the gamma-ray emissions should have no relations to the weak interaction force. The weak interaction force just causes the alpha-ray emission because only the protons and neutrons are components of the nucleus. It makes the current theory about the weak interaction force become more confusing.

However, if supposing that the protons and neutrons are composed of the photons and the photon is composed of a pair of electron and positron, the radioactive decay rays emitted from the nucleus can be explained easily.

As explained above, the nucleus is filled with a lot of photons. In the nucleuses of the atoms with high atomic numbers, there are more protons and neutrons, and so more electric dipoles and electrons. With increase of the protons and neutrons in the nucleus, because of various reasons including random thermal motions, the collisions among the protons and neutrons increase too. The lighter collisions produce alpha-rays. In the alpha-rays, two protons and two neutrons are still combined together. The heavier collisions produce gamma-rays. In the gamma-rays, an electron and a positron are combined together. The heaviest collisions produce beta-rays. In the beta rays, the electrons become independent particles completely.

In the atoms, the electrons, positrons, protons and neutrons are all bound tightly in the nucleus. Thus, only very strong forces can break them into different pieces. When these separated pieces go out from the nucleus, no matter they are the independent electrons, the pairs of the electron and positron (the photon) and the groups of two protons and two neutrons (helium nucleus), the formed beta-rays, gamma-rays and alpha-rays all have high energies.

The forces driving protons, neutrons and electrons to collide each other are electric forces because the collisions are just the processes of these microscopic particles pushing some other microscopic particles by electric forces. Thus, the so-called weak interaction force is the electric force too. The radioactive decay ray emissions don't need a special weak interaction force. There is no weak interaction force in the nucleus.

6. Conclusions

The four fundamental interaction forces of nature all are electric interaction forces in essence. Some of them are simple electric forces and some of them are complex electric forces. Thus, the four fundamental forces of nature can be united as one force.

The above-described new understandings are just author inferences and have no direct experimental evidences now. Especially, some contents of the paper are more discussable, such as those about the structures of the electron shells and sub-shells. The author purpose is to open his understandings to help for finding the natural truth earlier.

Although these understandings have no direct experimental evidences now, and some of them seem no possibility to do the tests in the foreseeable future, some inferences have been confirmed indirectly by astronomical and experimental observations. The author has good confidence in these understandings and welcomes discussions on this paper.

Disclosure

This paper is written partially based on the specifications recorded in the following patent applications:

1. Canada patent application titled "Methods of Changing Gravitational Force and Producing Electric Current", which was filed on August 8, 2024 with Transmission Identifier:

pef_sqliuicuc1_20240808071752421_20240808071014316_360517263_16901557;

2. USA patent application titled "Methods of Changing Gravitational Force and Producing Electric Current", which was filed on August 9, 2024 (Project Publication Date: 02/12/2026) with application number: 18/799,600.

The author declares no competing interests in this work.

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