Comparative Studies of Theories of Force as well as Generalized Theories Clusters of Force and Fifth Force — No.4 of Comparative Physics Series Papers

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Abstract: As No.4 of comparative physics series papers, this paper mainly discusses the comparative studies of various theories (or formulae) of force, and on this basis, presents the concepts of generalized theory of force and generalized theories clusters of force. The essence of generalized theory of force is the extension and generalization of Newton's second law. In Newton's second law, force is the product of mass and acceleration of the object; while in generalized theory of force, force is the product of generalized mass and generalized acceleration of the object, in which: the generalized mass (including quantity of electricity, and the like) and the generalized acceleration are both the functions of coordinates and time, as well as other appropriate variables. Various generalized theories of force form generalized theories clusters of force. In the unified framework of generalized theories clusters of force, the related problems of Newton's second law, law of gravity, law of Coulomb, special relativity, general relativity, strong interaction, weak interaction, and the like, are discussed. Finally, by comparison, concept of the fifth force in nature, namely quantum interaction (including quantum discontinuous interaction, quantum uncertain interaction, quantum stochastic interaction, quantum entanglement interaction, and the like), is proposed.

Key words: Comparative physics, comparative study, force, generalized theory of force, generalized theories clusters of force, fifth force, quantum interaction

Introduction

As well-known, the concept of force is a very important one in physics. Throughout the ages, there have been various theories (or formulae) of force, such as Newton's second law, law of gravity, law of Coulomb, special relativity, general relativity, and so on.

The concept of comparative physics is presented in reference [1]. As No.4 of comparative physics series papers, firstly this paper discusses the comparative studies of various theories (or formulae) of force, and on this basis, presents the concepts of generalized theory of force and generalized theories clusters of force. Finally, concept of the fifth force in nature, namely quantum force, or quantum interaction (including quantum discontinuous interaction, quantum uncertain interaction, quantum stochastic interaction, quantum entanglement interaction, and the like), is proposed.

1 The same points of original theories (or formulae) of force

The first same point: they belong to the most important contents in modern physics.

The second same point: they are all widely used in physics.

Moreover, in many cases they are used simultaneously. For example, Newton's second law and law of gravity are often used simultaneously.

2 The different points of original theories (or formulae) of force

The first different point: each theory (or formula) of force has a specific scope of application.

For example, the scope of application of law of gravity is completely different from that of law of Coulomb.

The second different point: the original theories (or formulae) of force cannot be discussed in a unified framework.

3 Comparative studies between original theories (or formulae) of force and Computer Information Library Clusters, as well as concepts of generalized theory of force and generalized theories clusters of force

One of the trends of science development is applying the least amount of laws as well as formulas and equations to solve the problems as many as possible. And people have been hoping that, all the laws as well as formulas and equations can be integrated into a unified model.

As the first step, based on creating generalized and hybrid set and library with Neutrosophy and Quad-stage method in reference [2], the concept of Computer Information Library Clusters is presented in reference [3]. There are various ways and means to form Computer Information Library Clusters. For example, Computer Information Library Clusters can be considered as the "total-library", and consists of several "sub-libraries". In which, it is very important to add the operating function into Computer Information Library Clusters, for instance, according to "natural science computer information library clusters", and applying "variation principle of library (or sub-library)", “partial and temporary unified theory of natural science so far” with different degrees can be established.

Similarly, in reference [4], the comparative literature is expanded into Comparative Sciences Clusters (including comparative social sciences clusters, comparative natural sciences clusters, comparative interdisciplinary sciences clusters, and so on). Among them, comparative natural sciences clusters include: comparative mathematics, comparative physics, comparative chemistry, comparative medicine, comparative biology, and so on.

By comparison we can find that, with the same method to establish "Computer Information Library Clusters" and "Comparative Sciences Clusters", we can also present the concepts of generalized theory of force and generalized theories clusters of force based on comparative studies of various theories (or formulae) of force.

Of course, we can also say that, as the practical application of "Computer Information Library Clusters", "Generalized Theories Clusters of Force" can be established.

Firstly, in "Computer Information Library Clusters", the concept of "library" is expanded from the concepts of "set" and the like. To compare with and refer to this way, in the scope of physics, original theories (or formulae) of force can be expanded in two directions.

The first direction: the concept of "mass" can be expanded into "generalized mass", and the concept of "acceleration" can be expanded into "generalized acceleration".

In reference [5], taking into account that the mass and the electric charge can be converted into energy, therefore the three concepts of energy, mass and electric charge can be summed up as "Multiform Energy" taking energy as the core, in order to co-ordinate the three basic conservation laws in modern chemistry: law of conservation of mass, law of conservation of energy, and law of conservation of electric charge.

Similarly, many physical quantities can be regarded as "generalized mass", therefore the concept of "mass" can be expanded into the concept of "generalized mass" taking mass as the core.

The second direction: Newton's second law can be expanded into generalized theory of force.

Now we discuss the problems related to various theories (or formulae) of force.

As well-known, Newton's second law gives a quantitative definition of force, namely it is equal to the time rate of momentum; if the mass does not change, the force equals mass multiply acceleration.

If the "mass" m is expanded into "generalized mass" m_G, here m_G is the function of coordinates and time as well as other variables, the "acceleration" a is expanded into "generalized acceleration" a_G, here a_G is the function of coordinates and time as well as variables; then Newton's second law can be expanded into the following generalized theory of force

$$F = m_G(x, y, z, t, \cdots)a_G(x, y, z, t, \cdots) \qquad (1)$$

In addition，various theories (or formulae) of force can be written as the form that the right side is equal to zero, and all the theories (or formulae) of force can be converted into the laws of conservation with the form that the right side is equal to zero.

In reference [5], law of conservation of energy can be written as the following form that right side of the expression is equal to zero

$$F_1 = 0 \qquad (2)$$

where: $F_1 = E - const$

Similarly, all the theories (or formulae) of force can be converted into the form that the right side is equal to zero.

For example, in reference [6], with the help of the equation derived by Prof. Hu Ning according to general relativity, and Binet's formula, we derived the following improved Newton's formula of universal gravitation

$$F = -\frac{GMm}{r^2} - \frac{3G^2M^2mp}{c^2r^4} \qquad (3)$$

where: G **is gravitational constant,** M **and** m **are the masses of the two objects,** r **is the distance between the two objects,** c **is the speed of light,** p **is the half normal chord for the object** m **moving around the object** M **along with a curve, and the value of** p **is given by:** $p = a(1-e^2)$ **(for ellipse),** $p = a(e^2-1)$ **(for hyperbola),** $p = y^2/2x$ **(for parabola). This formula can give the same results as given by general relativity for the problem of planetary advance of perihelion and the problem of gravitational defection of a photon orbit around the Sun.**

This formula can also be written as the following form

$$F_2 = 0 \qquad (4)$$

where: $F_2 = F + \frac{GMm}{r^2} + \frac{3G^2M^2mp}{c^2r^4}$

Similarly, all the theories (or formulae) of force can be writtrn as form of laws of conservation.

Comparing with and referring to the concept of Computer Information Library Clusters, various theories (or formulae) of force and various generalized theories of force can be categorized into theories (or formulae) clusters of force and generalized theories clusters of force.

In addition, theories (or formulae) clusters of force and generalized theories clusters of force can also be divided into subclusters. For example, theories (or formulae) clusters of force can be divided into: theories (or formulae) (sub)clusters of gravitational interaction, theories (or formulae) (sub)clusters of electromagnetic interaction, theories (or formulae) (sub)clusters of strong interaction, theories (or formulae) (sub)clusters of weak interaction, and so on; and generalized theories clusters of force can be divided into: generalized theories (or formulae) (sub)clusters of gravitational interaction, generalized theories (or formulae) (sub)clusters of electromagnetic interaction, generalized theories (or formulae) (sub)clusters of strong interaction, generalized theories (or formulae) (sub)clusters of weak interaction, and so on.

4 To discuss various theories (or formulae) of force in the unified framework of generalized theories clusters of force

4.1 Newton's second law

$$F = ma$$

To compare with generalized theory of force, it gives

$$m_G = m$$

$$a_G = a$$

4.2 Law of gravity

$$F = -\frac{GMm}{r^2}$$

To compare with generalized theory of force, it gives

$$m_G = m$$

$$a_G = -\frac{GM}{r^2}$$

Of course, m_G **and** a_G **can also be written as other forms, for example**

$$m_G = Mm$$

$$a_G = -\frac{G}{r^2}$$

4.3 Improved Newton's formula of universal gravitation

Improved Newton's formula of universal gravitation can be rewritten as follows

$$F = Mm(-\frac{G}{r^2} - \frac{3G^2Mp}{c^2r^4})$$

To compare with generalized theory of force, it gives

$$m_G = m$$

$$a_G = M(-\frac{G}{r^2} - \frac{3G^2Mp}{c^2r^4})$$

Of course, m_G **and** a_G **can also be written as other forms.**

4.4 Law of Coulomb

$$F = \frac{kq_1q_2}{r^2}$$

To compare with generalized theory of force, it gives

$$m_G = q_1$$

$$a_G = \frac{q_2k}{r^2}$$

Of course, m_G **and** a_G **can also be written as other forms.**

4.5 Friction force

$$F = \mu N$$

To compare with generalized theory of force, it gives

$$m_G = N$$

$$a_G = \mu$$

Of course, m_G and a_G can also be written as other forms.

4.6 Special relativity

Considering the case of uniform circular motion

$$F = ma = \frac{m_0}{\sqrt{1 - v^2 / c^2}} a$$

To compare with generalized theory of force, it gives

$$m_G = \frac{m_0}{\sqrt{1 - v^2 / c^2}}$$

$$a_G = a$$

Of course, m_G and a_G can also be written as other forms.

4.7 General relativity

According to the result of general relativity to discuss problem of gravitational defection of a photon orbit around the Sun.

Substituting the value of half normal chord p given by general relativity into Eq.(3), it gives the gravitational force between the Sun and the photon as follows

$$F = -\frac{GMm}{r^2} - \frac{1.5GMmr_0^2}{r^4}$$

where: r_0 is the nearest distance from the photon to the Sun, if the light is tangent to the Sun, it is equal to the radius of the Sun. It is very interesting that, the maximum value of the gravitational force given by this formula is two times as big as that given by Newton's law of gravity.

To compare with generalized theory of force, it gives

$$m_G = m$$

$$a_G = GM(-\frac{1}{r^2} - \frac{1.5r_0^2}{r^4})$$

Of course, m_G and a_G can also be written as other forms.

4.8 Strong interaction

Strong interaction force can be approximately written as the following form

$$F = \frac{f_{unknown}}{r^6}$$

where: $f_{unknown}$ **is an undetermined function.**

To compare with generalized theory of force, it gives

$$m_G = f_{unknown}$$

$$a_G = \frac{1}{r^6}$$

Of course, m_G **and** a_G **can also be written as other forms.**

4.9 Weak interaction

Weak interaction force can be approximately written as the following fractal form

$$F = \frac{f_{unknown}}{r^D}$$

where: $f_{unknown}$ **is an undetermined function,** D **is an undetermined constant.**

To compare with generalized theory of force, it gives

$$m_G = f_{unknown}$$

$$a_G = \frac{1}{r^D}$$

Of course, m_G **and** a_G **can also be written as other forms.**

4.10 Variational principle for unified processing of various theories (or formulae) of force

In reference [9], the following "partial and temporary unified variational principle of natural science so far" is presented

$$\Pi_{\text{NATURE}} = \sum_1^n W_i \int_{\Omega_i} F_i^2 d\Omega_i + \sum_1^m W_j' S_j^2 = \min_0$$

where: the subscript NATURE denotes that the suitable scope is all of the problems of natural science, all of the equations $F_i = 0$ **denote so far discovered (derived) all of the equations related to natural science, all of the equations** $S_i = 0$ **denote so far discovered (derived) all of the solitary equations related to natural science (its meaning can be found in reference [9]),** W_i **and** W_j' **are suitable positive weighted constants, and** $\min_0$ **denotes minimum and its value should be equal to**

zero.

To compare with "partial and temporary unified variational principle of natural science so far", if changing the subscript NATURE into ALL-FORCE, changing $F_i = 0$ into so far discovered (derived) all of theories (or formulae) of force, and changing $S_i = 0$ into so far discovered (derived) all of the solitary equations related various theories (or formulae) of force, thus it gives the following "Variational principle for unified processing of various theories (or formulae) of force"

$$\Pi_{\text{ALL-FORCE}} = \sum_{1}^{n} W_i \int_{\Omega_i} F_i^2 d\Omega_i + \sum_{1}^{m} W_j ' S_j^2 = \min_0$$

As for the application of "Variational principle for unified processing of various theories (or formulae) of force" and the like, please refer to references [7-9].

5 Fifth Force

When discussing the unified framework to process various theories (or formulae) of force, it is necessary to find the fifth force in nature. Considering all possible circumstances, there are two main ways to determine the fifth force: the first one is to find the fifth force through experimental method; the second one is that the fifth force has been clearly presented before people, while just not recognized, so people are only required to confirm the fifth force. The method of determining the fifth force in this paper is the second case.

By comparison, we think that the quantum interaction force (also called quantum force or quantum interaction) is the fifth force in nature.

According to quantum properties, quantum interaction should include: quantum discontinuous interaction, quantum uncertain interaction, quantum stochastic interaction, quantum entanglement interaction, and so on.

We will discuss the details of quantum interaction in another paper.

6 Conclusions

In comparative physics, the comparative studies of various theories (or formulae) of force can be discussed according to the method of comparison. On this basis, the concepts of generalized theory of force, generalized theories clusters of force, variational principle to process various theories (or formulae) of force in unified framework, and the fifth force in nature, namely, the quantum interaction force (can also be called quantum force or quantum interaction), are proposed.

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