Comparative Studies of Five Fundamental Interactions and Unified Theory of Five Fundamental Interactions Established by Law of Conversation of Energy — No.5 of Comparative Physics Series Papers

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Abstract: As No.5 of comparative physics series papers, this paper discusses the comparative studies of five fundamental interactions (gravitational interaction, electromagnetic interaction, weak interaction, strong interaction and quantum interaction), and focusing on the comparative studies of quantum interaction and other four fundamental interactions. The law of conservation of energy is put forward to deal with all kinds of fundamental interactions (including five fundamental interactions, and the sixth fundamental interaction that may appear in the future) with unified manner; in this process, there will be the unified theories of any two fundamental interactions, the unified theories of any three fundamental interactions, the unified theories of any four fundamental interactions, and so on. When law of conservation of energy can be used to deal with five fundamental interactions with unified manner, this unified theory of five fundamental interactions can be printed on a T-shirt.

Key words: Comparative physics, comparative study, quantum interaction, five fundamental interactions, unified theory

Introduction

The concept of comparative physics is presented in reference [1]. As No.5 of comparative physics series papers, firstly this paper discusses the comparative studies of five fundamental interactions (gravitational interaction, electromagnetic interaction, weak interaction, strong interaction and quantum interaction), and focusing on the comparative studies of quantum interaction and other four fundamental interactions. On this basis, the unified theories of various fundamental interactions are discussed in a way different from the existing unified electro-weak theory.

1 The same points of various fundamental interactions

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.

And, in many cases, they occur at the same time. Gravitational interaction, for example, occur at the same time with other interactions, but often neglected for it is too weak.

The third same point: the roles and positions of various fundamental interactions can be transformed. For example, the interaction of charged objects is dominated by electromagnetic interaction, but when the objects lose the charges, the interaction may be dominated by gravitational interaction.

The fourth same point: all fundamental interactions are accorded with law of conservation of energy. Accordingly, it is possible to consider applying law of conservation of energy to deal with various fundamental interactions (including the current five fundamental interactions, and the sixth fundamental interaction that may arise in the future).

2 The different points of various fundamental interactions

The first different point: each fundamental interaction 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.

Again, the existing unified electro-weak theory cannot be applied to gravitational interaction and strong interaction.

The second different point: the intensities of different fundamental interactions are not the same. Assuming that the magnitude of strong interaction is equal to 1, the weak interaction is 10^-12 and the gravitational interaction is 10^-40.

The third different point: at present, various fundamental interactions cannot be discussed in a unified framework.

Now we discuss the different points between the fifth force (namely the quantum interaction) and the other four fundamental interactions.

In reference [2] we already pointed out that quantum interaction should include quantum discontinuous interaction, quantum uncertain interaction, quantum stochastic interaction, quantum entanglement interaction, and so on. These characteristics are generally not possessed by other four fundamental interactions.

For example, in general, gravitational interaction and electromagnetic interaction are continuous.

Because of these differences, to compare with other four fundamental interactions, for the theory (or formula) of quantum interaction, some different methods should be added.

For example, in reference [2], for other four fundamental interactions, 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 other variables; then Newton's second law can be expanded into the following generalized theory of force

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

For the discontinuity of quantum interaction, a Walsh function (Wal) is

needed.

$$F = (Wal)m_G(x, y, z, t, \cdots)a_G(x, y, z, t, \cdots) \qquad (2)$$

It is important to note that, in special cases, these four fundamental interactions can also present some characteristics of quantum interactions, particularly with the help of artificial methods that these four fundamental interactions can also produce some of the characteristics of quantum interactions. For example, we can use artificial methods to make two objects, sometimes charged and sometimes not charged, so that the electromagnetic interaction between the two objects is discontinuous.

3 Applying law of conversation of energy to deal with various fundamental interactions with unified manner

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.

Considering this idea, people are increasingly interested in a variety of unified theories. At present, the most successful unified theory is the existing unified electro-weak theory (unified theory of electromagnetic interaction and weak interaction) that obtained the Nobel Prize. However, due to utilize complex mathematical tools, this theory is difficult to understand and very inconvenient to apply.

In order to overcome this difficulty, this paper puts forward the application of law of conservation of energy to deal with all kinds of fundamental interactions.

Comparing with the unified theory of electromagnetic interaction and weak interaction, we should also consider the unified theories of any two fundamental interactions. That is, in addition to the unified theory of electromagnetic interaction and weak interaction, consideration should also be given to: the unified theory of electromagnetic interaction and strong interaction, the unified theory of electromagnetic interaction and gravitational interaction, the unified theory of electromagnetic interaction and quantum interaction, the unified theory of gravitational interaction and weak interaction, the unified theory of gravitational interaction and strong interaction, the unified theory of gravitational interaction and quantum interaction, the unified theory of weak interaction and strong interaction, the unified theory of weak interaction and quantum interaction, the unified theory of strong interaction and quantum interaction. In other words, there are 10 unified theories consisting of two fundamental interactions.

In addition, the unified theories of any three fundamental interactions should be also considered, these unified theories have 10 kinds: the unified theory of electromagnetic interaction, gravitational interaction, and weak interaction; the unified theory of electromagnetic interaction, gravitational interaction, and strong interaction; the unified theory of electromagnetic interaction, gravitational interaction, and quantum interaction; the unified theory of electromagnetic

interaction, weak interaction and strong interaction; the unified theory of electromagnetic interaction, weak interaction and quantum interaction; the unified theory of electromagnetic interaction, strong interaction and quantum interaction; the unified theory of gravitational interaction, weak interaction and strong interaction; the unified theory of gravitational interaction, weak interaction and quantum interaction; the unified theory of gravitational interaction, strong interaction, and quantum interaction; and the unified theory of weak interaction, strong interaction and quantum interaction.

Moreover, the unified theories of any four fundamental interactions have 5 kinds: the unified theory of electromagnetic interaction, gravitational interaction, weak interaction, and strong interaction; the unified theory of electromagnetic interaction, gravitational interaction, weak interaction, and quantum interaction; the unified theory of electromagnetic interaction, gravitational interaction, strong interaction and quantum interaction; the unified theory of electromagnetic interaction, weak interaction, strong interaction, and quantum interaction; and the unified theory of gravitational interaction, weak interaction, strong interaction and quantum interaction.

Finally, we should consider the unified theory of five fundamental interactions, namely: the unified theory of electromagnetic interaction, gravitational interaction, weak interaction, strong interaction and quantum interaction.

The establishment of above mentioned 26 kinds of unified theories, if we still adopt the method of establishing the existing unified electro-weak theory, it is very difficult to use a unified model; but with the help of law of conversation of energy, it is very easy to use a unified model.

The idea of using law of conservation of energy to establish various unified theories is as follows: for two or more interactions, if law of conservation of energy can be used to simultaneously or separately derive the most important and most commonly used laws and formulae of the two or several interactions, then it can be considered that the unified theory of the two or several interactions is established with law of conservation of energy.

In order to be able to use law of conservation of energy to simultaneously or separately derive the most important and most commonly used laws and formulae of the two or several interactions, the following variational principle can be obtained.

Firstly, law of conservation of energy is written as the form that the right side of the expression is equal to zero.

$$F_1 = 0 \qquad (3)$$

where： $F_1 = E - const$

Then the variational principle of dealing with any two or several interactions can be written as follows

$$\Pi_{\mathrm{SCOPE}} = \sum_{1}^{n} W_i \int_{\Omega_i} (E_i - const_i)^2 \, d\Omega_i = \min_0 \qquad (4)$$

where: the subscript SCOPE denotes the applying scope of the unified theory, n is the number of interactions involved in the unified theory (for example, for the unified theory of electromagnetic interaction, gravitational interaction and weak interaction: $n=3$; but if it is used to simultaneously derive the most important and most commonly used laws and formulae for electromagnetic interaction, gravitational interaction, and weak interactions: $n=1$), Ω_i is the domain involved in each interaction, W_i is the suitable positive weighted constant, and $\min_0$ denotes minimum and its value should be equal to zero.

As for the application of the above mentioned variational principle, refer to references [3-5].

At present, it is ripe to establish the unified theory of electromagnetic interaction and gravitational interaction by applying law of conservation of energy. The reason for this is that, in references [3-5], law of conservation of energy has been applied to derive the law of gravity and Newton's second law; Similarly, for the examples of applying law of conservation of energy to derive the law of gravity and Newton's second law, if the no charged bodies are replaced by charged bodies, then the law of Coulomb and Newton's second laws can be derived. In fact, the example of applying law of conservation of energy to derive the law of Coulomb and Newton's second laws can be found in reference [6].

Accordingly, the variational principle for dealing with electromagnetic interaction and gravitational interaction with unified manner (i.e., the unified theory of electromagnetic interaction and gravitational interaction) can be written as follows

$$\Pi_{\text{E-G}}=\sum_{1}^{n}W_i\int_{\Omega_i}(E_i-const_i)^2d\Omega_i=\min_0 \qquad (5)$$

The further tasks should be to apply law of conservation of energy to derive the most important and most commonly used laws and formulae for other fundamental interactions (namely for weak interaction, strong interaction and quantum interaction), and once these tasks are completed, the above mentioned 26 unified theories can be obtained according to different combinations.

For example, the variational principle for dealing with five fundamental interactions (namely, the unified theory of five fundamental interactions) can be written as follows

$$\Pi_{\text{ALL-FORCE}}=\sum_{1}^{n}W_i\int_{\Omega_i}(E_i-const_i)^2d\Omega_i=\min_0 \qquad (6)$$

Obviously, this unified theory of five fundamental interactions can be printed on a T-shirt.

Not only that, if the sixth fundamental interaction, or even more fundamental interactions are found, it is also possible to establish a unified theory of all fundamental interactions with the same manner.

It is necessary to point out that the "unified theory" mentioned in this paper should be "partial and temporary unified theory so far". According to the viewpoint of reference [7]: the strict "unified theory" cannot be existed, there is only "partial and temporary unified theory so far" (sometimes it may be simplified as "unified theory so far"). In other words, "the strict unified theory of electromagnetic interaction and weak interaction" cannot be existed, and there is only "partial and temporary unified theory of electromagnetic interaction and weak interaction so far". In fact, not only the "strict unified theory" of two or more than two interactions cannot be existed, but also the "strict unified theory" of any kind of interaction cannot be existed. In other words, the "strict unified electromagnetic theory" cannot be existed, so do the "strict unified gravitational theory", the "strict unified strong interaction theory", and the "strict unified weak interaction theory". However, if the "unified theory" is changed into "partial and temporary unified theory so far", then it can be existed.

What is the "unified theory"? In 1980, Stephen Hawking once claimed, physicists have seen the outline of "final theory", this theory of everything can express all laws of nature with a single and beautiful mathematical model, perhaps that it is so simple and can be written on a T-shirt.

In other words, for any field, the strict "unified theory" refers to that all the laws of this field can be expressed in a single mathematical model.

If following this concept to understand the strict "unified theory", we have to say, such a "unified theory" is simply cannot be existed. In other words, there is only "partial and temporary unified theory so far".

4 Conclusions

In comparative physics, according to the method of comparison, we can discuss how to apply law of conservation of energy to establish various unified theories of all fundamental interactions. At present, It has been possible to apply law of conservation of energy to derive the most important and most commonly used laws and formulae for electromagnetic interaction and gravitational interaction, the remaining tasks are to apply law of conservation of energy to derive the most important and most commonly used laws and formulas for weak interaction, strong interaction and quantum interaction, once these tasks are completed, according to different combinations, 26 unified theories (including the unified theory of five fundamental interactions that can be printed on a T-shirt) can be obtained.

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