Unified Field Theory

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Abstract

The main problem, the solution of which will lead to the creation of the Unified Field Theory, is the difference in the methods of mathematical description of the charges of elementary particles - electric and color. This article provides a solution to this problem and its result - the Unified Field Theory.

Keywords

Unified field theory, electric charge, color charge, electromagnetic interaction, strong interaction, electrodynamics in curvilinear coordinates

1. Introduction

To combine electromagnetic and strong interactions, it is necessary to unify the method of mathematical description of the charges of elementary particles - electric and color. This can be done using the field and its geometric parameters. This will lead to a significant simplification of the classical interaction process.

The classic interaction process looks like this. A charge creates a field, and then this field acts on another charge. Using the field and its geometric parameters, we get that the interaction process will now look like this. Two spherically symmetric fields interact with each other. The stronger the interaction, the more the geometry of these fields will differ from the spherically symmetrical shape and vice versa. The weaker the interaction, the less the geometry of these fields will differ from the spherically symmetrical shape. Thus, the interaction of elementary particles can be described by the deviation of the geometry of their fields from a spherically symmetrical shape without using charges - electric and color.

2. Electrodynamics in curvilinear coordinates

This change in the classical process of interaction of elementary particles led the author of this article to the creation of a unified theory of electromagnetic and strong interaction. This theory was called Electrodynamics in Curvilinear Coordinates (ECC). ECC is presented in works [1,2,3].

The ECC is based on the principle of equivalence of the electromagnetic field and the strong interaction field to a free material particle [2,3]. From this principle follows the law of the formation of elementary particles from an electromagnetic field and a strong interaction field. Its experimental confirmation is the creation of particle-antiparticle pairs from a gamma quantum. This process was first observed in 1933 by Joliot-Curie. Another confirmation of this law is the theory that describes the latest results on measuring the expansion rate of the Universe. This theory is presented in article [3].

According to the law of the formation of elementary particles, the field tends to acquire a spherically symmetrical shape. Since with such a field geometry the action integral will be minimal. At the moment when the field acquires a spherically symmetrical shape, an elementary particle is formed. Consequently, the spherically symmetrical shape of the field leads to the appearance of mass and charges of elementary particles. Thus, the law of formation of elementary particles says that the nature of the mass and charges of elementary particles is explained by the spherically symmetrical shape of the field -

electromagnetic field and strong interaction field. The Law of Formation of Elementary Particles is the mathematical basis of a new process of interaction of elementary particles that does not require the use of the concept of charges - electric and color. This made it possible to combine electromagnetic and strong interactions into a single theory [2,3].

3. Unified field theory

The Law of the Formation of Elementary Particles allows us to unify not only the charges of elementary particles - electric and color, but also the mass of elementary particles. Mass unification makes it possible to combine the weak interaction with a theory that unites electromagnetic and strong interactions and create a Unified Field Theory at the microscopic level - without a gravitational field.

Mass unification has another important aspect. Discovering the nature of mass significantly changes our understanding of the nature of the laws of quantum mechanics. Now we know that it is the electromagnetic field and the field of strong interaction that are the carriers of wave-particle duality and those properties that are described by the wave function. This is confirmed by the fact that ECC allows us to obtain equations that are analogues of the Schrödinger equation and the Dirac equations. But these equations are written not for the wave function, but for the electromagnetic field and the strong interaction field and their geometric parameters [1,2,3]. Therefore, ECC is a Unified Field Theory that combines field theory with quantum mechanics.

4. Mass of elementary particles

The unified field theory, set out in [1,2,3], allows us to obtain a formula that determines the mass of elementary particles. In these works, the action integral is considered, which we will now write down, revealing the type of constant included in this integral:

$$S = \frac{\rho_0^2}{c} \iint_\sigma \Lambda \, du dv, \tag{1}$$

where c is the speed of light, ρ_0 is a constant that determines the radius of an elementary particle, σ is a region of two-dimensional space,

$$\Lambda = \frac{e}{16\pi\rho_0^2} F_{ik} f^{ik}, \tag{2}$$

e is the electron charge, $F_{ik}(x^l)$ is the electromagnetic field tensor,

$$f^{ik} \equiv \frac{\partial x^i}{\partial u}\frac{\partial x^k}{\partial v} - \frac{\partial x^k}{\partial u}\frac{\partial x^i}{\partial v}, \tag{3}$$

x^i are four-dimensional coordinates $i, k, l, ... = 0,1,2,3,$ $u^a = (u, v)$ are two-dimensional coordinates on a two-dimensional surface $x^i = x^i(u, v)$ $a, b, c, ... = 0,1$. This two-dimensional surface is the u,v coordinate surface of four-dimensional coordinates $x'^i = (u, v, w, n)$ [1]. And represents two-dimensional space. In this two-dimensional space, the energy-momentum tensor can be defined as follows:

$$T_a^b = \frac{\partial \Lambda}{\partial \frac{\partial x^i}{\partial u^b}} \frac{\partial x^i}{\partial u^a} - \delta_a^b \Lambda. \tag{4}$$

Substituting the right-hand side of equality (2) into definition (4) and then raising the index a, we obtain

$$T^{ab} = \frac{e}{16\pi\rho_0^2} F_{ik} f^{ik} g^{ab}. \tag{5}$$

The two-dimensional space under consideration is a coordinate surface of four-dimensional coordinates describing four-dimensional space, therefore the values of the components of the energy-momentum tensor in two-dimensional space (5) must completely coincide with the values similar components of the energy-momentum tensor of four-dimensional space. As is known, T^{00} is the energy density, therefore for the energy of the system we have

$$\int T^{00}\,dV. \tag{6}$$

The Law of the Formation of Elementary Particles was obtained for systems in which time synchronization was carried out [2]. In such systems, the components of the metric tensor g_{01}, g_{02}, g_{03} are equal to zero. Therefore $g^{00} = g_{00}$. As was shown in [1,2] for spherically symmetric systems

$$g_{00} = \frac{r^4}{\rho_0^4}, \tag{7}$$

where $\boldsymbol{r}$ is the three-dimensional radius vector.

Writing in (6) $dV = 4\pi r^2 dr$ and integrating from 0 to ρ_0, we obtain the formula determining the mass of an elementary particle

$$m = \frac{1}{c^2}\int T^{00}\,dV = \frac{e^2}{40\pi\varepsilon_0\rho_0 c^2}, \tag{8}$$

where ε_0 is the dielectric constant. When deriving this formula, we used the formulas found in [2]. From these formulas it follows that for a spherically symmetric field

$$\frac{1}{2}F_{ik}f^{ik} = \frac{e}{4\pi\varepsilon_0 r^2}. \tag{9}$$

The masses of many elementary particles are well known. Therefore, formula (8) can be used to determine the sizes of elementary particles. For example, for a proton we get $\rho_{0p} \approx 10^{-19}m$, for an electron we get $\rho_{0e} \approx 10^{-16}m$.

5. Two dimensional space

In [1], a law was proven stating that for a spherically symmetric system, the definitions of the determinants of the metric tensors of four-dimensional space and two-dimensional space completely coincide and lead to the same cubic equation

$$\left(\frac{r^2}{\rho_0^2}\right)^3 - \hat{q}\,\frac{r^2}{\rho_0^2} - g_2^2 - g_3^2 = 0, \tag{10}$$

where $\hat{q}$ is the determinant of the metric tensor of two-dimensional space, which is considered to be the surface $x^i = x^i(w,n)$. This two-dimensional surface is a coordinate surface w,n of four-dimensional coordinates $x'^i = (u,v,w,n)$ [1]. Moreover, $w^{\hat{a}} = (w,n)$ are two-dimensional coordinates on the indicated surface $\hat{a}, \hat{b}, \hat{c}, \ldots = 2{,}3$.

$$g_{\hat{a}} = -\frac{g_{0\hat{a}}}{g_{00}}. \tag{11}$$

This law operates when the determinant of the metric tensor of four-dimensional space is equal to

$$\det[g_{ik}] = -1. \tag{12}$$

This law can be considered as proof that in these systems the two-dimensional space u, v is an incompressible and inextensible film [1]. In mathematical terms, this means that when such a system is varied, the variations in coordinates u, v are equal to zero [1].

The solution to equation (10) is three roots:

$$\frac{r_1^2}{\rho_0^2} = \mathrm{A} + \mathrm{B};\ \frac{r_{2,3}^2}{\rho_0^2} = -\frac{\mathrm{A}+\mathrm{B}}{2} \pm i\sqrt{3}\,\frac{\mathrm{A}-\mathrm{B}}{2}; \tag{13}$$

where A,B are functions of $\hat{q}$ and $g_2^2 + g_3^2$..
Roots (13) satisfy the conditions [1]:

$$\frac{r_1^2}{\rho_0^2} + \frac{r_2^2}{\rho_0^2} + \frac{r_3^2}{\rho_0^2} = 0, \tag{14}$$

$$\frac{r_1^2 r_2^2}{\rho_0^4} + \frac{r_2^2 r_3^2}{\rho_0^4} + \frac{r_3^2 r_1^2}{\rho_0^4} = -\hat{q} = -3\mathrm{AB}, \tag{15}$$

$$\frac{r_1^2 r_2^2 r_3^2}{\rho_0^6} = g_2^2 + g_3^2 = \mathrm{A}^3 + \mathrm{B}^3. \tag{16}$$

Let $g_2^2 + g_3^2 \neq 0$. Dividing condition (15) by (16), we obtain:

$$\frac{\rho_0^2}{r_1^2} + \frac{\rho_0^2}{r_2^2} + \frac{\rho_0^2}{r_3^2} = -\frac{\hat{q}}{g_2^2 + g_3^2} = -\frac{3\mathrm{AB}}{\mathrm{A}^3 + \mathrm{B}^3}. \tag{17}$$

These conditions make it possible to find out that an elementary particle consists of individual quarks. A proton is formed by quarks with relative electric charges equal to:

$$-\frac{1}{3}; +\frac{2}{3}; +\frac{2}{3}. \tag{18}$$

Comparing these values with the conditions listed above, we note that the values $\frac{\rho_0^2}{r^2}$ can be considered as the relative electric charges of quarks. Thus, substituting values (18) into equality (17), we obtain for the proton

$$1 = -\frac{\hat{q}}{g_2^2 + g_3^2} = -\frac{3\mathrm{AB}}{\mathrm{A}^3 + \mathrm{B}^3}. \tag{19}$$

It follows that the opportunity to describe the quarks that make up the proton appears when two conditions are met:

$$\hat{q} = -g_2^2 - g_3^2. \tag{20}$$

$$\mathrm{A}^3 + \mathrm{B}^3 + 3\mathrm{AB} = 0. \tag{21}$$

From condition (20) it follows that in order to describe the quarks that make up the proton, the determinant of the metric tensor must be less than zero

$$\hat{q} < 0. \tag{22}$$

Condition (21) defines a Cartesian sheet for the case when the coefficient included in this condition is equal to -1. Condition (21) can be written using the parameter $-\infty \leq \alpha \leq +\infty$ as follows:

$$\mathrm{A} = -3\frac{\alpha^2}{\alpha^3 + 1}; \ \mathrm{B} = -3\frac{\alpha}{\alpha^3 + 1}. \tag{23}$$

Let us substitute roots (13) into the left side of equality (17), which for a proton is equal to unity, we obtain

$$\frac{1}{\mathrm{A} + \mathrm{B}} - \frac{\mathrm{A} + \mathrm{B}}{\mathrm{A}^2 + \mathrm{B}^2 - \mathrm{AB}} = 1. \tag{24}$$

Values (23) turn equality (24) into an identity. This proves that conditions (20) and (21) are satisfied. Using equation (10) and condition (20) we find:

$$\hat{q} = \frac{\left(\frac{r^2}{\rho_0^2}\right)^3}{\frac{r^2}{\rho_0^2} - 1}. \tag{25}$$

From this equality it follows that for $r > \rho_0$ we obtain $\hat{q} > 0$, and for $r < \rho_0$ we obtain $\hat{q} < 0$. Taking into account (20) and (22), we obtain that the radius ρ_0 can be considered as the radius of an elementary particle.

Note that the law of formation of elementary particles operates when the components of the metric tensor g_{01}, g_{02}, g_{03} are equal to zero. In this case, from (11) and (20) it follows that $\hat{q} = -g_2^2 - g_3^2 = 0$. This means that once we have formed an elementary particle, we can no longer consider quarks.

6. Conclusions

In the works [1,2,3], the Unified Field Theory was created at the microscopic level, without a gravitational field. This theory was constructed under the condition that the variation of the metric tensor describing the geometry of four-dimensional coordinates given in four-dimensional space-time is equal to zero.

7. References

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