The gravitational condensate of the higgs field

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Abstract

This paper analyses a method of producing the Higgs mass via the gravitational field. This approach has become very popular in recent years, as the consideration of other forces do not help in solving the problem of mass hierarchy. Not understand the difference between scales of the standard model and Grand unification theory. Here, we present a heuristic mechanism which eliminated this difference. The idea is that the density of the condensate of the Higgs is increased so that it is necessary to take into account self gravitational potential energy of the Higgs boson. The result is as follows. The mass of the Higgs is directly proportional to the cell density of the Higgs bosons. Or else the mass of the Higgs is inversely proportional to the cell volume, which is the Higgs boson in the condensate. The most interesting dimension of this cell condensation is equal to the scale of Grand unification. This formula naturally combines the scale of the standard model and Grand unification through gravitational condensation.

Recently used non-standard approaches to solving the problem of the Higgs mass. Previously popular methods of supersymmetry. However, besides it there are other trips, for example to take into account the entirety and gravity

\[ L = \frac{1}{2}m_H^2c^2\varphi^2 - h^2\nabla\varphi\nabla\varphi + \frac{c^4}{16\pi G} \sqrt{-g} R \]

This approach is recently often regarded as the most promising. Many have tried to create models where the scale of the Higgs mass. However, the exact mechanisms or the final result was different.

Here we consider the problem of the gravitational energy of the Higgs boson and discover their own formula for calculating the mass of the Higgs.

First recall that the total energy and mass in relativity theory depends on the contribution of kinetic and potential energy of different forces

\[ E = m_Hc^2 + K + U \]

Consider the quantum corrections to the kinetic part associated with very small scale and by relativistic effects

\[ K \approx pc = \frac{hc}{r} \]

\[ m_Hc^2 \approx E - \frac{hc}{r} - U \]

In addition it is necessary to consider the potential energy of interaction for the scalar Higgs boson will consider only its own gravitational part between the bosons in the condensate.
In total balance of energy and mass of the Higgs will be

\[ U = -\frac{G}{r} \left( m_H + \frac{h}{rc} \right)^2 \]

Will be considered that the scale of the quantum contribution is much greater than the mass of the Higgs boson.

\[ m_H \ll \frac{h}{rc} \]

Besides that, there is a quantum correction to the mass through a total energy balance

\[ E - \frac{hc}{r} = \Delta mc^2 \]

Hence, it turns out the General formula, where the mass of the Higgs in the total condensate depends on the quantum corrections and the gravitational energy of the forces between the bosons

\[ m_Hc^2 = \Delta mc^2 + \frac{Gh^2}{c^2r^3} \]

As can be seen the gravitational part depends inversely proportional of the cube of the distance, volume

\[ V = \frac{4\pi}{3} r^3 \]

Where the density of the condensate is, the number of bosons per unit volume

\[ n = \frac{N}{V} \]

Thus, a formula where the mass of the Higgs depends on the density of the number of bosons in the condensate

\[ m_Hc^2 = \Delta mc^2 + \frac{Gh^2}{c^2} \frac{N}{V} \]

The wave function of the condensate Higgs is the density of the number of bosons. So, there is a gravitational nonlinearity of the wave function of the condensate of Higgs bosons.

\[ n = \frac{N}{V} = |\psi|^2 \]

Consider the case when the mass of the Higgs is dominated by the gravitational contribution to the total condensate field.

\[ \Delta mc^2 \ll \frac{Gh^2}{c^2} \frac{N}{V} \]

\[ m_Hc^2 \approx \frac{Gh^2}{c^2} \frac{N}{V} \]
Given that the density of the Higgs bosons leads to the size of a single cell, where only one Higgs boson

\[ \frac{N}{V} \approx \frac{1}{L^3} \]

It turns out the dependence of the Higgs mass the size of a single cell of a condensate of Higgs bosons

\[ E_H = m_H c^2 \approx \frac{G h^2}{c^2} \frac{1}{L^3} \]

When the mass of the Higgs in the standard model, which determines the overall scale of the masses of fundamental particles

\[ E_H = 126 \text{ GeV} \]

The size of the individual volume of the Higgs boson in the condensate is equal to the length scale of Grand unification

\[ L \approx 10^{-29} \text{ (m)} \]

This is a very interesting result. The scale of the standard model follows from the scale of Grand unification in the case of accounting for the gravitational energy in the condensate of the Higgs. This relationship between the two scales exists if we use the gravitational condensate Higgs formula

\[ m_H c^2 \approx \frac{G h^2}{c^2} \frac{N}{V} \]

The wave function of the condensate of Higgs bosons

\[ \frac{N}{V} = |\psi|^2 \]

In general, the inclusion of gravity in the Higgs mass can lead to adequate estimates in the problem of the hierarchy of the standard model and the theory of great interaction. In addition, perhaps we are not observing the true Higgs mass, but its gravitational contribution, the true mass is on the scale of the theory of great interaction.

**Discussion**

We see that in addition to supersymmetry, there are other explanations in the Higgs mass problem. Recently, gravity has often been taken into account. In this work, a concrete result is obtained, the mass depends on the density of the Higgs condensate bosons. This allows us to relate the scale of the standard model and the scale of the theory of grand unification based on the Higgs field gravitational condensate. In this case, this method seems to us a more natural description of the Higgs mass problem.


[7] N. Pinto-Neto, gr-qc 0410001, 0410117, and 0410225


