Neutrino and Amplification of the Early Universe

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Abstract

In this research, it was proven that the speed of neutrinos is very close to the speed of light, which leads to the conclusion that the mass of neutrinos decreases exponentially with time, according to Newton's equation of motion and the equations of special relativity. If the universe contained neutrinos in abundance at its beginning and was a component of vacuum, then the equations of the Big Bang model predict an inflationary universe, which would solve the problems of entropy, horizon, flatness and singularity. The prediction is that the energy of vacuum decreases with time.

***Keywords**: Neutrino-Amplification- Early Universe.*

النيوترينو والتضخم المبكر للكون

الملخص

في هذا البحث تم ايجاد سرعة النيوترينو حيث وجد انها قريبة جدًا من سرعة الضوء، مما ادي إلى استنتاج أن كتلة النيوترينو تتناقص بشكل كبير مع الزمن، وفقًا لمعادلة نيوتن للحركة ومعادلات النسبية الخاصة. فاذا كان الكون يحتوي على النيوترينوات بكثرة في بدايته وكان متكونًا في الفراغ، فإن معادلات نموذج الانفجار العظيم تتنبأ بوجود كون تضخمي، مما يحل بعض المشاكل مثل مشاكل الإنتروبيا والأفق والتسطح والتفرد. مما يمكن التنبؤ بان طاقة الفراغ تتناقص مع الزمن.

الكلمات المفتاحية: النيوترينو، الكون التضخمي، بداية الكون.

1. Introduction

The general theory of relativity plays an important role in explaining the phenomena related to the origin and nature of the universe. It was able to explain many of the phenomena related to it such as the expansion of the universe, redshift, cosmic rays and other cosmic phenomena that were supported by physical experiments. Despite the success of the Big Bang model based on general relativity, it failed to explain other phenomena. The problems faced by the Big Bang model are called horizon, entropy, flatness and singularity problems. Scientists have developed many models to solve these problems and this model is based on the general theory of relativity . While some of them depend on the generalized gravitational field model . One of the most famous models developed to solve these problems is the inflationary model, The neutrino is considered one of the most mysterious physical particles, as scientists are still confused about its mass. Some scientists believe that its rest mass is equal to zero, while others believe that it has a rest mass, but it is very small, Cosmological implications of neutrino physics were first considered in a paper by Alpher et al. who mentioned that neutrinos would be in thermal equilibrium in the early universe. The possibility that the cosmological energy density of neutrinos may be larger than the energy density of baryonic matter and the cosmological implications of this hypothesis were discussed by Pontecorvo and Smorodinskii . A little later Zeldovich and Smorodinskii derived the upper limit on the density of neutrinos from their gravitational action. In a seminal paper in 1966, Gerstein and Zeldovich derived the cosmological upper limit on neutrino mass, see Section 4.1. This was done already in the frameworks of modern cosmology. Since then the interplay between neutrino physics and cosmology has been discussed in hundreds of papers, where limits on neutrino properties and the use of neutrinos in solving some cosmological problems were considered. Neutrinos could have been important in the formation of the large-scale structure (LSS) of the universe, in big bang nucleosynthesis (BBN), in anisotropies of cosmic microwave background radiation (CMBR), and some others cosmological phenomena. This is the subject of the present research. The field is so vast and the number of published papers is so large that I had to confine the material strictly to cosmological issues. Practically no astrophysical material is presented, though in many cases it is difficult to draw a strict border between the two. For the astrophysical implications of neutrino physics one can address the book , In this research, some equations were formulated to explain the very small mass of the neutrino, which requires that it travels at a very high speed, very close to the speed of light. Assuming that the density of neutrinos, which constitute dark matter, which some scientists believe constitutes a large part of the matter of the universe, is what generates the gravitational field. It becomes clear that the mass of the neutrino decreases exponentially with time, so that it is now very small. This is consistent with the fact that the mass of the neutrino is small at the present time.

2. Big Bang Theory Equations

The equations of the Big Bang theory]19[are based on Einstein's equation

$$R_{\mu\nu} - \frac{1}{2} g_{\mu\nu} R = -8\pi G T_{\mu\nu} \quad \rightarrow (1)$$

Where $R_{\mu\nu}$ it represents the Reiki curvature span, while $g_{\mu\nu}$ it represents the convexity function, and $T_{\mu\nu}$ expresses the energy and impulse span. When using the Roberson Walker kyphosis

$$g_{tt} = -1 \qquad g_{rr} = \frac{a^2}{(1-kr^2)} \qquad g_{\theta\theta} = a^2 r$$

$$g_{\phi\phi} = a^2 r^2 \sin^2\theta \qquad \rightarrow (2)$$

Einstein's equations become in the form

$$\dot{a}^2 + k = \frac{8\pi G}{3}\rho a^2 \qquad \rightarrow (3)$$

$$\dot{\rho} + \frac{4\dot{a}}{a}\rho = 0 \qquad \rightarrow (4)$$

Where ρ represents the density of the universe's matter and a is proportional to the diameter of the universe and k constant takes the following values

$$k = 0, \pm 1 \qquad \rightarrow (5)$$

3. Neutrino and its properties

Neutrino is one of the most mysterious particles. Some authors thought that neutrino constitute part of the vacuum energy, as scientists still perplexed about its mass [20]. Some Scientists believe that the rest mass is zero while others believe that the rest mass is very small. According to the theory of special relativity, the mass (m) can be found in terms of the rest mass speed v according to the formula

$$m = \frac{m_o}{\sqrt{1 - \frac{v^2}{c^2}}} \qquad \rightarrow (6)$$

Here one assumes the rest m_0 to be very small, i.e

$$m_o \rightarrow 0$$

For (m) to be finite (as experimentally observed) m limited, this requires

$$\sqrt{1 - \frac{v^2}{c^2}} \rightarrow 0$$

i.e

thus, the neutrino speed v becomes

$$v \rightarrow c \qquad \rightarrow (7)$$

According to the big bang model, the neutrino in an expanding universe moves against gravity force F. Thus, equation of motion becomes

$$\frac{d(mv)}{dt} = \frac{d(mc)}{dt} = c\frac{dm}{dt} = F = +\nabla\phi \qquad \rightarrow (8)$$

Where ϕ is the potential and this potential depends on matter density ρ according to the relation $\nabla^2\phi = 4\pi G\rho$

Considering the neutrino to have uniform density and spherical shape with radius r_0 .The neutrino density equals

$$\rho = \frac{3m}{4\pi r_0^3} \qquad \rightarrow (9)$$

Then the equation (9) becomes

$$\nabla^2 \phi = \frac{4\pi G(3m)}{4\pi r_0^3} = \frac{3G}{r_0^3} m \qquad \rightarrow (10)$$

using equation (8) yields

$$\frac{\partial \phi}{\partial x} = \nabla \phi = +c \frac{dm}{dt}$$

$$\nabla^2 \phi = \frac{\partial^2 \phi}{\partial x^2} = \frac{d^2 \phi}{dx^2} = \frac{\partial}{\partial x}\left(\frac{\partial \phi}{\partial x}\right) = \frac{\partial}{\partial x}\left(c \frac{dm}{dt}\right) = c \frac{d}{dx}\left(\frac{dm}{dt}\right)$$

$$= c \frac{d}{dt}\left(\frac{dm}{dt}\right) \times \frac{dt}{dx}$$

$$\nabla^2 \phi = +c \frac{d^2 m}{dt^2} \times \frac{1}{c} = + \frac{d^2 m}{dt^2}$$

And using equation (10) the resulting

$$\frac{d^2 m}{dt^2} = + \frac{3G}{r_0^3} m \qquad \rightarrow (11)$$

This equation describes the neutrino mass equation variable with time and the solution becomes

$$m = m_0 e^{-\gamma_0 t} \qquad (12)$$

Substituting equation (12) in equation (11) to give

$$\gamma_0^2 = \frac{3G}{r_0^3}$$

$$\gamma_0 = \sqrt{\frac{3G}{r_0^3}} \qquad (13)$$

thus equation (13) is consistent with the fact that the neutrino mass is very small now according to equation (12), were

$$m \rightarrow 0 \qquad t \rightarrow \infty$$

4. The role of the neutrino in the amplification of the universe

According to the Big Bang model, the universe in its infancy contained particle energy and vacuum energy, according to what some scientists believe . Some scientists consider the universe to contain a high density of dark matter, which they believe are neutrinos [13]. which makes the density of the universe in this case [14]

$$\rho = \frac{3N}{4\pi} \frac{m}{r_0^3} \qquad \rightarrow (14)$$

Where N represents to the total number for Neutrinos. If the equation (14) together with (12), one gets

$$\frac{-3N\gamma_0}{4\pi r_0^3} m = \frac{-2N}{4\pi r_0^3} m \frac{\dot{a}}{a}$$

$$\frac{\gamma_0}{4} = \frac{\dot{a}}{a} \qquad \rightarrow (15)$$

Then the standard cosmological factor a becomes:

$$\int \frac{da}{a} = \frac{\gamma_0}{4} \int dt + c_1$$

$$\ln a = \frac{\gamma_0}{4} t + c_1$$

Were

$$a = e^{c_1} e^{\frac{\gamma_0 t}{4}}$$

when

$$a = a_0 \qquad t = 0$$

$$a_0 = e^{c_1}$$

Then

$$a = a_0 e^{\frac{\gamma_0}{4} t} \qquad \rightarrow (16)$$

This equation predicts universe inflation and one can obtain the same solution of equation (3) and (12) for inflationary universe by assuming the universe to be flat (i.e k=0) in eqn (6.8.3) and assuming m to be constant at early stage, i.e

$$m \approx m_0 e^{-0} = m_0 \qquad t \rightarrow 0 \qquad \rightarrow (17)$$

Then equation (6.8.3) becomes

$$\dot{a}^2 = \frac{24\pi G}{3} \frac{m_0}{4\pi r_0^3} a^2$$

$$\dot{a}^2 = \frac{2Gm_0}{r_0^3} a^2$$

$$\dot{a} = \sqrt{\frac{2Gm_0}{r_0^3}}\, a \qquad (18)$$

Hence the solution is in the formula

$$a = a_0 e^{\beta_0 t} \qquad (19)$$

were

$$\beta_0 = \sqrt{\frac{2Gm_0}{r_0^3}} \qquad (20)$$

For consistency of the solutions of equations (6.9.3) and equation (6.9.7) one suggests

$$\gamma_0 = 4\sqrt{\frac{2Gm_0}{r_0^3}} \quad (21)$$

5.Discussion

The equations (6) and (7) show that the very small mass of the neutrino necessitates that it travels at a very high speed and very close to the speed of light. Assuming that the neutrino density that makes up the dark matter, which some scientists believe constitute a large part of the matter of the universe, is what generates the gravitational field lt becomes clear that the mass of the neutrino decreases exponentially with time, so that it becomes very small now. This is consistent with the fact that the mass of the neutrino is small today.

And the equations (6) and (7) also show that the neutrino must travel very close to the speed of light as long as its mass is small, and this is also consistent with the fact that the speed of the neutrino observed now is almost equal to the speed of light. This fact can be used in the neutrino motion equation, which shows that the mass of the neutrino decreases exponentially with time according to the equation (12).

If the universe contains dense neutrinos, as some research supposes , then substituting equation (12) in Einstein's equations for the universe. These equations predict an inflationary universe according to the two equations (16) and (19). Since these equations predict a decrease in vacuum energy with time, where the exponential coefficient depends on the gravitational constant which confirms the effect of gravitational forces on inflation and may be a repulsive force. This coefficient also depends on the neutrino's rest mass and radius, as shown by the equation. (21) This inflationary universe solves the problems of horizon, singularity, flatness and entropy. In this research, some equations were formulated to explain the very small mass of the neutrino, which requires that it travels at a very high speed, very close to the speed of light. Assuming that the density of neutrinos, which constitute dark matter, which some scientists believe constitutes a large part of the matter of the universe, is what generates the gravitational field. It becomes clear that the mass of the neutrino decreases exponentially with time, so that it is now very small. This is consistent with the fact that the mass of the neutrino is small at the present time.

6. Conclusion

As one can see from the material presented above, cosmological implications of neutrinos as well as implications of cosmology for neutrino physics are two vast fields that include diverse physical phenomena that have different “raison d’être”. It is important to distinguish the “confidence level” of particular physical models and assumptions discussed in this research. The existence of three families of neutrinos is a well-established fact, while the fourth generation, even very heavy , A neutrino (which can be considered a component of a vacuum) could cause the universe to inflate if the universe had neutrinos (dark matter) in abundance in the early universe. This inflationary universe would solve the problems of entropy, horizon, singularity, and flatness.

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