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Wave Function Mass and Energy and the Nature of the Universe

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Abstract: After defining open and closed universes, we define a wave function in which mass is separated from all other energies except gravitation. The mass and energies are located in the complex plane with trigonometric consequences. The square of the wave function yields an expression for total energy which is assumed to imply an open universe.This 'toy theory' is a minimalist construction demonstrating how such cosmological questions might be addressed.

Keywords: wave function, trigonometric analysis, opens Universe.

1 Introduction

The purpose of this paper is to consider the wave function in terms of mass and energy. Based on the analysis carried out, we have considered what this may mean about the nature of the universe: is it open or closed, finite or infinite?

Let us first briefly consider the current views on the nature of the universe and the nature of the wave function.

1.1.1. Views on the nature of Universe: finite or infinite Universe?

Is the volume of space in the Universe closed or open, finite or infinite? According to many cosmologists, the first possibility seems to be correct, ie a closed universe [1,2,3]. The closed universe theory assumes that the expansion of the universe is not infinite. In the closed-universe theory, the universe would arise in a big bang, which would cause it to expand rapidly, then slow down, stop, and finally contract. In quantum cosmology, closed models are preferred - with a finite volume of the Universe. The following properties of a closed universe follow from this: The universe is an isolated system - there is no other world outside of it. The total energy of the closed universe is zero, and the vector of the closed universe state cannot depend on time [1,2]seems to confirm this fact. According to quantum cosmology, the Big Bang phenomenon it can be treated as a kind of tunnel transition from the unavailable state to the available state [1,2]. This is not possible for an open Universe. According to t'Hooft [4] the ontological states concept refers to the closed universe. This concept assumes that: if the initial state is an ontological state, then the final state will be ontological too. This means that the universe had a beginning and will have an end. t'Hooft claims that the ontology conservation law is closely related to its counterpart - the initial state factors keep the same values in their final state.

What is the situation for the open universe? The following are the assumptions of the open universe theory. The universe in which there is insufficient matter, and thus insufficient gravitational force, to halt the expansion initiated by the Big Bang. The curvature of space is flat or curved away from itself, entailing that the size of the universe is infinite. Gravity between objects is not able to stop or reverse the expansion of the universe, thus objects continue to move farther and farther apart as space moves outward. An object moving in a straight line in an open universe would never return to its starting point. Such a universe will never end, but will eventually become very cold and dark because stars gradually lose all of their energy. Null probability of the tunnel effect in the open model. This means that the Big Bang cannot happen. The universe is the only isolated system, which means that, apart from it, there is no other world that can be invoked to establish margins or post-initial conditions. For an open universe, total energy is infinite. The instability of the three-dimensional metric of the universe is the root cause of all changes taking place in the universe.

According to t'Hooft' conception [4] the universe is in a superimosed state – there are a probabilistic muxture of different ontoligies. If the initial state is a probabilistic mixture of ontological state, the the final state is exactly the same as those of the initial state. The initial state cannot be an ontological stae then. It can be understood that the initial state does not exist.

Is the universe open or closed? Consider Olbers' paradox formulated by the German astronomer Heinrich Olbers in 1823. Olbers' paradox relating to the problem of why the sky is dark at night. This paradox presupposes: if the universe is endless and uniformly populated with luminous stars, then every line of sight must eventually terminate at the surface of a star. Hence, contrary to observation, this argument implies that the night sky should everywhere be bright, with no dark spaces between the stars.

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The problem was considered by earlier investigators and can be traced back to Johannes Kepler, who, in 1610, advanced it as an argument against the notion of a limitless universe containing an infinite number of stars. Why is the night sky dark then? The solution to the paradox could be due to several different possibilities:

1) The universe is finite, that is, it ends at some point.

2) The stars run out at large distances.

3) There hasn't been enough time for the light to reach us from the most distant stars. In the context of an expanding universe, it can be argued similarly: the universe is too young for light to have reached the Earth from very distant regions.

4) Presence of dark matter which makes up about 27 % of the Universe?

5) Perhaps the most likelythe solution to Olbers' paradox is the conclusion that there are not enough stars in the Universe to densely pack the entire observed field of the sky with them.

Let us take a look at Giordano Bruno's views on the nature of the Universe. In his most important works on cosmology and metaphysics: *On Infinity, the Universe and the Worlds*, and *On Cause, Origin and Oneness*, Giordano Bruno proves the existence of an immense Universe, composed of an infinite number of worlds, i.e. systems consisting of stars and planets orbiting around them. Bruno alluded to the concept of Aristotle. According to Aristotle, the Universe had no beginning, it is eternal and indestructible.

1.1.2. Contemporary view on the nature of the Universe.

Let's take a look at modern data on the nature of the universe. The WMAT experiment conducted in the early 2000s shed light on the nature of the universe. WMAP experiment determined that the universe is flat, from which it follows that the mean energy density in the universe is equal to the critical density (within a 0.4 -0.5% margin of error). The recent astronomical observations indicate that the expanding universe is homogeneous, isotropic and asymptotically flat. It means that total energy density of universe is approximately equal to 1. The total mass of ordinary matter in the universe can be calculated using the critical density and the diameter of the observable universe to be approximately 1.5×10^{53} kg. Based on observational data, especially an assessment of deuterium content in space it is estimated that the contribution of luminous matter constitutes about 5%. The estimated mass of the universe refers to this value. Based on the above data, it can be concluded that the sum of the total energy and mass of the universe is infinite.

If the universe were finite, reflections from starlight should be observed. This fact has not been observed, which contradicts the finite nature of the universe.

1.2 Views on the wave function

In 1926 E. Schrödinger formulated the wave mechanics dealing with the description of the wave properties of matter. According to this theory, a steady-state electron in an atom can be described in terms of standing waves of matter [5].This theory defines the laws of wave motion of particles in any microscopic system. Wave properties of a particle (or other object) in mechanics quantum describes the so-called wave function Ψ (x, t): contains all information about an object (e.g. a particle). In general, it is a complex function of coordinates of spatial and time, must be a continuous function and must also have a continuous derivative. The square of the wave function module is the probability density of finding the particle at the moment at some point in space. The wave functions for the entire universe are expressed as an integral along the trajectory of compact 4D geometries with the additional condition of a given compact 3D geometry as the boundary, which is the amplitude whose modulus is a probability. In 1927 Heisenberg discovered that it is impossible to accurately determine the position and momentum of a particle at the same time [6]. This is known as the uncertainty rule. According to t'Hooft' [4] quantum mechanics can then be treated as a device that combines statistics with mechanical, deterministic laws, such that uncertainties arre passed on from initial states to final states.

2 Materials and Methods

The subject of the considerations is conjugated wave function of an elementary particle (or other object) in terms of mass and energy. A trigonometric analysis of a complex function was used: mass as the real part and energy as the imaginary part. The helicity operator has been used to normalize both the real part - mass and the imaginary part – energy. Gravitational energy, which is negative has been excluded. Positive energy must be provided for a mass to escape from a gravitational well.

3 Results and Discussion

3.1 Analysis of wave function of mass and energy

Let us consider the wave function Ψ of a particle (or other object) focusing on the mass (density) and energy of the particle (object). Each particle or material object has a specific mass (or density) and energy. Therefore we choose these physical quantities for our considerations. On the complex plane (yellow background) (Fig.1), we can present these quantities as follows.

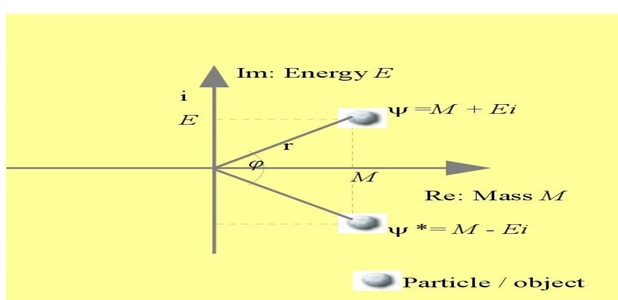

Fig. 1: Graphic illustration of the considered mass and energy wave function. The yellow background illustrates the complex plane.

The yellow background illustrates the complex plane.

where:

Re - reality part of wave function Ψ represented by a mass M of particle (object),

Im – imaginary part of wave function Ψ represented by an Energy E of particle (object), Wave function y is given:

$$\Psi = M + Ei \quad (1)$$

i - an imaginary entity

r - wave function module:

$$r = \sqrt{M^2 + E^2} \quad (2)$$

The position of the particle at a given point on the plane is defined as follows:

$$\cos(\varphi) = \frac{M}{r}$$

where

$$M = r\cos(\varphi) \quad (3a)$$

$$\sin(\varphi) = \frac{E}{r}$$

where

$$E = r\sin(\varphi) \quad (3b)$$

$$\tan(\varphi) = \frac{E}{M}$$

where

$E = M \tan(\varphi)$ or

$$M = \frac{E}{\tan\varphi} \quad (3c)$$

From Einstein's equation: $E = mc^2$ the energy-to-mass E/M ratio (eq. 3c) gives us the square of the speed of light $c.^{2.}$ Hence:

$$\tan(\varphi)=c^2 \quad (3d)$$

Substituting Eq. (3a) and (3b) to Einstein's

$E = mc^2$ equation we get:

$$r\sin(\varphi) = r\cos(\varphi)c^2 \quad (4)$$

Substituting relations (3a) and (3b) to eq. (1) we get:

$$\Psi = r[\cos(\varphi) + i\sin(\varphi)] \quad (5a)$$

or taking into account Euler's transformation:

$$\Psi = r \exp(i\varphi) \quad (5b)$$

A function coupled Ψ^* to a wave function Ψ describing by an Eq. (1) has the form:

$$\Psi^* = M - Ei \quad (6)$$

The product of function $\Psi\Psi^*$:

$$\Psi\Psi^* = (M + Ei)(M- Ei)^* = M^2 + E^2 = r^2 \quad (7)$$

Substituting Eq. (3a) and (3b) to Eq. (7) we get:

$$\Psi\Psi^*=r^2[(\cos^2(\varphi)+\sin^2(\varphi)]=r^2=M^2+E^2 \quad (8)$$

The above formula shows that the modulus squarecoupling of the wave function is the sum of the square of the mass of a particle (or other object) and its energy. The same relationship is illustrated by Eq. (7).

The modulus of the wave function is the probability of finding it at every point in space. It is like a square root of a number, a dimensionless quantity, whereas mass and energy have physical units. Therefore, it is necessary to normalize the dimensionless value of the function. The operato helicity can be used for this. Helicity is defined as the normalized component of the particle's spin along its direction of flight. When applied to the considered mass and energy wave function (Eq. 7 or 8), helicity is used as follows:

$$M^2 = \frac{S*M^2}{|M|} = (S*M)x,y,z \quad (9a)$$

$$E^2 = \frac{S*E^2}{|E|} = (S*E)x,y,z \quad (9b)$$

where:

S – *i*s the complex plane corresponding to the spin matrix,

x,y,z - are the direction of flight of the particle along the complex plane,

$|M|$,$|E|$ - absolute value of mass or energy.

From the above equations it follows:

$$\psi\psi^*=M^2 + E^2 = \sqrt{S*M} + \sqrt{S*E} \quad (10)$$

After the normalization procedure is applied, it can be seen that the considered wave function of mass and energy expressed by eq. (10) relates to dimensionless values, both mass and energy.

Let us also consider the sum $\Psi + \Psi^*$ and the difference $\Psi - \Psi^*$ of the coupled wave function:

$$\Psi + \Psi^* = M + Ei + M - Ei = 2M \text{ – the real part} \quad (11)$$

$$\Psi - \Psi^* = M + Ei - M - Ei = 2Ei \text{ - the imaginary part} \quad (12)$$

Normalizing the above equations in the same way as above, using the helicity operator, we get $2S$. This is a pure complex plane in two-dimensions.

Let's just include the energy of a particle $E=h\nu$ (or other objec where h is a Planck constant and ν is its frequency. Based on the above dependence and taking into account the infinite n number of particles in the universe,which results from the trigonometric analysis (see eq. 3c and 3d) equations (7) or (8) can be presented in the form:

$$\Psi\Psi^* = \sum [(h\nu)^2 + M^2] \quad (13)$$

where $h\nu = E$

or in a dimensionless version such as in the eq. (10). Inserting eq. (3c) to (13) in a dimensionless version we get:

$$\Psi\Psi^*= \text{sqrt}\{\sum S[M\tan(\varphi) + E/\tan(\varphi)]\} \quad (14)$$

Equation (13) and (14) describes the wave properties of each object: small or large mass and energy.

3.2 Discussion

The conducted analysis showed:

1) As equation (8) shows, our coupled wave function is normalized to 1. The conjugation of the trigonometric values of mass and energy normalizes the wave function to 1.

2) The square of the module contains the sum of the square of the mass of a particle (or object) and its energy.

3) The trigonometric analysis showed that the mass and energy values of a particle or other object are out of phase with each other.

4) The sum of the coupling of the wave function gives us only the real part, i.e. the mass of particles (or other object). The difference of the coupling of the wave function gives us only the imaginary part, i.e. the energy of particles (or other object). After applying the normalization procedure using the helicity operator, we get $2S$ - a pure complex plane in two-dimensions for both the real part (mass) and the imaginary part (energy).

What does the conducted analysis of the wave functions of mass and energy show about the nature of the universe? Equations (7) and (8) show that the square of the considered function is the sum of the squares of the mass and energy modulus. This is true for all particles in the universe. You can see the close connection of energy with the mass of the object. The connection of the energy of a particle with the energy following from of the Einstein formula we obtain the universal dependence on the wave properties of every particle and every object in the universe ((eq. (13)). After applying the normalization procedure, using the operator helicity illustrate the wave properties of each object in the universe. As it follows from eq. (13) for objects of low mass (elementary particles) the wave properties are visible. However, for objects with a large or very large mass, the wave properties are not visible. Each object has energy, although it does not have to have mass, e.g. photons. It means that energy is never zero. It follows from $h\nu$.

The trigonometric analysis showed that the energy-to-mass E/M ratio gives us the square of the speed of light c^2 which means, that $\tan(\varphi) = c^2$, this in turn means infinity. On the basis of trigonometric analysis, equation (3c) and (3d) clearly indicates the infinity of mass and energy. Inserting equations (3c) to (13) we get equation. (14). Eq. (14) clearly shows the infinity of mass and energy of the wave function under consideration.

Our wave function described in eq. (8) is normalized to the 1. The square of the module of our wave function is the sum of the squares of energy and mass of all particles in the universe (eq. (13) and (14). The question is: how many particles are there in the universe? We do not know exactly that. There are definitely more particles in the universe than exp(308), which means infinity.

General conclusion

The presented wave function of mass and energy relates **to the open universe** (Eq. 3d, Eq.4, Eq. 13 Eq.14). This is the main application of the mass and energy wave functions considered in this work. Summarizing: the above dependencies, (especially eq.(14)) seem to confirm the **infinity of mass and energy in the universe, and thus indicate an open universe.**

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