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Dark Energy Forms a Gravitational Field Resulting in the Uncertainty Principle

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Abstract

As an origin of dark energy, an X-particle with repulsive force proportional to energy density has been proposed [1]. In this paper, we will develop the X-particle theory further, and postulate how dark energy could form a ubiquitous gravitational field and inertial reference of frames, and why they might be the reason for the uncertainty principle. Like photon, an X-particle has only relativistic mass, and acts like a particle that has a definite position and momentum. It creates spaces between them by forces of gravitational attraction and repulsion. However, unlike photon that travels in space, an X-particle only needs to pass signals to its neighboring particles to form the ubiquitous gravitational field. This model could explain how gravitational signals propagate at the speed of light, how their values are stored in X-particles, and why the uncertainty principle could arise from this.

Keywords: X-particle, dark energy, gravitational field, inertial reference of frames, uncertainty principle

1 Introduction

It will be a waste of energy, if what dark energy does is *just* accelerating the expansion of the universe. The measurements indicate that dark energy contributes about 68.3% of the total energy in the universe. The mass energy of dark matter and ordinary baryonic matter contribute 26.8% and 4.9%, respectively, and other components such as neutrinos and photons contribute a very small amount [2]. We could ask how dark energy might play an important role in the fundamental laws of physics.

Dark energy is an unknown form of energy that is hypothesized to permeate all of space, tending to accelerate the expansion of universe [3][4][5][6][9][10]. As an origin of dark energy, an X-particle with repulsive force proportional to energy density has been proposed [1]. It provides a new perspective for the origin of dark energy. X-particles react only to gravitational attractive force F_a and repulsive force F_r. Each X-particle creates space between them where net repulsive force ($F = F_r - F_a$) matches with its neighboring particles' net repulsive forces. When F is larger than zero, the X-particle exerts pressure to expand. It worked as a model to explain the accelerated expansion of the universe [1]. In this paper, we will develop the X-particle theory further, and postulate how dark energy can form an ubiquitous gravitational field.

An X-particle has only relativistic mass (zero rest mass), and acts like a particle that has a definite position and momentum. In this model, the main cause of anomalies in quantum mechanics is postulated to be dark energy. Many parts of classical mechanics would be valid if we add dark energy, spacetime, and Lorentz transformation in the model. For any X-particle X_i, there are gravitational attractive forces and repulsive forces exerted by neighboring X-particles and other masses. Based on Newton's third law, the attractive forces and repulsive forces of X-particles balance each other by adjusting the distance l with neighboring particles. Therefore it creates quantized distribution of X-particles and spaces between them by forces of gravitational attraction and repulsion.

We postulate that an X-particle has a mechanism to form the gravitational field and convert it to a gravitational force. And the X-particle passes the gravity signals to its neighboring X-particles at the speed of light to form the ubiquitous gravitational field throughout the universe. For a particle, inertial frame of references can be created from the gravitational field formed by X-particles in proximity. In this process, the uncertainty principle could arise. Since all particles in the universe exist within the sea of X-particles, each particle's position and momentum is affected by the interaction or collision with X-particles around them.

The rest of the paper is arranged as follows. In section 2, the previous work on the X-particle is presented. In section 3, a gravitational field model based on the X-particle theory is described. In section 4, we explain how the inertial frame of references can be created from the gravitational field. In section 5, we present why the uncertainty principle may arise due to X-particles. Finally, the paper is ended with some remarks and future research topics in the last section.

2 Previous Work

To the best of our knowledge, X-particle theory is the only work on dark energy [1] that could be used to explain the ubiquitous gravitational field, the inertial frame of reference and the uncertainty principle. It was postulates that dark energy exists in the form of X-particle and permeates all of space. Like photon, the particle is a boson that has only relativistic mass (zero rest mass) and acts like a particle with a definite position and momentum. Quantum mechanics is essential to understanding the behavior of systems at atomic length scales and smaller. We postulate that the main cause of anomalies in quantum mechanics is due to dark energy. Thus many parts of classical mechanics would be valid if we add dark energy, spacetime, and Lorentz transformation in the model.

Suppose there are X-particles i, j with distance l_{ij}. If we squash them, there is a large repulsive force that pushes them apart. On the other hand, if we pull them apart, there is an attractive force field. When the attractive force is equal to the repulsive force ($F_a = F_r$), we define l_{ijo} as the "stable distance". At the same time, m_{io} and m_{jo} are defined as the "stable mass" for X-particle i, j. Throughout the universe, each X-particle exerts force to one another (negative pressure) to reach its stable distance l_{ijo}. We postulate the repulsive force to be proportional to energy density

$$F_r = G_r \frac{m_i + m_j}{{l_{ij}}^3}, \tag{2.1}$$

where G_r is a repulsive variable, and l_{ij} is the distance between particle i, j. The gravitational attractive force between particles i, j with G as the gravitational constant is

$$F_a = G \frac{m_i m_j}{{l_{ij}}^2}. \tag{2.2}$$

The relation between the the repulsive variable G_r and the gravitational constant G is

$$G_r = G \frac{m_i m_j}{m_i + m_j} l_{ijo}. \tag{2.3}$$

Therefore the "net" repulsive force F exerted on the particle can be defined as

$$F = F_r - F_a = G \frac{m_i m_j}{{l_{ij}}^2} (\frac{l_{ijo}}{l_{ij}} - 1). \tag{2.4}$$

As l_{ij} decreases (less than l_{ijo}), there is a large repulsive force F that pushes particles apart. On the other hand, as l_{ij} increases (larger than l_{ijo}), an attractive force F dominates. As l_{ij} increases to infinity, F approaches to zero. When l is equal to the stable distance l_{ijo}, particles i, j will experience zero force. We can observe an analogical example in electromagnetic forces between atoms, where at the radius of an atom, two atoms may experience nearly zero force.

When particles have a same mass, we can simplify variables as

$$m = m_i = m_j, \qquad l = l_{ij}, \qquad m_o = m_{io} = m_{jo}, \qquad l_o = l_{ijo}. \tag{2.5}$$

And the net repulsive force equation becomes

$$F = G (\frac{m}{l})^2 (\frac{l_o}{l} - 1). \tag{2.6}$$

We postulate that the angular frequency of X-particle as ω_x that satisfies

$$E = mc^2 = \hbar \omega_x, \tag{2.7}$$

and

$$c = l \omega_x. \tag{2.8}$$

From Eq.(2.7) and Eq.(2.8), we can obtain the key equation of X-particle that shows the relation between m and l

$$mlc = \hbar. \tag{2.9}$$

It is important to note that, assuming $\hbar$ and c are constants, the product of m and l (ml) is constant. We can get l as a function of m from Eq. (2.9) and vice versa

$$l = \frac{\hbar}{mc}. \tag{2.10}$$

In the following section, we will describe how the gravitational field can be formed with the X-particle distribution.

3 Gravitational Field

In physics, a gravitational field is a model used to explain the influence that a massive body extends into the space around itself, producing a force on another massive body [7]. In a field model, rather than two particles attracting each other, the particles distort spacetime via their mass, and this distortion is what is perceived and measured as a "force". In such a model one states that matter moves in certain ways in response to the curvature of spacetime [8].

In general the gravitational fields predicted by general relativity differ in their effects only slightly from those predicted by classical mechanics. However, the most dominant difference are the gravitational forces on massless objects, and instantaneous gravitational effects on objects. In our case, we postulate Newtonian's gravitational equation can be used for good approximation based on the following arguments. First, an X-particle with relativistic mass acts like a particle that has a definite position and momentum. Second, an X-particle only needs to pass gravity signals to its neighboring X-particles at the speed of light to form the ubiquitous gravitational field throughout the universe. Third, X-particles and their distribution take those delays into account to form the gravitational field.

In order to simplify the problem, one dimensional array of X-particles is considered first as an approximated model. Suppose X-particles from $X_1..X_\infty$ lined up from left to right with mass M ($M \gg m_i$) at the leftmost. For each X_i there is a gravitational attractive force $F_a[i]$ between M and X_i

$$F_a[i] = G\frac{Mm_i}{{R_i}^2}, \tag{3.1}$$

where m_i is the mass of X_i, and R_i is the distance between M and X_i. As X_i is attracted to M, Newton's third law of "action equals reaction" can be applied between X_i and X_{i-1}. Here X_i exerts a force $F_a[i]$ on the X_{i-1}, and the X_{i-1} will push back on X_i with an equal repulsive force $F_r[i-1,i]$ in the opposite direction

$$F_r[i-1,i] = G\frac{m_i m_{i-1}}{{l_{i,i-1}}^2}(\frac{l_o}{l_{i,i-1}} - 1), \tag{3.2}$$

where $l_{i,i-1}$ is the distance between X_i and X_{i-1}. For i from 2 to ∞, if we apply Newton's third law of action equals reaction,

$$F_a[i] = F_r[i-1,i]. \tag{3.3}$$

Using Eq.(3.1) and Eq.(3.2), if $l_{i,i-1} \ll l_o$, we get

$$l_{i,i-1} \approx \sqrt[4]{\frac{\hbar l_o R_i^2}{cM}}, \tag{3.4}$$

and

$$l_i \approx \frac{l_{i,i-1} + l_{i+1,i}}{2}, \tag{3.5}$$

where R_i is the sum of X-particle distances

$$R_i = R_1 + \sum_{j=2}^{i} l_{j,j-1}. \tag{3.6}$$

We can get m_i from

$$m_i = \frac{\hbar}{cl_i}. \tag{3.7}$$

Here we have all equations necessary to define the X-particle distribution in one dimension (l_i,m_i,R_i,$F_a[i]$). As an X-particle X_i gets closer to the particle M, Eq.(3.4) and Eq.(3.5) predict l_i to decrease, and Eq.(3.7) shows m_i to increase. Thus, from Eq.(3.1) the gravitational attractive force gets stronger by the increase of m_i as well as the decrease of R_i, and the particle forms very close ties with X-particles in close proximity.

Suppose we generalize the above example to three dimensional space with multiple mass objects. For any X-particle X_i, there are gravitational attractive forces and repulsive forces exerted by neighboring X-particles and other masses. Based on Newton's third law, the attractive forces and repulsive forces of X-particles balance each other by adjusting the distance l with neighboring particles. Therefore it creates quantized distribution of X-particles and spaces between them by forces of gravitational attraction and repulsion.

In that process, each X-particle i has the gravitational force field $g[i]$ information at the current position. From Eq.(3.1) we can get

$$g[i] = \frac{F_a[i]}{m_i} = G\frac{M}{{R_i}^2}. \tag{3.8}$$

We postulate that an X-particle has a mechanism to form the gravitational field and to convert it to a gravitational force. And the X-particle passes the gravity signals to its neighboring X-particles at the speed of light to form the ubiquitous gravitational field throughout the universe. For instance, if we place a mass $\hat{M}$ at the position of X-particle i, the force exerted by the gravitational force field i to the mass $\hat{M}$ is

$$F_{\hat{M}} = F_g[i] = \hat{M}g[i] = G\frac{M\hat{M}}{{R_i}^2}. \tag{3.9}$$

Therefore the signal that reflects the change of $\hat{M}$ will reflect the spacetime concept and reach mass M after some time delay

$$t_i = \frac{R_i}{c}. \tag{3.10}$$

If we place a mass $\hat{M}$ at the arbitrary position near X_i, the gravitational force $\hat{g}$ can be approximated as a weighted sum of $g[i]$

$$\hat{g} = \sum_{neighbors} w_i g[i], \qquad w_i \propto \frac{1}{l_{i\hat{M}}}, \qquad \sum_{neighbors} w_i = 1, \tag{3.11}$$

where w_i is the weighting factor inversely proportional to the distance between X_i and $\hat{M}$.

Here we have described that the gravitational field could be formed from the dark energy distribution of X-particles, and presented how gravitational force could be converted from it. However, alternative interpretations for Eq.(3.8) are possible. It could be graviton or dark matter that converts the gravitational force field to the gravitational force. Dark matter is composed of weakly interacting massive particles that interact only through gravity and the weak force. It is possible to create a model that dark energy and dark matter work together.

Force instance, an X-particle may take care of signal propagation, while dark matter may convert the gravitational force field to the gravitational force.

In the next section, we will discuss how inertial frame of references can be formed from the gravitational field. X-particles that are tightly connected by the attractive forces can form inertial frame of references varying from the sub-atomic scale to the universe.

4 Inertial Frame of Reference

An inertial frame of reference is a frame of reference that describes time and space homogeneously, isotropically, and in a time-independent manner [11]. All inertial frames are in a state of constant, rectilinear motion with respect to one another. Measurements in one inertial frame can be converted to measurements in another by the Galilean transformation in Newtonian physics and the Lorentz transformation in special relativity [12].

As an X-particle X_i gets closer to the particle M, the gravitational attractive force gets stronger by the increase of m_i as well as the decrease of R_i. Therefore the particle forms very close ties with X-particles in close proximity. In general relativity, in any region small enough for the curvature of spacetime and tidal forces to be negligible, one can find a set of inertial frames that approximately describe that region [13]. In a gravity field created by X-particles, a "hierarchical" inertial frame of reference is formed by X-particles that are tightly connected by the attractive forces. The boundary of hierarchical inertial frame of reference is fuzzy, dynamic, and relative to the other forces. The hierarchy can range from sub-atomic particles (leaf) to the earth, to the galaxy, and to the entire universe (root). Eq.3.1 shows that, as the magnitude of M increase, the attractive forces of X-particles increase, and the inertial frame of reference becomes larger and more stable. Therefore the "stability" of inertial frame of reference strongly depends on the mass M and the distance R_i.

Einstein's comment on the equivalence principle shows the limit in explaining the universe with dark energy. He assumed the "complete" physical equivalence of a gravitational field and a corresponding acceleration of the reference system. That is, being on the surface of the Earth is equivalent to being inside a spaceship (far from any sources of gravity) which is being accelerated by its engines [14].

Even though Einstein's equivalence principle is a good approximation of nature, it may not work for certain domains in physics, when the effects of X-particles are involved. First, we need to note that there is a huge gap between the mass of the Earth and that of the spaceship. The gravitational field and the inertial frame of reference have to be different to each other at the quantum scale. Second, he assumed a spaceship far from any sources of gravity, which is not plausible in reality. The universe is under the influence of the ubiquitous X-particle gravitational field.

Therefore Einstein's assumption on physical equivalence of a gravitational field and a corresponding acceleration of the reference system is incomplete. It may provide an interesting research topic for certain scientists who think that the best evidence for quintessence would come from violations of Einstein's equivalence principle [15]. In the next section, we will discuss how the quantized gravitational field, which forms the hierarchical inertial frame of reference, could be the cause of the uncertainty principle.

5 Uncertainty Principle

In quantum mechanics, the uncertainty principle is any of a variety of mathematical inequalities asserting a fundamental limit to the precision with which certain pairs of physical properties of a particle, known as complementary variables, such as position x and momentum p, can be known simultaneously [16]. It states that the more precisely the position of some particle is determined, the less precisely its momentum can be known, and vice versa [17].

$$\Delta x \Delta p \geq \hbar/2. \tag{5.1}$$

where $\hbar$ is the reduced Planck constant, Δx and Δp are the error in our knowledge of the position and the momentum respectively of the object we are measuring. This equation is a statement of the Heisenberg uncertainty principle.

The ideas of probability are certainly useful in describing the behavior of the molecules, for it is impractical even to attempt to write down the position or velocity of each molecule. When probability was first applied to such problems, it was considered to be a way of dealing with very complex situations [7].

Suppose you try to measure a particle with mass M and momentum P in the sea of X particles. The uncertainty of momentum is caused by a collision between the measured particle and the X-particle. Conservation of linear momentum is implied by Newton's laws and it also holds in general relativity. Therefore the uncertainty of momentum in the X-particle should be equal to the uncertainty of momentum in the measured particle. The average magnitude of momentum for X_i is $p = m_i c_i$. The uncertainty of momentum arises depending on the relative direction of momentum at the time of collision

$$\Delta p \geq m_i c_i. \tag{5.2}$$

The effect of the uncertainty of position arises depending on how far M is from the nearest X-particle. If we define l_i as the average distance between neighboring particles,

$$\Delta x \geq l_i/2, \tag{5.3}$$

If we combine Eq.5.2 and Eq.5.3, we get

$$\Delta x \Delta p \geq (m_i c_i l_i)/2. \tag{5.4}$$

From Eq.2.9, since mcl is equal to $\hbar$

$$\Delta x \Delta p \geq \hbar/2, \tag{5.5}$$

Thus we get same result as the Heisenberg uncertainty principle.

We argue that X-particles create a quantized gravitational fields that have uncertainty in the direction of momentum and in the effect of the position. The degree of uncertainty will increase even more at the boundary of the hierarchical inertial frame of reference due to increased interactions. The uncertainty principle describes an inherent fuzziness that must exist in any attempt to describe nature. Our most precise description of nature must be in terms of probabilities. In the early days of the development of quantum mechanics, Einstein was quite worried about the uncertainty problem and said, "God does not throw dice in determining how electrons should go." He never reconciled himself to the fact that this is the best description of nature that one can give [7]. In X-particle theory, we argue, "God does not throw dice, but made an X-particle to work like a dice in determining how electrons should go."

6 Conclusion

We developed a dark energy theory to explain how X-particles could form the ubiquitous gravitational field, and described why the dark energy might be the reason behind the uncertainty principle. Our research is based on the previous work on the origin of dark energy that proposed an X-particle with repulsive force proportional to energy density [1].

An X-particle has only relativistic mass, and acts like a particle that has a definite position and momentum. For any X-particle X_i, there are gravitational attractive forces and repulsive forces exerted by neighboring X-particles and other masses. Based on Newton's third law, the attractive forces and repulsive forces that works of X-particles balance each other by adjusting the distance l with neighboring particles. Therefore it creates quantized distribution of X-particles and spaces between them by forces of gravitational attraction and repulsion.

We postulated that an X-particle has a mechanism to form the gravitational field and to convert it to a gravitational force. As an alternative, graviton or dark matter could take a role of the conversion. And the X-particle passes the gravity signals to its neighboring X-particles at the speed of light to form the ubiquitous gravitational field throughout the universe. The gravitational field formed by X-particles can create an inertial frame of reference varying from the sub-atomic particle to the universe.

The uncertainty principle could arise due to ubiquitous X-particles which forms the gravitational field. Since all particles in the universe exist within the sea of X-particles, each particle's position and momentum are affected by the interaction or collision with X-particles around them. In some sense, the uncertainty principle is a byproduct of forming the ubiquitous gravitational field.

The future research topic will be a computational modeling and simulation of the gravitational field created by dark energy based on the X-particle theory. Another topic will be exploring an alternative interpretation for Eq.(3.8) including graviton or dark matter which converts the gravitational force field to the gravitational force.

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