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Dark Matter

-Tanush Bhatnagar

Abstract— This research paper is based on the studies done by Mr. Tanush Bhatnagar, and proving the theoretical presence of these dark matter particles. It also describes the relation between gravitons and the WIMP particles. This research paper is specialized in the fields related to Dark Matter.

Index Terms— Quantum Gravity, Particle physics, Classical Physics, Dark Matter

1.1 About The Authors

The author of this research paper is Tanush Bhatnagar, who is from India and has come up with a theory on Dark Matter supported by the previous ideas given by great scientists expert in the fields of Cosmology, quantum gravity and the string theory. The author is below 18 and is an ordinary child coming from a middle class background. Studying in grade 8, he is considered to be under matured for such elaborate research papers and scientific research. But the author has gained information and knowledge in the streams of cosmology, particle physics, and quantum mechanics through great hard work and is still on his journey to learn more about these topics.

1.2 Introduction

The matter we can see accounts for less than 5% of the known universe. About 25% is dark matter; and 70% is dark energy. Both of which are invisible. This is kind of strange because it suggests that everything we experience is really only a tiny fraction of reality. Physicist Patricia Burchat sheds light on two basic ingredients of our universe: dark matter and dark energy, they can't be directly measured, but their influence is immense. Super symmetry is one of the most popular of the speculative ideas that theorists have proposed to understand the puzzle known as the hierarchy problem. It has many wonderful features, ranging from mathematical beauty to its potential ability to explain other puzzles in particle physics, such as the nature of dark matter.
How do we know if dark matter exists or not? Well there is some evidence supporting the theory of dark matter, which is

- Primary evidence for dark matter comes from calculations showing that many galaxies would fly apart, or that they would not have formed or would not move as they do, if they did not contain a large amount of unseen matter.
- Other lines of evidence include observations in gravitational lensing and in the cosmic microwave background along with astronomical observations of the observable universe's current structure, the formation and evolution of galaxies, mass location during galactic collisions, and the motion of galaxies within galaxy clusters.
- The view of galaxies far away from Earth is distorted due to the bending of light caused by the gravity of dark matter around the light source or the light rays.

Quantum Gravity

Einstein's theory revolutionized the concept of the gravity, by showing that it was caused by curves in space-time rather than by a force. In contrast, quantum theory has successfully shown other forces, such as magnetism, are the result of fleeting particles being exchanged between interacting objects. Quantum gravity is a field of theoretical physics that seeks to describe gravity according to the principles of quantum mechanics, and where quantum effects cannot be ignored, such as in the vicinity of black holes or similar compact astrophysical objects where the effects of gravity are strong, such as neutron stars. The most popular theory of quantum gravity is String theory which is not just a theory of quantum gravity in the strict sense, because its objective is wider: the theory aims at giving a unified description of the physical world, where all physical entities are understood as manifestations of the motion of a single object: a string. Gravity emerges in the theory as one of the aspects of the dynamics of the string. String theory can be defined in terms of a perturbation expansion around a fixed space-time. Remarkably, in this formulation certain infinities that plague perturbative quantum general relativity do not appear and there is an ongoing program to establish that each term in the series is in fact finite. However, when summed the entire series appears to be divergent. In any case, a definition of the theory as a perturbation expansion is not sufficient for describing genuine quantum gravitational phenomena, which appear in the non perturbative regime. Therefore much of the research in this area in recent years focuses on non perturbative effects. Numerous indications point out to the existence of a fundamental non perturbative definition of string theory, to which the various perturbative formulations should converge, and various partial attempts to define this non perturbative theory are ongoing. In this sought-for non perturbative formulation, the characteristic features of quantum gravity become manifest: for instance, the lack of a fixed background space and time, and the resulting conceptual difficulties. Research is currently active to try to find this fundamental description of string theory. Another popular topic is the loop approach to quantum gravity is ten years old. The first announcement of this approach was given at a conference in India in 1987. This tenth anniversary is a good opportunity to attempt an assessment of what has and what has not been accomplished in these ten years of research and enthusiasm. During these ten years, loop quantum gravity has grown into a wide research area and into a solid and rather well-defined tentative theory of the quantum gravitational field. The approach provides a candidate theory of quantum gravity. It provides a physical picture of Planck scale quantum geometry, calculation techniques, definite quantitative predictions, and a tool for discussing classical problems such as black hole thermodynamics.

Particle Physics

We all are aware of the study of atoms and the subatomic particles inside it. This study is known as particle physics. The theories and discoveries of thousands of physicists since the 1930s have resulted in a remarkable insight into the fundamental structure of matter: everything in the universe is found to be made from a few basic building blocks called fundamental particles, governed by four fundamental forces. Our best understanding of how these particles and three of the forces are related to each other is encapsulated in the Standard Model of particle physics. Developed in the early 1970s, it has successfully explained almost all experimental results and precisely predicted a wide variety of phenomena. Over time and through many experiments, the Standard Model has become established as a well-tested physics theory.There are various classifications of the subatomic particles found in the atoms, which broadly include the Bosons and the Fermions. To understand the structure of a WIMP particle we first have to know about these classifications and the particles which fall under these categories. As all of us know about the common concept of particle decay, its causes and possible outcomes we should also know that the subatomic/elementary particles that make up the composite particles (such as a proton or neutron) will be released if the particle decays completely. Hence there is no matter lost and none gained. Among the proven and researched particles there are some unproven, hypothetical particles which are thought to carry forces or energy like the "photon" carries light as energy and "gravitons" carry the force of gravity. There are 4 fundamental forces in Quantum mechanics and classic physics, which are weak nuclear force, strong nuclear force, gravity and electromagnetism. All of these fundamental forces have particles that have been proven over time, except of gravity. For example, the weak nuclear force is carried by Z and W bosons, the strong nuclear force is carried by the gluons, the electromagnetic force is carried by photons with different energy levels or frequencies and the force of gravity is mediated by hypothetical, yet to be proven particles known as gravitons. Even though the Standard Model is currently the best description there is of the subatomic world, it does not explain the complete picture. The theory incorporates only three out of the four fundamental forces, omitting gravity. There are also important questions that it does not answer, such as "What is dark matter?", or "What happened to the antimatter after the big bang?", "Why are there three generations of quarks and leptons with such a different mass scale?" and more. Last but not least is a particle called the ***Higgs boson***, an essential component of the Standard Model.

2.2 My Theory

This unnamed theory which is still a hypothesis and neither proven mathematically nor by experimental evidence is developed by the authors of this research paper themselves. The theory suggests that the WIMP is a type of graviton, more like an isotope but it cannot exactly be called an isotope because the chemical properties of WIMPs aren't known yet. My theory is based on two hypothetical imaginary particles, one being graviton and the other being WIMP.

The evidence to support my theory is-

- Both have weak interactions
- Both interact with gravity
- Both cannot be detected using EMR
- Both have zero net charge and
- Both have very little mass (the sub GeV WIMP particles)

My theory also has some drawbacks; it does not have experimental evidence nor does it have any mathematics to support it. This is one possible scenario in the case of dark matter. The other possible scenario is that the gravitons decay into WIMPs. The evidence to support this part of my theory is, we know that the gravitons have a spin of 2 and hence can be called bosons whereas the WIMPs have a spin ½ and hence can be called fermions. Through the principles of particle physics and quantum physics we get to know more about these types of particles. There is a common phenomena observed within these subatomic particles which is the boson-fermion decay. Another evidence is that, scientists have previously observed what happens when a graviton decays and they found out that the matter and energy released when a graviton decays is unknown, and hence can be called dark matter and dark energy. Looking at the pieces of evidence gathered by me, the possible conclusion drawn out of this is that the statement that "The gravitons can decay into WIMPs" could be true.

We will majorly focus on gravitons in this research paper, which is because one of the only forces of interaction used by the Dark matter particles (WIMPs) is gravity. In the classical limit, a successful theory of gravitons would reduce to general relativity, which itself reduces to Newton's law of gravitation in the weak-field limit. The term graviton was originally coined in 1934 by Soviet physicists Dmitri Blokhintsev and F.M. Gal'perin. The gravitons as we know them remain hypothetical and undiscovered and theoretically also there is an absence of their presence. They have mass lesser than an electron which is 7.7×10^{-23} eV/c^2, and a spin of 2 due to their light mass. Now, seeing that Gravitons are massless, but they do carry energy, we can conclude that a graviton can create more gravitons. Like other quantum particles, gravitons can carry a lot of energy, or momentum, when confined to a small space. A graviton is confined to a small space when one graviton is popping out another graviton. Though gravitons are individually too weak to detect, most physicists believe the particles roam the quantum realm in droves, and that their behavior somehow collectively gives rise to the macroscopic force of gravity, just as light is a macroscopic effect of photons. The graviton applies a tiny force as it impacts the nuclei of atoms. All atoms themselves have these graviton particles in orbit around them. If you gather a lot of atoms together the population of orbiting gravitons increases proportionately. As a result, a large asteroid for example will have more gravity than a small one. Because the graviton is a particle that has force (gravity), it is classed as a gauge boson (Other gauge bosons include the photon, the gluon, and the W and Z particles). Another interesting thing, we study is a fermion-boson transformation. Our approach is based on the 3 × 3 equations which are sub equations of both the Dirac and Duffin-Kemmer-Petiau equations and thus provide a link between these equations. We show that solutions of the free Dirac equation can be converted to solutions of spin- 0 Duffin-Kemmer-Petiau equation and vice versa. Mechanism of this transition assumes existence of a constant spinor. The FB duality was first discovered for zero-mass relativistic equations: it was shown that some zero-mass equations, for example the massless Dirac equation, can describe fermionic as well as bosonic states. Furthermore, Polyakov discovered possibility of fermion-boson transmutation of elementary excitations of a scalar field interacting with the topological Chern-Simons term in (2 + 1) dimensions. The FB duality was further studied for the massive Dirac equation.