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Modern physics; problems and solutions

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Abstract:

Some of the major unsolved problems in physics are theoretical, meaning that existing theories seem incapable of explaining a certain observed phenomenon or experimental result. The others are experimental, meaning that there is a difficulty in creating an experiment to test a proposed theory or investigate a phenomenon in greater detail. Can quantum mechanics and general relativity be realized as a fully consistent theory (perhaps as a quantum field theory)? [1] Is space-time fundamentally continuous or discrete? Would a consistent theory involve a force mediated by a hypothetical graviton, or be a product of a discrete structure of space-time itself (as in loop quantum gravity)? Are there deviations from the predictions of general relativity at very small or very large scales or in other extreme circumstances that flow from a quantum gravity theory? [2]

In general, there are some unanswered questions or complex concepts in modern physics. These issues are divided into two categories:

A: The questions that modern physics does not have answers for, and the physicists believe that it is due to the inability of theories.

B - Complex concepts that seem unrealistic, but physicists have admitted they do not know the problems of modern physics.

There are concepts and equations in physics (classical mechanics, relativity and quantum mechanics) that we can use to reach an understanding that is able to be experienced and by which we can review relativistic Newton's second law.

Using the revised relativistic Newton's second law, we can make it easier to express complex concepts in modern physics and respond to many unanswered questions in modern physics.

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Reconsidering the relativistic Newton's second law is a powerful tool that deepens our understanding of space-time and can be an important step in understanding the nature of interactions and unifying them easier.

Keyword: graviton, photon, relativity, blueshift, pair production, virtual photon, interactions, Zero point energy, Singularity

Questions and complex concepts

In this paper are a lot of unanswered questions and complex concepts of which the most important parts have been propounded and at the end of each question the paper of solution is given here.

1- Infinity in space-time: Assume that the observable universe would collapse due to gravity, is there any force that can counteract the gravity collapse in the universe? In other word, after the universe collapses, how and by which law (or force) will the universe expand again? A gravitational singularity or space-time singularity is a location where the quantities that are used to measure the gravitational field become infinite in a way that does not depend on the coordinate system. These quantities are the scalar invariant curvatures of space-time, which includes a measure of the density of matter. For the purposes of proving the Penrose–Hawking singularity theorems, a space-time with a singularity is defined to be one that contains geodesics that cannot be extended in a smooth manner. The end of such a geodesic is considered to be the singularity. This is a different definition, useful for proving theorems. The two most important types of space-time singularities are curvature singularities and conical singularities. Singularities can also be divided according to whether they are covered by an event horizon or not (naked singularities). According to general relativity, the initial state of the universe, at the beginning of the Big Bang, was a singularity. Both general relativity and quantum mechanics break down in describing the Big Bang. My question is, if the universe collapses, will it reach to infinite density and zero volume? Or is there a force that will counteract it? (For solution see [3]).

2- Reviewing the special relativity postulates, always raises some questions like, “Does the constant speed of light (photon energy), result from a natural accident?” or “what is the difference between the characteristics of mass and energy while the speed rate of energy is fixed; the speed of matter can change and cannot reach the speed of light?”. Meanwhile when the physical and chemical processes occur, some amount of matter is converted into energy; what happens during this process that mass with non-constant speed is converted into energy with the constant speed? (For solution see [4]).

3- According to the fundamental particle physics theories and energy issues in the production and decay of pairs of matter–antimatter are included in finding the common features between matter and energy which can be considered the constant velocity of photon as a property that can be transmitted from matter into energy and vice versa and also differences in the mass, structure of matter and its relation fields are explained by the relationship between length contraction (reduce in volume) and relativistic mass and relativistic Newton second law which show the mass variations (i.e., the infinite speed in classical mechanics is replaced by the infinite mass). Infinite mass is not observable (such as infinite velocity), how can we explain the limit of speed without infinite mass? (For solution see [4]).

4- This may probably seem an unusual question in physics however, taking it into consideration may lead us to solve some of the problems in this science. As every physicist knows, in quantum mechanics and relativity, it has been accepted that field and mass-energy are two separable items. In general relativity, gravity is replaced by space-time, therefore it is is not a fundamental force. Quantum mechanics is a very good set of mathematical models that show how many elementary forces work, but it does not explain how they work. What is the main obstacle in the way of uniting the four forces and all of the elementary particles? We do not know how a charged particle produces an electric field or virtual photons in quantum mechanics. And many other unanswered questions. Maybe thinking about this seems useless or maybe it can be a step in order to find a theory of super-symmetry. Is it possible for force, energy and mass to convert to each other? If not, why? If so, how? (For solution see [5]).

5- Late nineteenth century physics was faced with a crisis in the speed of light and energy. Quantum characteristic of radiation was proposed by Max Planck and during the past century his theory was developed and it reached to the quantum mechanics and elementary particles models. Einstein proposed the speed of light by special relativity theory. In this theory the speed of light in inertial frame of reference is constant “c”, and also it is the limit rate of speed. On the other hand, visible light is a radiation which is the small part of electromagnetic spectrum. The question is: On the constancy of the speed of light: a nature law or a natural accident! (For solution see [4]).

6- The Einstein field equations or Einstein equation are not a dynamical equations that describe how matter and energy change the geometry of space-time, this curved geometry being interpreted as the gravitational field of the matter source. Einstein tried to propound geometrical structures of space by mathematical equations. So, he used non-Euclidian geometry. There are three considerable notes on Einstein’s equations;

1- Einstein Field Equations do not come from the equivalence principle directly. These equations are simply equations that are suitable for general relativity.

2- There is a physical explanation for the path of light in a gravitational field. Although explaining the frames of reference is a physical concept, there is not any explanation of how gravitational field affects photons in general relativity. Then how can we explain this phenomenon by quantum mechanics?

3- Space-time is a continuous quantity in general relativity. But the changing of photon frequency and production of energy are quantized. That gravitational blueshift (or redshift) is a special case of gravitational field that affects the photon. My question is therefore: how can we explain the gravitational blueshift according to the relationship between photon energy and its frequency? (For solution see [6]).

7- The important concept in relationship between 'mass' and energy is c, regarding the phenomena of creation and decay of electron-positron pair, why do the related photons move at constant speed, but we could change the speed of matter and antimatter? What is the unique characteristic of matter which is convertible to photons that move with constant speed c (speed of light)? The idea that object/particle could not travel at superluminal speeds, originates from the structure of matter and the mechanism of interaction between field and mass; that with presenting a postulate we could generalize the constancy of speed from energy to mass. By gravitational blueshift, the energy of photon and consequently its frequency will increase. What is the mechanism of increasing in the photon energy that causes increase in its frequency? Are there more results than before in the energy-mass equivalence equation? (For solution see [7]).

8- All our theories today seem to imply that the universe should contain a tremendous concentration of energy, even in the emptiest regions of space. The gravitational effects of this so-called vacuum energy would have either quickly curled up the universe long ago or expanded it too much greater size. The Standard Model cannot help us understand this puzzle, called the cosmological constant problem [8].

9- The expansion of the universe was long believed to be slowing down because of the mutual gravitational attraction of all the matter in the universe. We now know that the expansions accelerating and that whatever causes the acceleration (dubbed “dark energy”) cannot be Standard Model physics.[8]

10- There is very good evidence that in the first fraction of a second of the big bang the universe went through a stage of extremely rapid expansion called inflation. The fields responsible for inflation cannot be Standard Model ones.[8]

11- The Standard Model cannot include gravity, because it does not have the same structure as the other three forces. In expressing these mysteries, when I say the Standard Model cannot explain a given phenomenon, I do not mean that the theory has not yet explained it but might do so one day. The Standard Model is a highly constrained theory, and it cannot ever explain the phenomena listed above.[8]

12- Richard Feynman once quipped that "Time is what happens when nothing else does." But Julian Barbour disagrees: if nothing happened, if nothing changed, then time would stop. For time is nothing but change. It is change that we perceive occurring all around us, not time. Put simply, time does not exist. [9] Efforts to understand time below the Planck scale have led to an exceedingly strange juncture in physics. The problem, in brief, is that time may not exist at the most fundamental level of physical reality. If so, then what is time? And why is it so obviously and tyrannically omnipresent in our own experience? (For solution see [10]).

“The meaning of time has become terribly problematic in contemporary physics,” says Simon Saunders, “The situation is so uncomfortable that by far the best thing to do is declare oneself an agnostic.” [11] The question is, what is the physical nature of time? Which physical beings are not subject to the passage of time? (For solution see [10]).

13- In quantum electrodynamics (QED) a charged particle emits exchange force particles continuously. This process has no effect on the properties of a charged particle such as its mass and charge. How is it explainable? If a charged particle as a generator has an output known as a virtual photon, what will be its input? (For solution see [5]).

14- Zero-point energy, also called quantum vacuum zero-point energy, is the lowest possible energy that a quantum mechanical physical system may have; it is the energy of its ground state. All quantum mechanical systems undergo fluctuations even in their ground state and have an associated zero-point energy, a consequence of their wave-like nature. The uncertainty principle requires every physical system to have a zero-point energy greater than the minimum of its classical potential well. This results in motion even at absolute zero. For example, liquid helium does not freeze under atmospheric pressure at any temperature because of its zero-point energy. If the zero point energy in space (vacuum) exists, how we can describe it without using the uncertainty principle? (For solution see [5]).

15- In quantum mechanics, the concept of a point particle is complicated by the Heisenberg uncertainty principle, because even an elementary particle, with no internal structure, occupies a nonzero volume. There is nevertheless a distinction between elementary particles such as electrons, photon or quarks, which have no internal structure, versus composite particles such as protons, which do have internal structure. According to the quantum mechanics that photon is an unstructured particle, how can we explain the relationship between the photon energy and frequency, and also pair production and decay? (For solution see [12]).

16- QED rests on the idea that charged particles (e.g., electrons and positrons) interact by emitting and absorbing photons, the particles of light that transmit electromagnetic forces. These photons are virtual; that is, they cannot be seen or detected in any way because their existence violates the conservation of energy and momentum. If the electromagnetic field is defined in terms of the force on a charged particle, then it is tempting to say that the field itself consists of photons which cause a force on a charged particle by being absorbed by it or simply colliding with it - as in the Photo-electric effect. The electric repulsion between two electrons could then be understood as follows: One electron emits a photon and recoils; the second electron absorbs the photon and acquires its momentum. Clearly the recoil of the first electron and the impact of the second electron with the photon drive the electrons away from each other. So much for repulsive forces. How can attraction be represented in this way? The uncertainty principle makes this possible. The attraction between an electron and a positron may be described as follows: the electron emits a photon with momentum directed away from the positron and thus recoils towards the positron. This entails a degree of definiteness in the momentum of the photon. There must be a corresponding uncertainty in its position - it could be on the other side of the positron so that it can hit it and knock it towards the electron. Is there a way to explain virtual photon (in fact interaction between charged particles) without using the uncertainly principle? (For solution see [5]).

17- In physics, the graviton is a hypothetical elementary particle that mediates the force of gravitation in the framework of quantum field theory. If it exists, the graviton must be massless (because the gravitational force has unlimited range) and must have a spin of 2. This is because the source of gravitation is the stress-energy tensor, a second-rank tensor, compared to electromagnetism, the source of which is the four-current, a first-rank tensor. Additionally, it can be shown that any massless spin-2 field would be indistinguishable from gravitation, because a massless spin-2 field must couple to (interact with) the stress-energy tensor in the same way that the gravitational field does. This result suggests that if a massless spin-2 particle is discovered, it must be the graviton, so that the only experimental verification needed for the graviton may simply be the discovery of a massless spin-2 particle. (For solution see [4]).

Gravitons are postulated because of the great success of quantum field theory (in particular, the Standard Model) at modeling the behavior of all other known forces of nature as being mediated by elementary particles: electromagnetism by the photon, the strong interaction by the gluons, and the weak interaction by the W and Z bosons. The hypothesis is that the gravitational interaction is likewise mediated by a – yet undiscovered – elementary particle, dubbed the graviton. In the classical limit, the theory would reduce to general relativity and conform to Newton's law of gravitation in the weak-field limit. However, attempts to extend the Standard Model with graviton has run into serious theoretical difficulties at high energies (processes with energies close to or above the Planck scale) because of infinities arising due to quantum effects (in technical terms, gravitation is non-renormalizable). Since classical general relativity and quantum mechanics are incompatible at such energies, from a theoretical point of view the present situation is not tenable. Some proposed models of quantum gravity attempt to address these issues, but these are speculative theories. As long as you think like the past, you will get the same results that you've already earned, Feynman said. Does a new definition of the graviton solve the problem of quantum gravity? (For solution see [5, 12]).

According to reconsidering relativistic Newton's second law, in solution article have answered these questions.

Conclusion:

At the beginning of the 20th century, Newton's second law was corrected considering the limit speed c and the relativistic mass. In this paper, through various arguments and investigation of some physical phenomena, it has been attempted to show the necessity of reviewing relativistic Newton's second law. Today Physics literature faces numerous problems and questions that without considering the internal structure of the particles, they would remain unanswered. Moreover, the classical definition of energy that defines energy as the ability to do work, could not explain the interaction among the particle in high energies. The true understanding of physical entity of energy and the structure of photon, enable us to understand the structure of matter.

Attention to photon structure and using new definitions for graviton, charged and exchange particles, will change our perspective on modern physics. It also provides us with a new tool to be able to overcome physics problems in a better way. This approach will show us how particles are formed and when physical symmetries are broken spontaneously.

Moreover, one could explain the expansion of the universe better and more real through reviewing relativistic Newton's second law.

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