

Virtual particles in the vacuum as the source of gravity

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Abstract- Heisenberg's uncertainty principle in energy and time, comes in the form of virtual particle pairs in empty space. These virtual pairs of matter and anti-matter in empty space pop in and out of existence. Their short existence can be measured directly through the Casimir effect [1]. These virtual particles constitute the Hawking radiation. They carry the latent black hole information from the surface of the event horizon into the void of space during the evaporation process of the black hole[2],[3].In this article I suggest a model in which these virtual particles in the vacuum are the source for gravity, curvature of space and time dilation.

Keywords- *Holographic principle; virtual particles; gravity*

1. Introduction

Albert Einstein generated on 1915 his General Relativity theory in which gravity between objects is their geodesic movement in a curved space time [4].When a small object interacts with the gravitational field of a large object it gains kinetic energy during this process. A question that this article confronts with is where does this kinetic energy come from? Where is it concealed when we refer to it as potential energy? Is the definition of movement in a curved space-time a holistic explanation to this added kinetic energy?

I suggested a new approach to the holographic principle [5], in which for any three dimensional (3D) volume of matter (or energy) within a 3D sphere of empty space, the virtual particles that pop in and out of existence on the two dimensional (2D) outer surface of this sphere, will represent the concealed information (or entropy) of the 3D volume of matter (or energy) within the sphere. I refer to that as the information storage principle and refer to the virtual surrounding particles that conceal the information as "surrounding field of virtual particles – the VP field" [6]. So for every object of mass or energy there are infinite surrounding fields of virtual particles that store its information bits in the size of Planck's area and this information bits pop in and out of existence all the time as fluctuations in the vacuum ,based on Heisenberg's uncertainty principle and can be measured through the Casimir effect. One way to prove this theory is to measure the Casimir effect around and nearby an energetic collision of protons at the LHC. The theory predicts an increase in the Casimir effect during the collision, since these virtual particles that surround the collision conceal the entropy

information of the collision. A second way to prove the theory is to measure the Casimir effect in different locations in space. For each two locations that are close by to each other the expected correlation between the measured Casimir effects should be higher compared to locations that are farther away since the assumption is that these virtual particles conceal the information of the mass/energy within the sphere that they are on its surface area. Since these virtual particles conceal the information of the 3D internal mass/energy on a 2D surface area of the surrounding sphere, it is assumed that the information is arranged in a pattern of a hologram where 2D surface can represent 3D volume. Based on that there is an expected correlation of the measured Casimir effect as a function of distance between regions and as the regions get closer and the information within the surrounding sphere is non homogenous, the correlation of the virtual particles activity as a function of distance is more distinct.

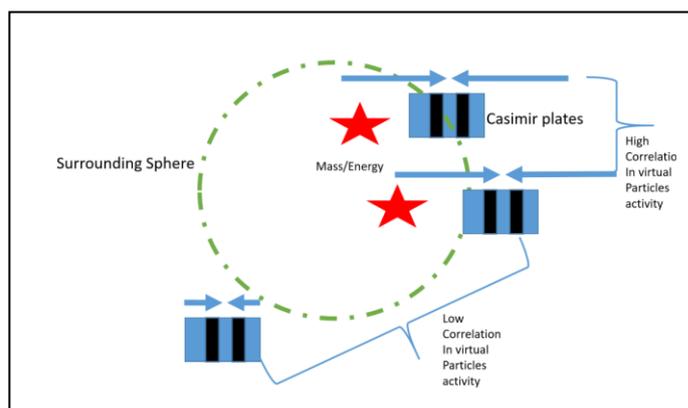


Figure 1. In this illustration we show that the correlation between the measured Casimir effect due to virtual particles increases as the distance between the measured region decreases. The blue rectangles illustrate the Casimir vacuum chamber, the black bars illustrate the Casimir plates, the blue arrows represent the Casimir measured force (the larger the arrow the larger the force), the red stars illustrate mass and energy within the sphere, and the green dot-dashed circle illustrates the surface of the sphere surrounding the mass and energy (the Casimir plates measure the virtual particles activity on this surface of the sphere).

This paper will show that these surrounding fields of virtual particles in the vacuum are the source for the gravitation force between objects.

2. Virtual particles in the vacuum as the source of gravity

Let us describe carefully as an example the standard interaction between a hydrogen atom and a pair of virtual particles which consist of an electron and its anti-particle pair, the positron. In most cases the pair of virtual particles will borrow for a short time energy from the fabric of space-time as defined by Heisenberg's uncertainty principle. As these virtual particles are formed, and only during their short existence period, the fabric of space-time surrounding these particles is distorted causing space to curve and time to slow down (time dilation). This distortion of the fabric of space-time will last for a short period of time until they annihilate each other and disappear back into the fabric of space-time. When they annihilate, the energy is returned back to space time and the distortion in space-time disappears.

Now let's describe another, non-standard option for this interaction between the hydrogen atom and the pair of virtual particles. In figure 2. We see an hydrogen atom schematically represented by a proton and an electron marked the letter A surrounding it while a pair of virtual particles, electron marked with the letter B and a positron are generated out of the vacuum, nearby for a short period of time

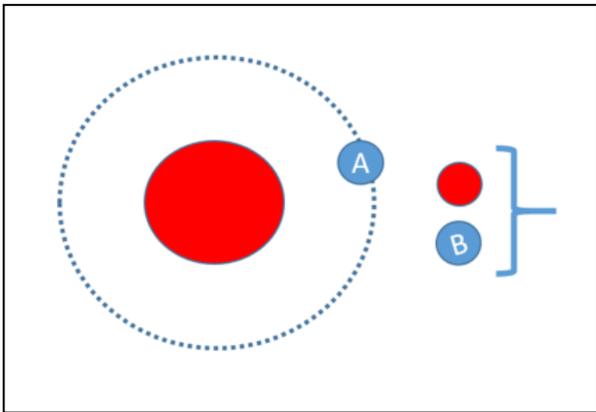


Figure 2. In this schematic illustration we show a Hydrogen atom with a Proton (red large circle) in the center surrounded by an electron (blue small circle marked with the letter A). nearby a pair of virtual particles were formed for a short period, causing a local distortion in their near region space-time. The distortion comes in the form of a shrinkage in space and time dilation. The virtual particle pair consist of an electron (small blue circle marked with the letter B) and a positron (small red circle).

As can be seen in figure 3, in the non-standard interaction, the virtual positron gets close enough to the real electron (marked A) and because of the opposite electric charge between them they become a pair of electron and positron, leaving the virtual electron (marked B) without his virtual partner.

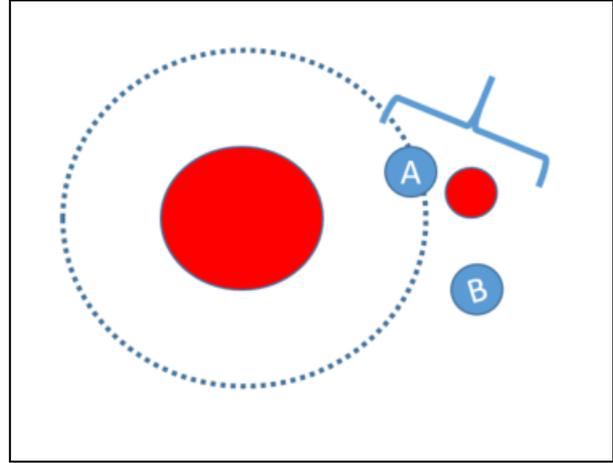


Figure 3. In this schematic illustration the virtual positron pairs together with the real hydrogen electron (marked A) leaving the virtual electron (marked B) without its virtual partner.

When this situation happens, the real electron (marked A) and the virtual positron annihilate each other and the virtual electron (marked B) becomes the real electron of the Hydrogen atom, instead of the real electron (marked A) that annihilated with the virtual positron. This annihilation is described in figure 4. This annihilation between a real electron and a virtual positron generates energy. The annihilation energy does not return back to the fabric of space-time, as in the case of the annihilation of two virtual particles and the distortion of the space-time fabric is kept. This distortion is the gravitational effect on the curvature of space and on the time dilation. This energy that was generated out of the vacuum causing a distortion to space-time, is the basic building block of gravitation.

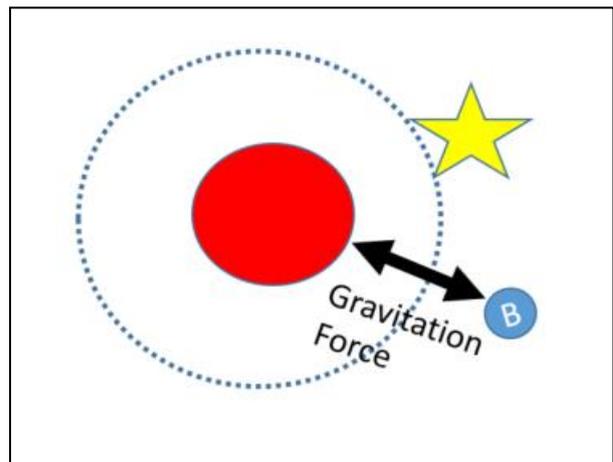


Figure 4. In this schematic illustration we show the annihilation (yellow star) of real electron A with the virtual positron while the virtual electron B becomes the real electron of the Hydrogen atom. This annihilation process is a basic building block for generation gravitational forces and distortion of space-time.

Let's look at an example consists of two masses ,M and m while $M \gg m$ at a distance R from each other. For simplicity reasons let's assume that m is infinitesimally small (compared to M) in dimensions (its infinitesimal diameter is dR),and that it has only two interactions with the virtual particles (VP) generated by the large mass M, vp_R and vp_{R+dR}

$$vp_R = \frac{M}{2\pi R}$$

vp_R = virtual particles generated by M on the surface of the surrounding sphere at a distance R (sphere I),assuming they are homogenly spread on this surface .

$$vp_{R+dR} = \frac{M}{2\pi(R + dR)}$$

vp_{R+dR} = virtual particles generated by M on the surface of the surrounding sphere at a distance $R+dR$ (sphere II), assuming they are homogenly spread on this surface . dR ,represents the diameter of m and it is an infinitesimal small change in R.

Let's assume that the probability for a non standard interaction (as described un figure 2,3 & 4) between an atom in mass m and a virtual particle (VP) generated by M on spheres I and II is $G \ll 1$ (figure 5).

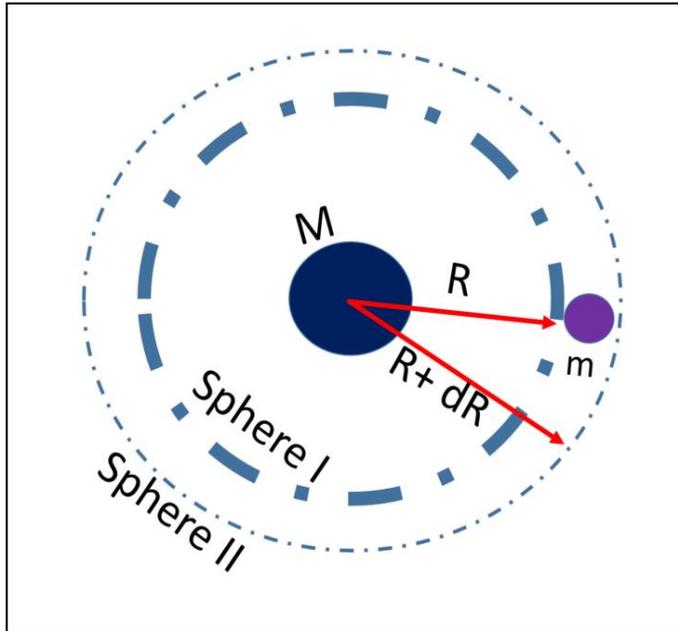


Figure 5 .Two masses M and m in a distance R from each other . mass m interacts with the virtual particles generated by mass M on sphere I and on sphere II. The interaction with sphere I generates a force towards mass M and the interaction with sphere II generates a force away from mass M.

$$\varepsilon vp_R = G \frac{M * m}{2\pi R}$$

εvp_R , is the number of virtual particles generated by M on a sphere at a distance R that annihilate with the atoms of mass m

as described above in figures 2,3&4. In this paper we refer to that as the force in which M attracts towards it mass m.

$$\varepsilon vp_{R+dR} = G \frac{M * m}{2\pi(R + dR)}$$

εvp_{R+dR} , is the number of virtual particles generated by M on a sphere at a distance $R+dR$ that annihilate with the atoms of mass m as described above in figures 2,3&4. In this paper we refer to that as the force in which M rejects away from it mass m.

$$\frac{\Delta \varepsilon vp_R}{\Delta R} = \frac{\varepsilon vp_R - \varepsilon vp_{R+dR}}{dR}$$

$\frac{\Delta \varepsilon vp_R}{\Delta R}$ = The neto force in which mass M attracts towards it mass m ,or in another words the neto gravitational force between mass M and mass m.

$$\frac{\Delta \varepsilon vp_R}{\Delta R} = \text{Gravitational force} = G \frac{M * m}{R^2}$$

As expected ,we received the Newtonian equation formation for the gravitational force.

Conclusion

We show a new approach to the Holographic principle [6] where the information (entropy) bits of a 3D volume of matter (or energy) are stored as 2D bits in the size of Planck's area on any 2 dimensional surface of empty space surrounding this 3 dimensional volume of matter (or energy) .These bits of information come in the form of a virtual particles that are being generated and annihilated based on Heisenberg's uncertainty principle and can be measured through the Casimir effect (we refer to it in this paper as the VP field). When this VP field interacts with an atom of a real mass m, nothing happens in most cases. Never the less, there is a small probability $G \ll 1$, that a real electron of an atom in mass m will annihilate with the virtual positron pair in the VP field and this nonstandard annihilation generates energy. This energy is the basic building block of gravity. Going back to the introductory discussion, I can now summarize that when a small mass m gains kinetic energy when it interacts with strong gravitational forces of mass M, the source of this kinetic energy are the non-standard annihilation energetic building blocks described in this paper. Since during this non-standard annihilation process, the energy is not returned back on time to space -time as Heisenberg's uncertainty principle dictates, space time is distorted causing an increase in space curvature and time dilation, exactly as described by Einstein's field equations.

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