A Solution to Black Hole Information Paradox

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Abstract

This theoretical framework aims to unify black holes, dark matter, and dark energy into a single quantum gravity theory. I address the black hole information paradox, proposing three fundamental postulates which lead to deeper understanding of black hole quantum gravity And a mechanism where photons decay into positive and negative two spin-half photons under extreme gravitational environment and this article also predicts the existence of spin-zero particle whose mass is close to the mass of electron. Using the scalar stress-energy tensor and its connection to the event horizon, we established a relationship between event horizon and cosmological constant. this article shows a thought provoking relationship between gravitational potential energy and cosmological constant, and the role of entanglement in preserving information across the event horizon.

Introduction

The pursuit of a unified theory of quantum gravity is central to resolving some of the most profound mysteries in theoretical physics, including the black hole information paradox. This paradox arises from the conflict between general relativity and quantum mechanics: while general relativity predicts that information entering a black hole is lost to the outside world, quantum mechanics maintains that information cannot be destroyed.

The framework proposed in this article builds on these concepts, suggesting that black holes, dark matter, and dark energy can be understood within a single unified theory of quantum gravity. In quantum electrodynamics electrons and positrons interact by exchanging virtual photons which are the quanta of electromagnetic field.

- *Suppose a spin zero particle at the event horizon of a black hole decays into electron-positron pairs. One outside the event horizon and the other inside the black hole. What will be the nature of the outgoing and the incoming particles?*

- *"Speed of light is quantized."*

$$T^2 = 1 - \chi \quad (1)$$

Binomial approximation of scalar stress-energy tensor $T^2 = 1 + nx$ where $n = \frac{v}{c}$ is velocity and c is the speed of light. At $x = -1, T^n = 1 - n$ when the velocity is equal to one speed $T^1 = 0$ and at two speed of light it becomes $T^2 = 3\ for\ torus\ and\ T^2 = -1\ for\ sphere$. Where x is Euler characteristics and It shows that stress-energy scalar tensor is related to discrete speed and specifically two speed of light.

$$R\mu\nu - \frac{1}{2}Rg\mu\nu = 0 \quad (2)$$

$$R\mu\nu R^{\mu\nu} = 1 - \frac{1}{4}R^2 g\mu\nu g^{\mu\nu} \quad (3)$$

$$R\mu\nu - \frac{1}{2}g\mu\nu = 1 \quad (4)$$

$$R\mu\nu R^{\mu\nu} = \frac{1}{4}g\mu\nu g^{\mu\nu} \quad (5)$$

$$R^2 = 3 \quad (6)$$

equation (2) is the vacuum solution of Einstein's Ricci curvature tensor, if put together equation(3) and equation (5) we will arrive at equation(6) which is value of second order in ricci scalar curvature. We would observe that the value we got from second order in stress-energy scalar tensor for torus in equation (1) was the same as the value of second order in ricci scalar curvature in equation(7), So they are interchangeable.

$\langle \Lambda^2 \rangle$ represent the vacuum expected value of dark energy or cosmological constant and n represents the number of particles in particle states, before the particle decays $n = 1$ and after the particle decays $n = 2$ Special orthogonal group SO(2) implies that $\det(A)^2 = \pm 1$ so,

$$\langle n|det(A)^2|n\rangle = \langle \Lambda^2 \rangle = \langle AA^T \rangle \quad (8)$$

$$\langle \Lambda^2 \rangle = \pm\frac{2}{3}n^2 Mev \quad (9)$$

The vacuum expectation value of cosmological constant determines the energy scale. Before the spin zero particle decays the energy scale is 0.666Mev and after the it decays into electro-positron pairs the energy scale becomes 2.666Mev.

We know the empirical value of masses of electro-positron pairs, in the light of this we can determine the mass of the spin zero particle. I claim the mass of the spin zero particle is very close or equal to the mass of electron (0.511MeV).

Cosmological constant accelerates a particle at two speeds of light in the vacuum. So the rest mass of the spin zero particle increases up to twice of its original value, hence the particle decays into electro-positron pairs.

If this true for spin zero particle then we can do the same thing for photon. Cosmological constant at the event Horizon accelerates photon at two speed of light, so its kinetic energy becomes twice its original value (2MeV) and it will become unstable. Hence it decays into spin-half photon and its anti particle. The value of cosmological constant increases as the particle decays implies that cosmological constant is stronger after the particle decays. It is shown that speed is a inherent property of the curvature and that at two speed of light Ricci curvature is raised to power of two. We will describe gravity in terms of curvature and refine the above description in terms of gravitational potential energy later in this article.

Concerning the charge of the particles, n represents number of particles in particle states. The azimuthal quantum number can be defined as $\ell = n - 1$ so in the light of this we can describe the charge associated to each ground state as $Q = \pm\ell$. so for one particle where $n = 1\ then\ \ell = 0\ therefore\ Q = 0$ and also for the two particles $n = 2,\ \ell = 1\ so\ Q = \pm 1$

Therefore photon will have $Q = +1$ charge and $Q = -1$ charges for their anti particles but the spin zero particle will have $Q = 0$ Charge.

$$R^2 = \frac{\Lambda^2}{2n\pi\Phi} A\mu A^\mu \tag{9}$$

$$R^2 = \frac{\Lambda^2}{2n\pi\Phi} J\mu J^\mu \tag{10}$$

$$\frac{1}{\Phi} A\mu A^\mu + \nabla^2\Phi = \frac{1}{\Phi}\ A'\mu A'^\mu \tag{11}$$

$$\frac{1}{\Phi} J\mu J^\mu + \nabla^2\Phi = \frac{1}{\Phi}\ J'\mu J'^\mu \tag{12}$$

$$\nabla^2\Phi = 0 \tag{13}$$

Equation (11) and (12) relate electromagnetic potential $A\mu$ and electromagnetic potential to gravitational potential energy Φ in such a way that is gauge invariant.

$$\frac{A'\mu A'^{\mu}}{\Phi} = 1 \tag{14}$$

$$\frac{J'\mu J'^{\mu}}{\Phi} = 1 \tag{15}$$

The laplacian $\nabla^2\Phi = 0$ implies that the right hand side and left hand side of equation (11) and (12) are equal is a crucial aspect of the theory.

Event horizon and entanglement entropy

$$A = 2n\pi R^2 = \Lambda^2 \tag{16}$$

Equation (17) shows a relationship between area of event horizon and cosmological constant. Cosmological constant is the vacuum expected value it determines the energy available at the surface area of event horizon.

$$S = = \frac{A}{2n} \tag{17}$$

The work of Stephen hawking and Bekenstein provide a fascinating and direct connection between area and entropy of events horizon of a black hole ref[1] and ref[5]. In this article equation (18) is written in the similar spirit.

$$T\frac{\partial^2}{\partial x^2} \quad \psi(x) = T^2\psi(x) \tag{18}$$

Using the Taylor series expansion, we can solve the equation(19) around $x = 0$. Assuming $\psi(x)$ is analytic at $x = 0$. $\frac{\partial^2}{\partial x^2}$ is the second derivative with respect to position (x)

$\psi(x)$ is the wave function or displacement and T represents scalar Stress-Energy tensor and Stress-Energy scalar tensor represents the spring constant or stiffness .

$$\psi(x) = \psi(0) - \frac{x^2T^2}{2}\psi(0) + \cdots \tag{19}$$

Ads/CFT correspondence and the holographic principle laid the foundation for the understanding entanglement entropy in the context of black and intersection of gravity, thermodynamics and quantum mechanics ref[6]. $p = p1e1 + p2e2 + p3e3$ represents probability momentum state and $q = q1e1 + q2e2 + q3e3$ also represents probability momentum state of its anti particle. Where $e = e1 + e2 + e3 + \cdots + en$ is Clifford algebra bases and we can relate it to Pauli matrices to describe entanglement of black hole such

as $p+q=\ \sigma 1(p1+q1)+\sigma 2(p2+q2)+\cdots+\ \sigma n(pn+qn).\ \sigma n$ Is Pauli matrices though we are only interested in the x-axis direction. Now let us consider the spin correlation conditions: if the spin of the particles such as electron-positron pairs and spin half positive photon and it anti particle are the same then $p-q=0$ otherwise $p+q=1$. Event horizon entropy is defined as $S=\pi T^2\ ,where\ T^2=pq.$

$$\frac{x^2}{2}=\frac{p+q}{pq} \tag{20}$$

- "The laws of physics are invariant"

Since the Galilean transformation of Newtonian mechanic to Einsteinian relativity. Motion has been relative and the laws of physics hold true. If we consider non relative motion the laws of are still intact.

$$\Phi(x)=\frac{x^2}{2}T^2 \tag{21}$$

The gravitational potential energy of a black hole accelerates a spin-zero particle at twice the speed of light, doubling its rest mass and triggering decay into electron-positron pairs. Similarly, it increases the momentum up to twice of its original value then photons decay into positive-spin half-photons and their antiparticles.

The laws of physics are invariant, suggesting that physical principles remain unchanged inside and outside the black hole. However, this invariance requires a crucial assumption: *black hole has no boundary.*

Crucially, both particles (electron-positron pairs or spin-half photons and their antiparticles) remain within the black hole's gravitational potential energy. As their potential increases, the black hole's gravitational potential energy strengthens, effectively Preserving information within the black hole's gravitational potential energy.

$$\Phi(x)=p+q \tag{22}$$

This causes a blurring the distinction between inside and outside the event horizon and challenges our classical understanding of black holes and space-time. In General Relativity, the event horizon marks the point of no return. However, this article suggests that the event horizon is no longer a boundary, as the black hole's gravity continues to affect particles beyond the traditional boundary."

$$\Phi(x) = \Lambda^2 + w(t) \tag{23}$$

The work function $w(t)$: the Gravitational potential energy required to escape the event horizon of black hole.

- *"It is the nature of the ground state of black holes to be steady"*

$$w(t) = \int xe^x \ t^{-x} \ dx = \left(\frac{1}{1-t}\right)x \tag{24}$$

Equation (24) is Laplace transformation over interval [0, ∞] where $t\ is\ time$ At $t = 0, w(0) = x$, which implies No energy threshold and Continuous transition: There is no energy barrier or threshold at $t = 0$ and The linear relationship between $w(t)$ and x suggests a continuous and smooth transition. Work function w(t) does not exhibit any singularities or divergences at $t = 0$.

No Energy Threshold: Particles such as electrons/positrons (0.511 MeV) and hypothetical spin-1/2 photons/anti particles (1 MeV), can cross the event horizon without encountering a sudden energy barrier, as there is no minimum gravitational potential energy requirement.

Smooth Transition: Quantum Field Theory (QFT) suggests that electromagnetic field fluctuations create particles that interact with electron-positron pairs. Similarly, the transition from the gravitational field outside the event horizon to the field inside is continuous and smooth, without a sharp distinction between the two. This implies that the black hole's gravitational field is stable and non-fluctuating within and beyond event horizon. At $t = \infty \ , w(\infty) = 0$.

EPR=ER model conjectured that wormhole exist between a maximum ally entangled states of two black holes that form complex EPR pairs ref[3] doesn't allow superluminal signals whereas this article heavily depends on the Idea of faster than speed of light.

EPR =ER is a suggested solution to AMPS model that claims the event horizon is a destructive boundary where information is lost and suggesting that firewall exist at the event horizon ref[4]. on the contrary this article claims that information is preserved across event horizon within gravitational potential energy of black hole.

According to Black Holes Complementary, From an Observer's Perspective the infalling particle gains energy as it approaches the stretch horizon. The region just outside the event horizon where gravity is extremely strong. The energy from the infalling particle is transferred to the stretch horizon and re-radiated as Hawking radiation ref[2].

This article suggests that particles such as electron, spin half photon and their anti particles could be radiated from the event horizon but these particles are still within black hole's gravitational potential energy.

Summary and Conclusion

- The framework presented in this article provides a novel approach to reconciling black hole physics, dark matter, and dark energy within a unified theory of quantum gravity. we have formulated a theory where black holes maintain a steady ground state, the speed of light is quantized, and the laws of physics hold true across the event horizon.
- This theoretical frame works bridge the gap between general relativity and quantum electrodynamics and the mystery surrounding black holes, dark matter and dark energy.
- I demonstrate how photon decays into spin-half positive charged photon and its anti particle and also predict the existence of a spin zero particle whose mass is equivalent to mass of electron. I believe these are possible candidates for dark matter.
    - This understanding could offer a resolution to the black hole information paradox, and show that black hole preserves information within its gravitational potential energy.
    - The proposed theory also provides insights into the behavior of photons at the event horizon and the role and nature of dark energy and dark matter.

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