The paradox of Schrodinger's cat in a black hole

Corresponding author: Eran Sinbar, Ela 13, Shorashim, Misgav, 2016400, Israel,

Telephone: +972-4-9028428, Mobile phone: +972-523-713024,

Email: eyoran2016@gmail.com

Abstract

Based on Prof. Bekenstein and Prof. Hawking, the black hole maximal entropy , the maximum amount of information that a black hole can absorb, beyond its event horizon is proportional to the area of its event horizon surface divided by quantized area units, in the scale of Planck area (the square of Planck length).[1] . This article suggests the following new information paradox, in which a box with the Schrodinger's cat thought experiment passes the black hole event horizon towards the black hole singularity.

Introduction

Prof. Bekenstein equation of black hole entropy, limits the amount of the entropy in the volume of space within the event horizon to be proportional to the area of the event horizon divided by Planck's area (the square of Planck's length). Since information is never lost [2] and entropy always increases, we assume that when a black hole evaporates through its Hawking radiation [3], this radiation contains the black hole's latent information, which radiates back into space. Since the Hawking radiation is being generated by the black hole's outer surface virtual particles, in the outer region of the event horizon, we assume that the entire information within the black hole is located on the event horizon surface. On the other hand, based on Einstein's field equations, the entire information is located in the singularity point at the center of the black hole. This contradiction lead to the interpretation that there are two points of view regarding the black hole information. Alice who has passed the event horizon towards the singularity assumes that the information is concentrated in the singularity of the black hole while Bob floating afar outside the black hole's event horizon will assume that the information spreads on the surface of the event horizon based on Bekenstein's equation. This contradiction lead to the holographic principle [4].

Schrodinger's cat in a black hole paradox

Let us assume that Alice is carrying a box with the Schrodinger's cat experiment setup [5] and when she reaches the event horizon, she does not make any observation, which can conclude if the cat is dead or alive. From Bob's perspective, the information on the event horizon surface includes a superposition in which the cat is both dead and alive. Now let us assume that as Alice passes the event horizon and falls towards the singularity she opens the box and she notices that the cat is alive .Now, from her perspective, the information in the black hole singularity will include only the information that the cat is alive. There is a disagreement between Bob's and Alice perspectives and the information on the event horizon does not include the results of Alice observation regarding her Schrodinger's cat experiment and it can never be fully reconstructed from outside the event horizon.

Conclusion

Since a black hole evaporates through the Hawking radiation, generated by virtual particles on the outer edge of the black hole event horizon, Bob can never re construct ,by measuring the Hawking radiation, if the cat reached the black hole singularity dead or alive . If the black hole evaporates totally due to the Hawking radiation this information will be lost forever. This conclusion comes as a contradiction to the information conservation of quantum theory. In other words, it means that the entropy on the surface of the event horizon described by the Bekenstein's equation does not include the added entropy due to Alice measurement results which are influenced by the Schrodinger's wave function collapse [6] , in the quantum domain, as she is drifting passed the event horizon towards the black hole singularity. We can replace the Schrodinger's cat setup with the double slit experiment that Alice will perform after passing the event horizon before reaching the black hole singularity point while Bob can never reconstruct outside the event horizon the deterministic outcome of her measurement only their probabilistic behavior. One explanation that can overcome this information paradox is that Alice never passed the event horizon since there is a firewall at the surface of the event horizon preventing from matter or energy to drift passed the event horizon [7]. This explanation contradicts Einstein General Relativity theory. In order to overcome this information paradox and stay loyal to the Einstein general Relativity theory we must assume that the information regarding the results of the Schrodinger's cat experiment performed by Alice after passing the event horizon, reached the black hole singularity and radiated back to space through an Einstein – Rosen bridge (ER=EPR) [8]. Without this assumption, from Bob's perspective, the results of Alice cat experiment will be lost forever in the black hole singularity.

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