The weak cosmic censorship conjecture may be violated

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According to traditional theory, the Schwarzschild black hole does not produce superradiation. If the boundary conditions are set up in advance, this possibility will be combined with the boson-coupled wave function in the Schwarzschild black hole, where the incident boson will have a mirrored mass, so even the Schwarzschild black hole can generate superradiation phenomena. Recently, an article of mine obtained interesting results about the Schwarzschild black hole can generate superradiation phenomena. The result contains some conclusions that violate the "no-hair theorem". We know that the phenomenon of black hole superradiation is a process of entropy reduction I found that the weak cosmic censorship conjecture may be violated.

Keywords: weak cosmic censorship conjecture, entropy reduction, Schwarzschild-black-hole

I. INTRODUCTION

Since the physical behavior of the singularity is unknown, if the singularity can be observed from other time and space, the causality may be broken and physics may lose its predictive ability. This problem is unavoidable, because according to the Penrose-Hawking singularity theorem, singularities are unavoidable when physically reasonable. There is no naked singularity, the universe, as described by general relativity, is certain: it can predict the evolution of the entire universe (may not include some singularities hidden in the horizon of limited regional space), only knowing its state at a certain moment Time (more precisely, spacelike three-dimensional hypersurfaces are everywhere, called Cauchy surface). The failure of the cosmic censorship hypothesis leads to the failure of determinism, because it is still impossible to predict the causal future behavior of time and space at singularities. The cosmic review is not just a matter of form; as long as the black hole event horizon is mentioned, it is assumed that some form of black hole exists.

This hypothesis was first proposed by Roger Penrose in 1969, and it was not stated in a completely formal way. In a sense, this is more like a research plan proposal: part of the research is to find an appropriate formal statement that is physically reasonable and can be proved to be right or wrong (and it is common enough And interesting). Because this expression is not a strictly formal expression, there is (at least) enough space to express two independent expressions, the weak form and the strong form.

The weak and strong universe censorship hypotheses are two conjectures related to the overall geometry of time and space.

The weak universe check hypothesis holds that there is no singularity from the perspective of zero infinity in the

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future. In other words, the singularity needs to be hidden from the observer at infinity through the event horizon of the black hole. Mathematically, the conjecture points out that for general initial data, the largest Cauchy development has a complete future zero infinity.

The powerful cosmological review hypothesis asserts that general relativity is a deterministic theory, which has the same meaning as classical mechanics. In other words, the classical fate of all observers should be predictable from the initial data. Mathematically speaking, the conjecture points out that the maximum Cauchy expansion of the initial data that is generally compact or asymptotically flat cannot be used as a regular Lorentz manifold expansion locally. This version was verified by Mihalis Dafermos and Jonathan Luk in 2018 for the Cauchy horizon of a charged rotating black hole.

These two conjectures are mathematically independent. Because of the existence of time and space, the weak cosmic review is effective, but violates the strong cosmic review. On the contrary, the existence of time and space, the weak cosmic review is violated, but the strong cosmic review is effective.

In 1972, Press and Teukolsky[14] proposed that it is possible to add a mirror to the outside of a black hole to make a black hole bomb (according to the current explanation, this is a scattering process involving classical mechanics and quantum mechanics[2, 9, 12, 13]).

When a bosonic wave is impinging upon a rotating black hole, the wave reflected by the event horizon will be amplified if the wave frequency $\omega$ lies in the following superradiant regime[14–16]

$$0 < \omega < m\Omega_H, \Omega_H = \frac{a}{r^2 + a^2},$$

where $m$ is azimuthal number of the bosonic wave mode, $\Omega_H$ is the angular velocity of black hole horizon. This amplification is superradiant scattering. Therefore, through the superradiation process, the rotational energy of the black hole can be extracted. If there is a mirror between the black hole’s horizon and infinite space, the amplified wave will scatter back and forth and grow exponentially, which will cause the black hole’s superradiation to become unstable.

We know that the weak cosmic supervision hypothesis has a corollary that the original entropy of the black hole will not decrease [8]. However, in my recent article[5], it is shown that if the incident boson is preset with certain boundary conditions, the Schwarzschild black hole can produce superradiation. So that the original entropy of the Schwarzschild black hole becomes less. That shows that under the quantum effect, the hypothesis of weak cosmic supervision may not be established.

II. DESCRIPTION OF THE SCHWARZSCHILD-BLACK-HOLE SYSTEM

The metric of the Schwarzschild black hole[10, 11] (in natural unit $G=c=1$) is (contrast the metric of KERR black hole)

$$ds^2 = \frac{\Delta}{\rho^2} dt^2 - \rho^2 dr^2 - \rho^2 d\theta^2 - \frac{\sin^2 \theta}{\rho^2} [(r^2) d\phi]^2,$$

$$\Delta = r^2 - 2Mr, \rho^2 = r^2.$$  

We know the Klein-Gordon equation

$$(\nabla^\nu \nabla_\nu - m^2) \Psi = 0.$$
Eigenvalues of the above formula and spherical harmonic functions can be written as

\[ \Psi_{lm}(t, r, \theta, \phi) = \sum_{l,m} e^{\text{i}m\phi} S_{lm}(\theta) R_{lm}(r) e^{-\text{i}\omega t}. \]  

(5)

III. THE SUPERRADIATION EFFECT OF BOSON SCATTERING

The Klein-Gordon equation can be written that

\[ \Phi_{,\mu}^{\mu} = 0, \]

(6)

where \( \Phi_{,\mu} = (\partial_{\mu} - ieA_{\mu})\Phi \) and \( e \) is the charge of the scalar field. We get \( A^{\mu} = \{A_{0}(x), 0\} \) and \( eA_{0}(x) \) can be equal to \( \mu \) (where \( \mu \) is the mass, \( A^{\mu} \) can be connection form).

\[ A_{0} \rightarrow \begin{cases} 0 & \text{as } x \rightarrow -\infty \\ V & \text{as } x \rightarrow +\infty \end{cases}. \]

(7)

We know that \( \Phi = e^{-\text{i}\omega t} f(x) \) and the ordinary differential equation

\[ \frac{d^{2}f}{dx^{2}} + (\omega - eA_{0})^{2} f = 0. \]

(8)

We see that particles coming from \(-\infty\) and scattering off the potential with reflection and transmission amplitudes \( R \) and \( T \) respectively. With these boundary conditions, the solution to behaves asymptotically as

\[ f_{\text{in}}(x) = I e^{\text{i}kx} + R e^{-\text{i}kx}, x \rightarrow -\infty, \]

(9)

\[ f_{\text{in}}(x) = T e^{\text{i}kx}, x \rightarrow +\infty \]

(10)

where \( k = \pm(\omega - eV) \).

The reflection coefficient and transmission coefficient depend on the specific shape of the potential \( A_{0} \). We show that the Wronskian

\[ W = \tilde{f}_{1} \frac{df_{2}}{dx} - \tilde{f}_{2} \frac{df_{1}}{dx}, \]

(11)

between two independent solutions, \( \tilde{f}_{1} \) and \( \tilde{f}_{2} \), of is conserved. From the equation on the other hand, if \( f \) is a solution then its complex conjugate \( f^{*} \) is another linearly independent solution. We find \( |R|^{2} = |I|^{2} - \frac{\omega - eV}{\omega} |T|^{2} \). Thus, for \( 0 < \omega < eV \), it is possible to have superradiant amplification of the reflected current, i.e., \( |R| > |I| \). There are other potentials that can be completely resolved, which can also show superradiation explicitly.

IV. THAT RESULT CONTAINED SOME CONCLUSIONS THAT VIOLATED THE WEAK COSMIC CENSORSHIP CONJECTURE

We can pre-set the boundary conditions \( eA_{0}(x) = y\omega \) (which can be \( \mu = y\omega \)) [3][4][6][7], and we see that when \( y \) is relatively large (according to the properties of the boson, \( y \) can be very large), \( |R|^{2} \geq \frac{\omega - eV}{\omega} |T|^{2} \) may not hold. In the end, we can get \( \Delta x \Delta p \geq 1/2 \) may not hold. If the boundary conditions of the incident boson are set in advance,
the two sides of the probability flow density equation are not equal because of the boundary conditions. Implying a certain probability, this also explains why the no-hair theorem is invalid in quantum effects.

It was previously proved[4] that, the no-hair theorem is not necessarily true under the superradiation quantum effect. The previous literature[1] indicates that the superradiation effect is a process of entropy subtraction. In my recent article[5], it is shown that if the incident boson is preset with certain boundary conditions, the Schwarzschild black hole can produce superradiation. So that the original entropy of the Schwarzschild black hole becomes less. We know that the weak cosmic supervision hypothesis has a corollary that the original entropy of the black hole will not decrease. That shows that under the quantum effect, the weak cosmic censorship conjecture may not be established.

V. SUMMARY

Recently, an article of mine obtained interesting results about the Schwarzschild black hole can generate superradiation phenomena. The result contains some conclusions that violate the "no-hair theorem". We know that the phenomenon of black hole superradiation is a process of entropy reduction I found that the weak cosmic censorship conjecture may be violated.

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