The concept of the system in the Hawking radiation

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1 Overview

When the system of Hawking radiation, which is generally considered, a pair of virtual particles pair production near the event horizon is, the one is fallen to a Black hole by the powerful gravity, and the other to be pulled away to the far, far away particle is interpreted as a radiation.

However, I think that in the interpretation there are some problems.

1. Why the energy of the flying away particles, what must be compensated as a reduction of the mass of the Black hole?
2. The virtual particles to be realized particles, although it is needed to supply of energy from the outside, we do not know the system.

In order to solve the problem, It is needed to build a theory to explain the radiation to the outside of the event horizon from the Astronomical object itself of the Black hole.
In earlier Physics in the Classical Limit than Einstein's theory of general relativity, it is impossible to explain the radiation from the Black hole.
I think that it may be possible to explain by using the quantum mechanics the radiation from the Black hole.

Uncertainty principle of Werner Karl Heisenberg, which discussed the accuracy of the ambiguity of the mainly observed value, it should be noted that this ambiguity indicates the physical quantity itself.
Uncertainty principle is there are two versions.

1. Relationship of energy and time
   $\Delta E \cdot \Delta T \leqq \hbar/2$

   Δ ambiguity
   E Energy
   T Time
   $\hbar$ Planck constant(=h)/2π

2. Relationship of position and momentum

$\Delta X \cdot \Delta P \leqq \hbar/2$

Δ ambiguity

X position

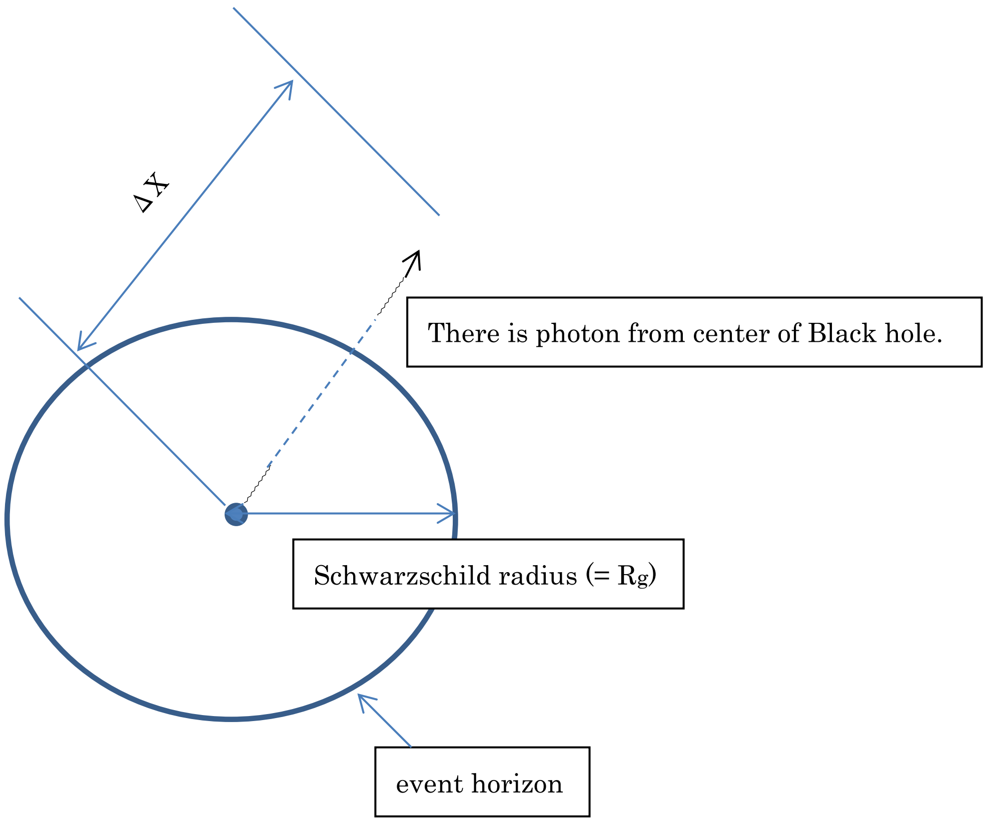
P momentum

ħ Planck constant(=h)/2π

In the second of the equation, consider compared with Schwarzschild radius (= Rg) and ΔX. Schwarzschild radius, from the center of the black hole, is the distance to the event horizon. When ΔP is small, ΔX becomes Rg larger state.

$Rg < \Delta X$

If ΔX to satisfy this equation exists, photons emitted from celestial body surface of the Black hole, it is possible to exist beyond the stochastically event horizon.



Photon image of the radiation from the event horizon

2 Equation of the temperature of the Black hole

If a Black hole is absolutely no radiation, temperature in the event horizon of the Black hole is to absolute zero.($T=0$)

However, if there is a radiation beyond the event horizon from the Black hole, the temperature is greater than absolute zero.($T>0$)

$$\Delta X \cdot \Delta P \leqq \hbar/2 \quad \ldots(1)$$

I think, in the formula of (1), ΔX is greater than the distance (R_g) to the event horizon from the center of the black hole, from the black hole that there is a possibility that there is radiation.

If there is radiation from a black body of Black hole, the spectral radiance of the electromagnetic wave radiated from the Planck's law ($I'(\lambda, T)$) is the wavelength (λ) as a function of temperature (T).

$$I'(\lambda, T) = \frac{2hc^2}{\lambda^5} \frac{1}{e^{hc/\lambda kT} - 1} \quad \ldots(2)$$

(h: Planck constant　k: Boltzmann constant　c:speed of light)

The peak value of this function occurs when the following conditions. Here, in this peak value condition and assuming that selectively radiation have been made.

$$hc = 4.97\ \lambda kT \ \ldots(3)$$

For ΔX, but is a temporary, in the range of approximately 8 times the Schwarzschild radius (R_g) is, seems to be the most efficient radiation is carried out. It will use that value.

(I would like to advance the future of research for ΔX)

$$\Delta X = 8R_g \ \ldots(4)$$

ΔP is the range of the momentum of the photon. P is in proportion to the frequency of the photons, but take a value from 0 to P_{max}, expressed this in a wavelength range ($\Delta\lambda$), it becomes the following equation.

$\Delta P = h/\Delta\lambda \geqq h/2\Delta X$

$\Delta\lambda \geqq 2\Delta X$ …(5)

(3) equation of λ. (5) equation will be as follows to be substituted as the type of Δλ.

$$\frac{hc}{4.97kT} \geqq 2\Delta X \quad \ldots(6)$$

Replacing ΔX as R_g by the formula of (4)

$$\frac{hc}{4.97kT} \geqq 16R_g \quad \ldots(7)$$

R_g is the Schwarzschild radius. Schwarzschild radius will be determined from the Schwarzschild solution of general theory of relativity as follows.

$$R_g = \frac{2GM}{C^2} \quad \ldots(8)$$

(C:speed of light G: constant of gravitation M: mass of Black hole)

R_g of formura (8) assign to formura (7).

$$\frac{hc}{4.97kT} \geqq \frac{32GM}{C^2} \quad \ldots(9)$$

Equation (9), to organize in the black hole temperature (T). In addition to use in terms of Planck's constant ($\hbar$).

$$T \leqq \frac{\hbar c^3}{25.32kGM} \quad \ldots(10)$$

T depends only on M. The constant of proportionality and *A*. In addition, since it expressed as 25.32 is approximately 8π

$$T(M) \leqq A \cdot \frac{1}{M} \simeq \frac{\hbar c^3}{8\pi kGM} \quad \ldots(11)$$

Thus, that there may be a temperature in the Black hole was shown. Since radiation from real Black holes appear to be electromagnetic waves Very the Low Frequency(VLF) or more wavelengths, the electromagnetic wave of the band is to observe whether it is emitted from the Black hole is believed to be good.