Information Amount and Entropy of Black Holes(BH) M_b and its Hawking Quantum Radiation(HQR) m_{ss}

== The total information amount I_m of a BH of M_b, $I_m = 4GM_b^2/C$. The minimum information unit I_o of any m_{ss} of any BH included $M_{bm} = m_p$, $I_o = h/2\pi = 1$ bit .The entropy S_{Bbm} of $M_{bm} = m_p$, $S_{Bbm} = \pi$. The total entropy S_{BM} of a BH of M_b, $S_{BM} = (\pi/I_o) I_m = (\pi/I_o) \times 4GM_b^2/C = 2\pi^2 R_b^2 C^3/hG$==

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【Abstract】。Hawking theories about BHs have been the epoch-making significances, they were build on the foundations of quantum mechanics and thermo-mechanics. Hawking proposed any BH being temperature on its Event Horizon (EH) R_b, and having Hawking quantum radiations(HQR) m_{ee} to be emitted out. As the result, BHs could lose its energy-matters M_b 、reduce its R_b and disappear finally in Planck ERa. It is said, any BH must accord with the same general law of life and death as anything in the Universe. [1]. Although Hawking derived out the famous temperature T_b formula on R_b of BHs, i.e, **$T_b M_b = (C^3/4G) \times (h/2\pi\kappa)$, i**t is the greatest contribution to the theories of BHs. The second famous formula about BHs is Schwarzchild solution to EGTR, i.e, **$GM_b/R_b = C^2/2$,** it is the existent condition of any BH. **However, those two formulas are not enough to solve many important problems about the properties and destiny of BHs, because the amount of m_{ss} could not be found out by Hawking.** He might be over-wholeheartedly busy to look for m_{ss} from virtual particles in Dirac's sea as to neglect to find out m_{ss} from classical theories. **In this article, author can find out the relationships of exact numerable values between HQR m_{ss} and M_b, I_o, I_m, S_B, S_{Bm} etc.**
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【Key Words】. Black Hole(BH); Hawking Quantum Radiation(HQR-- m_{ss}); Information amount I_m and I_o of BHs and m_{ss}; Entropy of BHs-- S_B, S_{Bm}

【1】。Building the formula between mass M_b of a BH and its HQR-- m_{ss}. New formulas(1d) $m_{ss}M_b = hC/8\pi G = 1.187\times10^{-10}g^2$ and (1e) $M_{bm} \equiv m_p = (hC/8\pi G)^{1/2} = 1.09\times10^{-5}$g are derived as below:

M_b –- mass of a BH, T_b –-temperature on EH(Event Horizon) of a BH, m_{ss} –-mass of a Hawking quantum radiation, R_b –-radius of EH of a BH, m_p –- Planck participle, h—Planck constant = $6.63\times10^{-27}g*cm^2/s$, , C –-light speed =$3\times10^{10}$cm/s,, G –-gravitational constant = $6.67\times10^{-8}cm^3/s^2*g$, Bolzmann constant $\kappa = 1.38\times10^{-16}g*cm^2/s^2*k$, L_p ---Planck length, T_p ---Planck temperature, M_{bm}—minimum BH in the Universe, its corresponding parameters-- R_{bm}, T_{bm},

$$T_b M_b = (C^3/4G) \times (h/2\pi\kappa) \approx 10^{27}gk, \quad [1][2] \quad (1a)$$

(1a) is famous Hawking temperature formula,

m_{ss} is Hawking quantum radiation(HQR) on R_b; according to formula of energy transformation,

$$m_{ss} = \kappa T_b/C^2 \quad [5] \quad (1b)$$

T_b is also valve temperature on R_b. according to Schwarzchild solution to EGTR,

$$GM_b/R_b = C^2/2 \quad [1][5] \quad (1c)$$

From (1a) and (1b), it is easily got,

$$m_{ss} M_b = hC/8\pi G = 1.187\times10^{-10}g^2 \quad (1d)$$

(1d) is a new generally effective formula on R_b of any BHs。 Now $m_{ss}M_b$ = constant, according to thermo-mechanics, certainly $T_b \neq 0$, thus, $M_b \neq 0$, $R_b \neq 0$ and $m_{ss} \neq 0$. Consequently, m_{ss} 、M_b and R_b are all impossibly equal to zero or infinity. Then, m_{ss} 、R_b and M_b must have its respective limit。From (1d), **According to axiom of any part ≦ the whole**, at the limited condition, $M_b = m_{ss} = M_{bm} = (hC/8\pi G)^{1/2}$。 **Owing to $(hC/8\pi G)^{1/2} \equiv m_p$ = Planck particle,** [3] so, (1e) is another new important formula,

$$M_{bm} = m_p = m_{ss} = (hC/8\pi G)^{1/2} = 1.09\times10^{-5}g \quad (1e)$$

$$m_{ss}R_b = h/(4\pi C) \quad (1f)$$

$$R_{bm} \equiv L_p \,[3] \equiv (Gh/2\pi C^3)^{1/2} \equiv 1.61\times10^{-33}cm \quad (1g)$$

$$T_{bm} \equiv T_p \,[3] \equiv 0.71\times10^{32}k \quad (1h)$$

$$R_{bm}m_{ss} = h/(4\pi C) = 1.0557\times10^{-37}cmg \quad (1i)$$

Compton time t_c = Schwarzchild t_s ,

$$t_c = t_s = R_{bm}/C = 1.61\times10^{-33}/3\times10^{10} = 0.537\times10^{-43}s \quad (1j)$$

$$\rho_{bm} \approx 10^{93}g/cm^3 \quad (1k)$$

From $M_b = 4\pi\rho R_b^3/3$ and (1c), for any BHs, (1n) is only and always valid,

$$\rho_b R_b^2 = 3C^2/(8\pi G) = \text{constant} \quad (1n)$$

It can be seen from above formulas,

A. once formulas (1d) and (1e) are build up, all the relationship between M_b and R_b、T_b、m_s and the final destiny of any BHs are well known. They can only finally become $M_{bm} = m_p = m_{ss}$ and disappear in Planck Era.

B. The relationship between M_b and R_b、T_b、m_{ss} are all the simplest and liner relationship. Thus, BHs are the simplest objects in the Universe.

C. All BHs with the same mass-- M_b can have the same numerable values of R_b、T_b、m_{ss}、I_o、I_m、S_B, S_{Bm}、etc, but the states and structures inside any BHs can be very great different.

【2】。According to analogy of thermo-dynamics in the theory of BHs, the entropy S_B of a BH in Einstein gravity theory is as follow:

$$S_B = A/4l^2 \ [2] = 2\pi^2 R_b^2 C^3/hG \quad (2a)$$

In above (2a), A—surface of a BH--M_b, $A = 4\pi R_b^2$。 l –Planck length, S_B-- entropy of a BH,

$$l = (HG/C^3)^{1/2} \ [3] \quad (2b)$$

(2a) is the famous Bekenstein-Hawking formula。 From (1c) $GM_b/R_b = C^2/2$, then,

$S_B = A/4l^2 = 4\pi R_b^2/(4GH/C^3) = 4\pi R_b^2 \times C^3/4GH = \pi R_b R_b C^3/GH = \pi \times Ct_s \times 2GM_b C^3/GHC^2 = \pi 2t_s \times M_b C^2/H$, **$t_s$ –Schwarzschild time, C $t_s = R_b$。 So,**

$$S_B \times (h/2\pi) = \pi(2t_s \times M_b C^2), \text{ or } S_B = \pi(2\pi/h) \times (2t_s \times M_b C^2) \quad (2c)$$

In above (2c), $H = (h/2\pi) = I_o$, According to **Heisenberg's Uncertainty Principle**, two complementary physical dimensions; such as time and energy, location and momentum, angle and angular momentum, if both have no way to be measured precisely, their product is equal to a constant = H = $h/2\pi = 1.058\times10^{-34}$ **Js** = 1.058×10^{-27} g*cm^2/s。 Then,

$$2t_s \times M_b C^2 = h/2\pi = I_o \quad (2d)$$

$$\Delta E \times \Delta t \approx h/2\pi = I_o \quad (2e)$$

Doing analogy between (2d) and (2e), (2e) is mathematical formula of Uncertainty Principle. $2t_s$ is corresponding to Δt, and M_bC^2 is corresponding to ΔE。 Iτ shows that, BHs emitting m_{ss} are all quantum.

【3】。The information unit I_o and entropy S_{Bbm} of $M_{bm} = m_{ss} = m_p = (hC/8\pi G)^{1/2}$

In above【1】, it was proved that, $M_{bm} = m_{ss} = m_p = (hC/8\pi G)^{1/2}$, and $R_{bm} \equiv L_p \equiv (Gh/2\pi C^3)^{1/2} \equiv 1.61\times10^{-33}$cm, $t_{sbm} = R_{bm}/C = 0.537\times10^{-43}$s。 Let check up **data of $M_{bm} = m_{ss} = m_p$** .

According to **(2c) and (2d):**

$$2t_{sbm} \times M_{bm} C^2 = 2\times0.537\times10^{-43}\text{s}\times1.09\times10^{-5}\text{g}\times9\times10^{20} = 1.054\times10^{-27}\text{gcm}^2/\text{s}. \quad (3a)$$

$$h/2\pi = 6.63\times10^{-27}/2\pi = 1.06\times10^{-27}\text{g*cm}^2/\text{s}. \quad (3b)$$

It can be seen, **(3a) = (3b), so,**

$$2t_{sbm} \times M_{bm} C^2 = h/2\pi = H = I_o \quad (3c)$$

Thus, $h/2\pi = H = I_o = 1$ bit is the minimum information unit in the Universe, and I_o = minimum information unit of $M_{bm} = m_{ss} = m_p$ and m_{ss}. Owing to the lifetime of $M_{bm} = m_p$ only being 0.537×10^{-43}s and $I_o = 1$ bit, the sole way for $M_{bm} = m_p$ could disintegrate themselves into many smaller energy-particles for prolonging the lifetime of themselves.

If applying natural Planck constant, **let $h/2\pi = 1 = H = I_o$, so, $t_{sbm} \times M_{bm} C^2 = 1$.**

From (3c), the entropy S_{Bbm} of $M_{bm} = m_p$, due to $S_B (h/2\pi) = \pi\, 2t_s \times M_{bm} C^2$, **so,**

$$S_{Bbm} = \pi, \text{and } I_o = 2t_{sbm} \times M_{bm} C^2 = h/2\pi, \quad (3d)$$

It shows, the information unit < ($I_o = h/2\pi$) of any BH could be impossible to exist in the Universe, and $I_o = h/2\pi = 1$ bit = the minimum information unit of our Universe.

An amateur physicist, Ms. Feng (方舟の女) explained: [On philosophy, existence is just perceived by sensory organs, and perceptibility is just the information to be got and transformed. Anything bringing no information could have no way to be perceived. Thus, information is just existence. Thus,

Information= Existence= energy × time .

Correspondingly, Planck constant H = energy Uncertainty × time Uncertainty.

Why does existence= energy× time? It reflects existence has only two essential factors. Any existent thingmust have its energy and its living time. A thing of no energy or no living time can be really no existence.] [4]

I think, her concept to information is rather correct and accepted.

【4】。The information amount of any different m_{ss} radiated by any BH of M_b is completely the same = $I_o = h/2\pi$, and has nothing to do with the amount of M_b and m_{ss}。

For getting the general formula of information amount of m_{ss}, from (1d), $m_{ss}M_b = hC/8\pi G = 1.187\times10^{-10}\text{g}^2$。 So,

$$I_o = m_{ss}C^2 \times 2t_c = C^2 hC/(8\pi GM_b) \times 2R_b/C = C^2 hC/(8\pi GM_b) \times 2 \times 2GM_b/C^3 = h/2\pi \quad (4a)$$

Above (4a) shows, the information unit of any m_{ss} of a BH is always equal to $I_o = h/2\pi$, no matter whether M_b and m_{ss} is big or small. Thus, I_o is the minimum, the most basic information unit = 1 bit.

To getting the total information amount I_m and total entropy S_{BM} of a BH of M_b, let $n_i = M_b/m_{ss}$.

$$I_m = n_i I_o \quad S_{BM} = n_i \pi = (\pi/I_o) I_m, \quad (4b)$$

$$\text{Owing to } M_b = n_i m_{ss}, \ I_m = I_o M_b/m_{ss}, \quad (4c)$$

From (1d) and (4c),

$I_m = I_0 M_b/m_{ss} = 4GM_b^2/C$ **(4d)**

From (4b), $S_{BM} = (\pi/I_o)\, I_m = (\pi/I_o) \times 4GM_b^2/C = 2\pi^2 R_b^2 C^3/hG = S_B$, **(4e)**

(4e) is completely the same with previous (2a), it can be proved that, all formulas derived above are perfectly correct and very harmonious..

From energy transformation, $m_{ss}C^2 = (h/2\pi) \times C/\lambda_{ss}$, so, **any wave length λ_{ss} of m_{ss} is equal to the diameter of BH of M_b.**

$\lambda_{ss} = 2\, t_c C = 2R_b = D_b$ **(4f)**

【5】. It has been testified that our Universe is a really cosmic-BH(CBH).[6] As a real calculated example, the numerable values of various parameters of our Universe(CBH) as a real BH can be calculated out with all above formulas. The only known number of CBH is its current mass $M_{bu} = 10^{56}$g.

As the results: from(1c), $R_{bu} = 1.5\times10^{28}$cm; from(1a), T_{bu} on $R_{bu} = 10^{-30}$k; from(1d), Hawking quantum radiation on R_{bu}, $m_{ss} = 10^{-66}$g; total numbers of m_{ss}, $n_{iu} = M_{bu}/m_{ss} = 10^{122}$; from(4f), the wave length of m_{ss}, $\lambda_{ss} = 2R_{bu} = 3\times10^{28}$cm; from(4a), information amount of any different m_{ss}, $I = h/2\pi = 1.06 \times10^{-27}$ g*cm^2/s; from(3d), entropy of any different m_{ss}, $S_{Bbm} = \pi$; from(4d), the total information amount of CBH, $I_{mu} = 10^{95}$ g*cm^2/s; from(4e), the total entropy of CBH, $S_{BMU} = 10^{122}\pi$.

Hawking formula of BH's lifetime τ_b,

$\tau_b \approx 10^{-27} M_b^3$ **(5a)**

So, if no energy-matters outside to be engulfed, the lifetime τ_{bu} of our Universe will be, $\tau_{bu} \approx 10^{134}$years. It is said, Our Universe due to emitting Hawking Quantum Radiations(HQR) will finally become $M_{bm} = m_p$, **and disappear in Planck Era after 10^{134}years. From(5a),**

$-d\tau_b \approx 3\times10^{-27} M_b^2\, dM_b$ **(5b)**

Let $dM_b = 1\, m_{ss}$, then, $-d\tau_b$ is the time needed by emitting 1 m_{ss} of any BH. So, for our **Universe(CBH),** $-d\tau_{bu} \approx 10^{12}$ **years.** It is said, our current Universe emitting 1 m_{ss}(HQR) needs 10^{12}years $\approx$ 100 times of current age of our Universe.

【6】. Some very significant and effective conclusions from above calculations:

A; If our CBH having energy-matters outside , which will be thoroughly engulfed. After that, the bigger CBH in future will nonstop emit HQRs(m_{ss}) to contract its size finally to become $M_{bm} = m_p$, and disappear in Planck Era after 10^{134}years. However, the lifetime of the bigger CBH >>10^{134}years. Then, the destiny of our Universe from the viewpoints of BH's theory can be very great different with the General Theory of Relativity. Thus, $\Omega \neq 1$ got out from GTR can be a false proposition.

B; After new formulas(1d), (1e), (4a), (4b). (4d), (4f), (5b) derived by author, the theory of BHs will go to a rather complete system. The relationships between various parameters are very harmonious. Owing to the states and structures inside BHs having nothing to do with the mass of any BH, they can be very great different.

C; . The wave length of m_{ss}, $\lambda_{ss} = 2R_{bu} = 3\times10^{28}$cm, so, m_{ss} emitted by our Universe should be the gravitational waves.

D. The information amount I_m of combinations of two BHs($M_{b1} + M_{b2}$) can not be conservative. From(4b), owing to $I_m \backsim M_b^2$(I_m is directly proportional to M_b^2), after combinations of two BHs of $M_{b1} + M_{b2}$, their total information amount $I_{m1+m2} \backsim (M_{b1} + M_{b2})^2$; but $I_{m1} \backsim M_{b1}^2$, $I_{m2} \backsim M_{b2}^2$; then, $I_{m1+m2} > I_{m1} + I_{m2}$. Similarly. If a BH of M_b, its original I_m of M_b, $I_m \backsim M_b^2$, after M_b emitting m_{ss} of 0.5 M_b, the rest 0.5 M_b will only have 0.25 I_m, but the lost 0.5 M_b bring away 0.75 I_m. However, the original total information amount I_m of M_b does not be increases or degreases any more, and is equal to a constant in the process of emitting m_{ss}. Obviously, from(4f), owing to I_o of any $m_{ss} = h/2\,\pi$, the bigger M_b emit the longer λ_{ss} of m_{ss}, and bring away the less mass of a m_{ss}. Therefore, the lost 0.5 M_b emit out more information amount of 0.75 I_m, but the rest 0.5 M_b only keep 0.25 I_m. Entropy is the same conditions with the information above.

E. Now that the information amount of any m_{ss} emitted by any BHs is always equal to $h/2\pi = 1$ bit = minimum information unit, and BH can only emit 1 m_{ss} each time, is the same condition available with all other objects emitting information?

====The End====

【Referances】.

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