The Hawking Temperature Intensive Crisis and a Possible Solution that Leads to an Intensive Schwarzschild Radius Temperature *

Espen Gaarder Haug
Norwegian University of Life Sciences
espenhaug@mac.com

November 28, 2018

Abstract

Crothers and Robitaille have recently pointed out that the Hawking temperature and the Unruh temperature are not intensive, which suggests that the theory around the temperature of black holes is flawed, incomplete, or at least not fully understood. Here we offer a modified Newtonian type acceleration field linked to the Planck scale that leads to a new modified intensive Schwarzschild surface temperature for so-called black holes.

Key words: Hawking temperature, Unruh temperature, Planck scale, Schwarzschild radius .

1 The Intensive Crisis in the Hawking temperature and the Unruh Temperature

In 1974, Hawking [1] introduced the idea of black hole radiation and a corresponding temperature at the black hole's surface, better known today as Hawking radiation and Hawking temperature. The Hawking temperature is given by

$$T_H = \frac{\hbar g}{2\pi c k_B} \tag{1}$$

where c is the speed of light, k_b is the Boltzmann constant, and g is the gravitational acceleration field. The Hawking temperature was originally stated as what

> *"?one would expect if the black hole was a body with temperature of* $(\kappa/2\pi)(\hbar/2k_b)$*..."*
> – Stephen Hawking, 1974

and the Unruh temperature is very similar to the Hawking temperature

$$T_U = \frac{ha}{4\pi^2 c k_B} \tag{2}$$

The Newton gravitational acceleration at the Schwarzschild radius is given by

$$g = \frac{GM}{R_s^2} = \frac{GM}{\left(\frac{2GM}{c^2}\right)^2} = \frac{c^4}{2GM} \tag{3}$$

and when replaced in the Hawking temperature it is

$$T_H = \frac{hc^3}{8\pi^2 GM k_B} \tag{4}$$

When the mass increases, the Hawking temperature and Unruh temperature at the Schwarzschild radius will fall. Crothers and Robitaille [2, 3] have recently pointed out that the Hawking temperature and the Unruh temperature at the Schwarzschild radius of a so-called black hole, therefore, not is intensive but directly linked to the extensive mass. Temperature must, according to thermodynamics, be intensive [4]. So, could this indicate that the Hawking temperature is flawed or incomplete? In this paper, we are examining the Hawking and Unruh intensive crisis.

*Thanks to Victoria Terces for helping me edit this manuscript.

We think one should be careful with making harsh criticism of predictions at the Schwarzschild radius. The smallest Schwarzschild radius is the Planck length and, we will claim, the Schwarzschild radius is directly is linked to the Planck scale. Recent research also shows that we can measure the Schwarzschild radius without any knowledge of general relativity theory or Newton's gravitational constant. The Schwarzschild radius is, in our view, essential for gravity, but what does it truly represent? See [5, 6]. Yet, the importance of the Schwarzschild radius seems to have little to do with the traditional view on black holes; it should instead be connected to our recent progress in quantum physics

At the Planck scale, several physical laws could break down, including Lorentz symmetry; this is also predicted by several quantum gravity theories. However, we do not expect the requirement of intensity of temperature to be one of the rules that breaks down, and we expect that the Crothers and Robitaille paper, which points out the intensive crisis in the Hawking and Unruh temperatures, to be valid. This means the intensive crisis should be investigated further.

2 Modified Gravitational Acceleration Field

What is described in this section was first suggested by Haug [7] in early 2018, before Crothers and Robitaille pointed out the intensive crisis in the Hawking and Unruh temperatures. Thus, there is an interesting timeline with regard to thoughts on this subject in very recent history; we did not try to come up with the modification in gravitational acceleration field (as suggested below) simply to fudge the intensive crisis in Hawking and Unruh temperatures. In fact, we have been working on similar topics and came up with this suggestion before we had heard of the intensive crisis. The modified gravitational acceleration field, even if somewhat ad-hoc, is based on deep tinkering with gravity at the Planck scale and we have contributed to the literature on this subject previously.

The acceleration field is unrealistically low under classical Newtonian [8] physics at the Schwarzschild radius. And yet the escape velocity at the Schwarzschild radius is always the speed of light, as we think it should be. Assume a super-massive object that is 10^{14} solar masses. The gravitational acceleration field at the Schwarzschild radius is, under Newton's universal gravitation, only

$$g = \frac{GM}{R^2} = \frac{GM}{\left(2\frac{GM}{c^2}\right)^2} \approx 0.152 \text{ m}/s^2 \tag{5}$$

How can the escape velocity be c and at the same time the surface gravity field is much weaker than that on Earth, where it is about 9.8 m$/s^2$? According to Einstein's theory of general relativity, the gravitational acceleration field under the Schwarzschild metric is supposedly going towards infinite strength at the Schwarzschild radius. We will suggest that no acceleration field can be stronger than the Planck acceleration field

$$a_p = \frac{c^2}{l_p} \approx 5.56092 \times 10^{51} \text{ m}/s^2 \tag{6}$$

If the shortest possible time interval during which something can undergo acceleration is one Planck second, then if an object undergoes Planck acceleration for this time interval, it will reach the speed of light

$$a_p t_p = \frac{c^2}{l_p}\frac{l_p}{c} = c \tag{7}$$

As matter cannot travel at the speed of light, in our interpretation this means only a Planck mass particle can undergo this acceleration. As shown by Haug in a series of papers, the Planck particle is likely at absolute rest and within one Planck second will dissolve into pure energy [9]. This also explains why the mass can accelerate from rest-mass to the speed of c within a Planck second; it has to dissolve into pure energy in this time frame. From mathematical atomism, only the Planck mass particle can do this within a Planck second. We will assume the Planck acceleration is what we have at the Schwarzschild radius. Further, we will assume the inverse square rule basically holds for a radius going out from the Schwarzschild radius rather than from the very center of the mass. Based on this scenario, our modified formula for gravitational acceleration field is

$$\begin{aligned} g &\approx \frac{GM}{r^2 - \left(\frac{2GM}{c^2}\right)^2 + \left(\frac{GM}{c^2}\right) l_p} \\ g &\approx \frac{c^2 N l_p}{r^2 - (2Nl_p)^2 + N l_p^2} \end{aligned} \tag{8}$$

where N is the number of Planck masses in the object. Now the acceleration field for a 10^{14} solar mass object at the Schwarzschild radius, $r = \frac{2GM}{c^2}$, gives

$$g \approx \frac{GM}{r^2 - \left(\frac{2GM}{c^2}\right)^2 + \left(\frac{GM}{c^2}\right) l_p} = \frac{GM}{\left(\frac{2GM}{c^2}\right)^2 - \left(\frac{2GM}{c^2}\right)^2 + \left(\frac{GM}{c^2}\right) l_p} = \frac{c^2}{l_p} \approx 5.56092 \times 10^{51} \text{ m}/s^2 \tag{9}$$

Next, the mass of the Earth is approximately 2.74388×10^{32} Planck masses. Further, the radius of the Earth is 6,371,000 km; this gives an acceleration field of the Earth at the surface of Earth equal to

$$g \approx \frac{c^2 N l_p}{r^2 + N l_p^2 (1 - N)} = \frac{c^2 \times 2.74388 \times 10^{32} \times l_p}{6371000^2 + (2 \times 2.74388 \times 10^{32} \times l_p)^2 - 2.74388 \times 10^{32} \times l_p} \approx 9.8194 \ m/s^2$$

Still, this formula always gives the Planck acceleration at the modified Schwarzschild radius. We have not evaluated this adjustment completely yet, and it should be investigated further for possible weaknesses.

3 Back to the Intensive Crisis in Hawking Temperature

Haug has suggested that the gravitational acceleration field should possibly be modified to

$$\begin{aligned} g &\approx \frac{GM}{r^2 - \left(\frac{2GM}{c^2}\right)^2 + \left(\frac{GM}{c^2}\right) l_p} \\ g &\approx \frac{c^2 N l_p}{r^2 - (2N l_p)^2 + N l_p^2} \end{aligned} \tag{10}$$

When $r = R_S = \frac{GM}{c^2}$, this gives

$$\begin{aligned} g &\approx \frac{GM}{R_s^2 - \left(\frac{2GM}{c^2}\right)^2 + \left(\frac{GM}{c^2}\right) l_p} \\ g &\approx \frac{GM}{\left(\frac{GM}{c^2}\right)^2 - \left(\frac{2GM}{c^2}\right)^2 + \left(\frac{GM}{c^2}\right) l_p} = \frac{c^2}{l_p} \end{aligned} \tag{11}$$

The acceleration, as stated earlier, is always the Planck acceleration at the Schwarzschild radius:

$$g_{r_s} = \frac{c^2}{l_p} \tag{12}$$

which gives a black hole surface temperature of

$$T_H = \frac{h g_{r_s}}{4\pi^2 c k_B} = \frac{h \frac{c^2}{l_p}}{4\pi^2 c k_B} = \frac{\hbar}{l_p k_B} c \frac{1}{2\pi} \tag{13}$$

That is now intensive; no matter what the mass of the so-called black hole may be, our surface temperature is always the same, it is the Planck temperature divided by 2π, and it is intensive.

4 Possible Implications for Quasars

As quasars are considered black holes (at least at their core), our modified Schwarzschild radius (Hawking) radiation should be valid for them. Our new model predicts that the quasar radiation is much higher than expected at the surface of the Schwarzschild object (quasar). This also means that the life expectancy of quasars would be much shorter than expected from modern cosmology. We observe that the life expectancy of quasars could also be dependent on the density of particles with mass surrounding the quasar. Particles with mass around the quasar will be moving towards the quasar due to gravity and will reflect radiation out from the quasar back to the quasar and therefore this will also increase the life expectancy. We will suggest that the shortest possible life expectancy of a quasar (hypothetically surrounded by only a vacuum) is simply related to the Schwarzschild radius divided by the speed of light, which gives

$$T_{r_s} = \frac{R_s}{c} = \frac{2GM}{c^3} \tag{14}$$

Ww should keep in mind that the Schwarzschild radius is the reduced Compton frequency per Planck second multiplied by the Planck length, $R_s = \frac{2GM}{c^2} = 2N\frac{\frac{c}{\bar{\lambda}}}{\frac{c}{l_p}}l_p = 2Nl_p\frac{l_p}{\bar{\lambda}}$, be aware that both l_p and $\bar{\lambda}$ can be measured independent of GR and even any knowledge of big G. For a quasar with 10^{14} solar masses, this means (the suggested formula above) a minimum life expectancy of just 15.6 years. This means the quasar could lose much of its mass within a few years. Recently, astronomers [10, 11] have observed quasars vanishing (or at least changing dramatically) within a 10-year period, where previous theories predicted that this would take at least 10 thousand years,

> *Although quasars turn off, transitioning into mere galaxies, the process should take 10,000 years or more. This quasar appeared to have shut down in less than 10 years – a cosmic eyeblink.* – see [12]

Our theory also means that the quasars must be extremely bright objects, something they are indeed. Our theory even explains why no micro black holes has been observed. The life expectancy of a micro black hole would only be one Planck second, as the Schwarzschild radius of the smallest so-called black hole is the Planck length. Further, as we have pointed out in several papers, mass is time dependent [9]; however, in general this is only directly observable when we approach reduced Compton time observational windows, and we are not there yet. As for the Planck mass particle, the micro black hole, the reduced Compton time is the Planck time.

5 The Black Hole Interpretation Crisis

Crothers [13] has been very critical to the modern physics interpretation of so-called black holes. We think he is right in much of his criticism. Still, based on recent progress in theoretical and applied physics, we also think that the Schwarzschild radius represents something very important related to gravity [5]. The Schwarzschild radius is the reduced Compton frequency of the gravity object per Planck second times the Planck length. Both the reduced Compton frequency per Planck second and the Planck length can be found independent of GR and also independent of any knowledge of big G, see [14]. We claim that even particles with less mass than the Planck mass have a Schwarzschild radius, but the Schwarzschild radius is then probabilistic [6]. We suggest that so-called black holes should be understood from a totally new perspective, namely mathematical atomism, which is linked directly to a new and revolutionary understanding of the Planck scale. This is something we will likely return to in a later version of this paper.

A series of modern physics predictions around AGN (quasars/black holes) seem to be totally different than what is observed, such as expected time-dilation in high Z quasars [6, 15, 16], as well as how fast quasars can vanish or change their observable characteristics. In addition, the fact that Hawking temperature is not intensive should make us question the incompleteness of the fundamental principles of existing theories and look more closely at criticisms as well as potential alternatives. One cannot just keep patching holes in a theory by creating new holes, one must go back to take a close look at the foundation.

6 Conclusion

Crothers and Robitaille have recently pointed out that the Hawking temperature is not intensive; that is to say, the Hawking temperature seems to be incomplete or flawed in some way. Earlier this year, Haug has suggested a modified Newton gravitational acceleration field that gives the same gravitational acceleration in weak gravitational fields as predicted by Newton and as observed, but gives very different gravitational acceleration linked to the Planck scale at the Schwarzschild radius (very strong gravitational fields). Using this modified gravitational acceleration field, we get a intensive temperature at the Schwarzschild radius. We think the intensive crisis should be taken seriously and that alternative theories about gravity should be examined more closely.

References

[1] S. Hawking. Black hole explosions. *Nature*, 248, 1974.

[2] P. M. Robitaille. Hawking radiation: A violation of the Zeroth law of thermodynamics. *http://vixra.org/pdf/1803.0264v1.pdf*, 2018.

[3] S. J. Crothers and P. M. Robitaille. The Unruh effect: insight from the laws of thermodynamics. *http://vixra.org/pdf/1811.0157v1.pdf*, 2018.

[4] P. Y. Landsberg. *Thermodynamics*. Interscience Publishers, New York, 1961.

[5] E. G. Haug. Gravity without newton's gravitational constant and no knowledge of mass size. *preprints.org*, 2018.

[6] E. G. Haug. Maximum velocity for matter in relation to the Schwarzschild radius predicts zero time dilation for quasars. *preprints.org*, 2018.

[7] E. G. Haug. A simple newtonian quantum gravity theory that predicts the same light bending as GR and also a new gravitational prediction that can be tested! *www.viXra.org 1802.0169*, 2018.

[8] Isaac Newton. *Philosophiae Naturalis Principia Mathematics*. London, 1686.

[9] E. G. Haug. Revisiting the derivation of Heisenberg's uncertainty principle: The collapse of uncertainty at the Planck scale. *preprints.org*, 2018.

[10] LaMessa, et. al. The discovery of the first "changing look" quasar: New insights into the physics phenomenology of AGN. *The Astrophysical Journal*, 800(2), 2015.

[11] Zhenfeng, et. al . Mid-infrared variability of changing-look AGN's. *The Astrophysical Journal*, 846(1), 2017.

[12] S. Hall. Galactic beacons get snuffed out in a cosmic eyeblink. *Quanta Magazine*, 2018.

[13] S. J. Crothers. Proof the the black hole has no basis in general relativity or Newtonian gravitation and therefore does not exist. *http://vixra.org/pdf/1212.0010v1.pdf*, 2012.

[14] E. G. Haug. Finding the Planck length independent of newton's gravitational constant and the Planck constant: The Compton clock model of matter. *https://www.preprints.org/manuscript/201809.0396/v1*, 2018.

[15] M. R. S. Hawkins. On time dilation in quasar light curves. *Mon. Not. R. Astron. Soc.*, 405:1940–1946, 2010.

[16] M. R. S. Hawkings. Time dilation and quasar variability. *The Astrophysical Journal*, 553:97–100, 2001.