



The Infoton at Hawking Temperature

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Abstract

By substituting Hawking temperature ($T_H = \hbar c^3 / 8\pi G M k_B$) into the Infoton equation $m = (k_B T \ln(2)) / c^2$, I derive the information-energy mass at a black hole horizon: $m = (\hbar c)(\ln(2)) / (8\pi G M)$. This result shows Infoton mass is inversely proportional to black hole mass — as a black hole evaporates, information at its horizon becomes more massive. More generally, temperature mediates the coupling between information and spacetime geometry.

Keywords: Physics; Information Theory; Information Physics; Quantized Information; Matter; Information Mass; Entropy; Landauer's Principle; Information Thermodynamics; Quantum Information, Infoton, Gravity, Spacetime Geometry;

1. Derivation

The Infoton [1] derives from coupling Einstein's mass-energy equivalence [2] with Landauer's thermodynamic bound [3]. Because the Infoton mass depends on temperature, we may substitute [4] other temperatures for T . For example, substituting Hawking temperature ($T_H = (\hbar c^3 / 8\pi G M k_B)$ [5] in $m = (k_B T \ln(2)) / c^2$ yields the information-energy mass at a black hole horizon.

We begin with Einstein's mass-energy equivalence and rearrange to solve for mass.

$$E = mc^2$$

$$m = E/c^2$$

Substitute Landauer's minimum energy ($k_B T \ln(2)$) for E . This is the Infoton equation.

$$m = (k_B T \ln(2)) / c^2$$

Substitute Hawking temperature $T_H = \hbar c^3 / 8\pi G M k_B$ for T .

$$m = (k_B (\hbar c^3 / 8\pi G M k_B) (\ln(2))) / c^2$$

Multiply through. When multiplying by a fraction, the top ($\hbar c^3$) goes to the numerator, the bottom ($8\pi G M k_B$) goes to the denominator. The c^2 that was dividing the whole expression joins the denominator.

$$m = ((k_B)(\hbar c^3)(\ln(2)) / (8\pi G M k_B)) / c^2$$

Cancel k_B . It appears in both numerator and denominator, so it eliminates.

Received: date: January 12, 2026

Published: January 12, 2026

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$$m = ((\hbar c^3)(\ln(2)))/(8\pi GM)/c^2 \quad 34$$

Dividing by c^2 is the same as multiplying the denominator by c^2 . The c^2 moves inside, joining $8\pi GM$ in the denominator. 35
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$$m = ((\hbar c^3)(\ln(2)))/((8\pi GM)(c^2)) \quad 37$$

Simplify $c^3/c^2 = c$ for the final form of Infoton mass at a black hole horizon. 38

$$m = (\hbar c)(\ln(2))/(8\pi GM) \quad 39$$

2. Implications 40

The equation $m = (\hbar c)(\ln(2))/(8\pi GM)$ reveals that Infoton mass at a black hole horizon is inversely proportional to black hole mass. As a black hole evaporates and M decreases, the information mass at its horizon increases. In the final moments of Hawking evaporation, information-energy approaches maximum mass density. More generally, because $m = (k_B T \ln(2))/c^2$, the Infoton mass depends directly on temperature. 41
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At $T \rightarrow 0$, $m \rightarrow 0$. Information becomes massless and exerts no gravitational influence. Information at absolute zero decouples from spacetime geometry [6]. 46
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At $T \rightarrow \infty$, $m \rightarrow \infty$. Information mass increases without bound. This suggests singularities may represent not infinite matter density, but infinite information density at maximum temperature. 48
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At $T > 0$, information has mass and therefore gravitational consequence. Temperature mediates the coupling between information and spacetime geometry. 51
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Funding 65

This research received no external funding. 66

Conflicts of Interest 67

The author founded Infoton based on the framework presented in this paper to explore methods for interacting with quantum systems both computational and in biology. 68
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