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The Infoton: A Fundamental Particle of Information-Energy

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Abstract

By applying Einstein's mass-energy equivalence ($E = mc^2$) to Landauer's thermodynamic bound on information ($E \geq k_B T \ln(2)$), I derive a fundamental unit of information-energy: the Infoton, with mass 3.19×10^{-38} kg. I propose this represents a minimum quantized unit of information on the scale of sub-atomic particles and discuss measurement implications for information-fundamental physics.

Keywords: Physics; Information Theory; Information Physics; Quantized Information; Matter; Information Mass; Entropy; Landauer's Principle; Information Thermodynamics; Quantum Information; Mass-Energy-Information Equivalence; Infoton

1. The Infoton

By combining Einstein's mass-energy equivalence and Landauer's thermodynamic principle—I derive a fundamental unit of information-energy with a calculable mass.

$E = mc^2$ states that mass is a form of energy, which may be changed into each other. The speed of light is $c = 3.00 \times 10^8$ m/s [1].

$E \geq k_B T \ln(2)$ establishes a fundamental connection between information theory and thermodynamics, providing physicality to information and establishing a lower bound for the energy required to encode one bit [2].

- E = Energy
- k_B = Boltzmann constant (1.38×10^{-23} J/K)
- T = Absolute temperature in Kelvin
- $\ln(2)$ = Natural logarithm of 2 ≈ 0.693

If information has physicality and is equal to E at the theoretical lower bound then we may substitute ($k_B T \ln(2)$) for E in $E = mc^2$ [3]. ($k_B T \ln(2)$) = mc^2 states information-energy is equal to the mass of light squared. To calculate the mass, we rearrange the equation structure $m = (k_B T \ln(2))/c^2$. We select $T = 300$ K as the natural reference point because it represents the typical operating regime for biological and computational information systems, where Landauer's principle governs energy-information coupling.

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$$\text{Mass} = ((1.38 \times 10^{-23})(300\text{ K})(0.693))/\,(3.00 \times 10^{8})^{2}$$
$$\text{Mass} = (2.87 \times 10^{-21})/(9.00 \times 10^{16})$$
$$\text{Mass} = 3.19 \times 10^{-38}\text{ kg}$$

The mass of information is 3.19×10^{-38} kg or 3.19×10^{-35} g and is in the sub-atomic/nuclear scale. At equilibrium, information storage requires no energy dissipation. The mass equivalent of information's thermodynamic bound represents the minimum quantized unit of information that can exist.

I propose adopting information particle or 'Infoton' as a formal term in quantum information physics to denote the quantized unit of information derived from combining Landauer's principle with $E = mc^2$. This terminological framework enables analysis of information-theoretic phenomena at sub-atomic scales without requiring commitment to a specific coupling mechanism at this stage.

2. Measurement Implications

In Wheeler's paper, he proposes that information is fundamental to physical reality [4]. If the Infoton exists as proposed, traditional collisional measurement approaches would destroy the information-energy coherence being observed [5]. Instead, detection methods based on quantum information-theoretic inference—entropy decay [6], observation, quantum computing performance metrics, and neural systems—offer non-destructive approaches to validating the Infoton hypothesis.

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Conflicts of Interest

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.