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Comment on "Statistical Mechanical Origin of the Entropy of a Rotating, Charged Black Hole"

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Zurek and Thorne [1] have shown that the number of bits of information lost in forming a rotating, charged black hole is equal to the area of the event horizon in Planck areas, i.e., the *Beckenstein number* [2]. Wheeler [3] has suggested that this could be a significant clue in the search through the foundations of physics for links between information theory and quantum mechanics. In this comment we show that if one accepts the conservation of baryon number, as attested by the *experimentally* unchallenged stability of the proton, one can argue that the proton is a stable, charged, rotating black hole with baryon number +1, charge $+e$, angular momentum $\frac{1}{2}\hbar$, and Beckenstein number $N = \hbar c/Gm_p c^2 \simeq 1.7 \times 10^{38}$.

Consider an assemblage of N proton-antiproton pairs with all quantum numbers zero that contains an additional proton; this system has baryon number +1, charge e, and angular momentum $\frac{1}{2}\hbar$. Suppose the average distance between each pair is $\hbar/m_p c$. Then the gravitostatic energy E is

$$E = \frac{NGm_p^2}{\hbar/m_p c} = N \frac{Gm_p^2}{\hbar c} (m_p c^2) ,$$

which is equal to the proton rest energy when $N = \hbar c/Gm_p^2$. This is analagous to the bound $N_e = 137 \simeq \hbar c/e^2$ on the number of charged particle-antiparticle pairs established by Dyson [4] when he showed that the renormalized QED perturbation series in α is not uniformly convergent. No particulate constituent of the gravitational system we envisage can escape; the escape velocity exceeds c. Yet proton-antiproton pairs can annihilate to produce Hawking radiation [5], which is not necessarily bound to the system. The predictable endpoint of this system—granted baryon number conservation, charge conservation, and quantized angular momentum conservation—is a system with mass and conserved quantum numbers indistinguishable from those of the proton. Since this system started from $N = \hbar c/m_p c^2$ indistinguishable pairs, the number of bits of information *lost* in this way can reasonably be called "the Beckenstein number of the proton."

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