LETTERS

Demon in the details

The feature article by Eric Lutz and Sergio Ciliberto (PHYSICS TODAY, September 2015, page 30) provides an interesting review of the basic theoretical ideas and recent experimental implementation of Maxwell's demon and its relation to Rolf Landauer's erasure principle. Unfortunately, the section on modern theory might give the impression that the second law of thermodynamics now has an extension that includes information and allows one to extract more work from a heat engine than the limit prescribed by the Carnot efficiency.

The problem is the formula for the work produced by the information-assisted heat engine, $W = W_C + k_B T_1 I$, where W_C is the work that would be produced by a Carnot engine, T_1 is the temperature of the cold reservoir, and I is the amount of information the detector obtains about the state of the engine.

The process that leads to the "modern" work equation returns the heat engine, but not the system as a whole, to its initial state. To return the system to its initial state, as required by the very notion of the heat engine, one needs to erase the information obtained in the process of engine operation. Optimal erasure of that information will generate heat in the engine environment; that heat, in turn, will remove all the gains obtained by measurements and return the system efficiency to its Carnot value. The second law remains unchanged.

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Authors Eric Lutz and Sergio Ciliberto implicitly assume time-reversal invariance. Indeed, to date, scientists have put forth thermodynamic arguments that implicitly made that assumption, and many have fretted about how to produce the arrow of time that entropy entails. However, time-reversal violation in scattering processes has been experimentally observed. Also, the expansion of the universe provides a "local" arrow of time in this universe—that is, a symmetry-violating vacuum state. When time-reversal invariance is broken, the analysis and conclusions made by Lutz and Ciliberto do not hold, and an effective Maxwell's demon may appear for distinguishable particles.[1]

Rolf Landauer's argument for the physical nature of information may be an even more significant fault point. Integers have physical representations, but I suspect that few mathematicians would accept the notion that integers are subject to the laws of physics. Indeed, many mathematical constructs—whether represented by symbols on paper or electronically or, as the authors say, "stored in physical systems"—from number theory through topology, hardly seem likely to be subject to the laws of physics, however useful to physics they so often turn out to be.

Reference

1. T. Goldman, D. H. Sharp, *Eur. Phys. Lett.* **97**, 61003 (2012).

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Bell the vegetarian

A friend has drawn my attention to a letter from Kerson Huang about my husband John Stewart Bell (PHYSICS TODAY, December 2015, page 8).

The writer claims that John was a vegetarian because of me. That is quite untrue. I believe that, influenced by George Bernard Shaw, he became a vegetarian in his teens. When I first met him he had been a vegetarian for many years. When we married it was, of course, convenient that I had been vegetarian all my life—my parents were vegetarian. As to the story about a hamburger, I can only presume that Kerson Huang misunderstood. My husband would never have eaten one.

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Corrections

June 2015, page 52—The grant that supported Peter Hirschfeld's work was NSF-DMR-1407502.

April 2016, page 14—In figure 1, the observed signal in the middle panel should have been orange and in the bottom panel blue. PT