Physics News in 2007

A Supplement to *APS News*

Edited by Phil Schewe, Ben Stein and Jason Bardi

Relativistic Thermodynamics

Einstein's special theory of relativity has formulas, called Lorentz transformations, that convert time or distance intervals from a resting frame of reference to a frame zooming by at nearly the speed of light. But how about temperature? That is, if a speeding observer, carrying her thermometer with her, tries to measure the temperature of a gas in a stationary bottle, what temperature will she measure? A new look at this contentious subject suggests that the temperature will be the same as that measured in the rest frame. In other words, moving bodies will not appear hotter or colder.

You'd think that such an issue would have been settled decades ago, but this is not the case. One problem is how to define or measure a gas temperature in the first place. James Clerk Maxwell in 1866 enunciated his famous formula predicting that the distribution of gas particle velocities would look like a Gaussian-shaped curve. But how would this curve appear to be for someone flying past? What would the equivalent average gas temperature be to this other observer? Jorn Dunkel and his colleagues at the Universitat Augsburg (Germany) and the Universidad de Sevilla (Spain) could not exactly make direct measurements (no one has figured out how to maintain a contained gas at relativistic speeds in a terrestrial lab), but they performed extensive simulations of the measurement.

Dunkel says that some astrophysical systems might eventually offer a chance to experimentally judge the issue. In general the effort to marry thermodynamics with special relativity is still at an early stage. It is not exactly known how several thermodynamic parameters change at high speeds. Absolute zero, Dunkel says, will always be absolute zero, even for quickly-moving observers. But producing proper Lorentz transformations for other quantities such as entropy will be trickier to do. (Cubero et al., *Phys. Rev. Lett.* **99**, 170601 (2007))