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Experimental test of the Fluctuation Theorem using a microsphere in a rarefied gas[1] CHUN-SHANG WONG, JOHN GOREE, BIN LIU, Dept. of Physics and Astronomy, The University of Iowa — The Second Law of Thermodynamics can be violated on short time and distance scales. The extent of the violation is quantified by the Fluctuation Theorem, which was the subject of the 2004 Boltzmann Medal. A variation of the theorem, the Work Fluctuation Theorem, can be tested experimentally [G.M. Wang, PRL 2002], but these experimental tests are still few. We have devised a test using Brownian motion of a 5 μm polymer sphere in a rarefied gas while pushing the sphere with a constant force applied by the radiation pressure of an incident laser beam. To avoid friction with solid surfaces, the microsphere is electrically charged and levitated by a vertical electric field, which is provided by partially ionizing the argon gas to make a plasma. A time series of the microsphere's position is measured using video microscopy with a high speed camera (400 fps), yielding a measure of the fluctuating work done. For various time intervals, τ, the work done on the particle, W_τ, can be calculated by integrating $\mathbf{F}_{\text{laser}} \cdot \mathbf{v}$ over $d\tau$. Finally, a histogram of observed W_τ values is used to test the Fluctuation Theorem prediction $P(W_\tau > 0)/P(W_\tau < 0) = \langle \exp(W_\tau) \rangle$, where P is a probability.

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