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Experimental Test of a Thermodynamic Paradox

D. P. Sheehan · D. J. Mallin · J. T. Garamella · W. F. Sheehan

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Abstract In 2000, a simple, foundational thermodynamic paradox was proposed: a sealed blackbody cavity contains a diatomic gas and a radiometer whose apposing vane surfaces dissociate and recombine the gas to different degrees ($A_2 \rightleftharpoons 2A$). As a result of differing desorption rates for A and A_2, there arise between the vane faces permanent pressure and temperature differences, either of which can be harnessed to perform work, in apparent conflict with the second law of thermodynamics. Here we report on the first experimental realization of this paradox, involving the dissociation of low-pressure hydrogen gas on high-temperature refractory metals (tungsten and rhenium) under blackbody cavity conditions. The results, corroborated by other laboratory studies and supported by theory, confirm the paradoxical temperature difference and point to physics beyond the traditional understanding of the second law.

Keywords Second law of thermodynamics · Nonequilibrium · Catalysis · Paradox

D. P. Sheehan (✉)
Department of Physics, University of San Diego, San Diego, CA 92110, USA
e-mail: dsheehan@sandiego.edu

D. J. Mallin
Department of Physics and Astronomy, University of California, Irvine, Irvine, CA 92617, USA

J. T. Garamella
Department of Physics and Astronomy, University of Minnesota, Minneapolis, MN 55414, USA

W. F. Sheehan
Department of Chemistry, Santa Clara University, Santa Clara, CA 95053, USA