

## A Solid-State Maxwell Demon

D. P. Sheehan,<sup>1</sup> A. R. Putnam,<sup>1</sup> and J. H. Wright<sup>2</sup>

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*A laboratory-testable, solid-state Maxwell demon is proposed that utilizes the electric field energy of an open-gap p-n junction. Numerical results from a commercial semiconductor device simulator (Silvaco International-Atlas) verify primary results from a 1-D analytic model. Present day fabrication techniques appear adequate for laboratory tests of principle.*

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**KEY WORDS:** second law; nonequilibrium; thermodynamics; nanotechnology; Maxwell demon.

### 1. INTRODUCTION

Over the last ten years, an unprecedented number of challenges have been leveled against the absolute status of the second law of thermodynamics. During this period, roughly 40 papers have appeared in the general literature [e.g., Refs. 1–20], representing more than a dozen distinct challenges; the publication rate is increasing. Recently, for the first time, a major scientific press has commissioned a monograph on the subject,<sup>(21)</sup> and a first international conference has been convened to examine these challenges.<sup>(22)</sup>

Second law challenges are often referred to as Maxwell demons, both to honor the seminal work by J. C. Maxwell,<sup>(23)</sup> and to defend against the jejune stigma often attached to them. The original Maxwell demon<sup>(24)</sup> is a hypothetical microscopic, sentient creature who, through skillful sorting of individual molecules across a gated partition, is able to create artificial temperature or pressure gradients by which work can be performed at the expense of heat from a heat bath and in violation of the second law. It was

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<sup>1</sup> Department of Physics, University of San Diego, San Diego, California 92110; e-mail: dsheehan@sandiego.edu

<sup>2</sup> Department of Mathematics and Computer Science, University of San Diego, San Diego, California 92110.