Mellon College of Science — Center for Theoretical Science

Guest Lecture: **Christopher Jarzynski, UMD**

Scaling Down the Laws of Thermodynamics

October 19 at **12:30 p.m.**
Mellon Institute Conference Room

Bio: Chris Jarzynski is a Princeton graduate with PhD in physics from the University of California, Berkeley in 1994. He was a postdoc at the University of Washington in Seattle and worked at Los Alamos National Laboratory. He is a Distinguished University Professor at the University of Maryland in Chemistry and Biochemistry, and the Institute for Physical Science and Technology, with a joint appointment in the Department of Physics. He received Fulbright Fellowship and the Sackler Prize in the Physical Sciences, and he is a Fellow of the American Physical Society and the American Academy of Arts and Sciences.

Abstract: Thermodynamics provides a robust conceptual framework and set of laws that govern the exchange of energy and matter. Although these laws were originally articulated for macroscopic objects, it is hard to deny that nanoscale systems, as well, often exhibit "thermodynamic-like" behavior. To what extent can the venerable laws of thermodynamics be scaled down to apply to individual microscopic systems, and what new features emerge at the nanoscale? I will review recent progress toward answering these questions, with a focus on the second law of thermodynamics. I will argue that the *inequalities* ordinarily used to express the second law can be replaced by stronger *equalities*, known as fluctuation relations, which relate equilibrium properties to far-from-equilibrium fluctuations. The discovery and experimental validation of these relations has stimulated interest in the feedback control of small systems, the closely related Maxwell demon paradox, and the interpretation of the thermodynamic arrow of time. These developments have led to new tools for the analysis of non-equilibrium experiments and simulations, and they have refined our understanding of irreversibly and the second law.

The informal preparatory talk will be announced later.
For updates see: **https://www.cmu.edu/mcs/theory**

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