

# Spring 2025 Physics Colloquium

Friday, April 4<sup>th</sup>

3:00 PM

PAS 201 or Zoom

(<https://arizona.zoom.us/j/86395646910>)

## Chris Jarzynski

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## Scaling down the laws of thermodynamics

**Abstract:** The study of thermodynamics originated in an engineering problem: how to build a better steam engine. From these beginnings the field has evolved into a remarkable conceptual framework and set of laws that govern the exchange of energy and matter. Einstein called it “the only physical theory of universal content which I am convinced will never be overthrown”. Although the laws of thermodynamics were originally developed with macroscopic objects in mind, nanoscale systems also exhibit “thermodynamic-like” behavior. The biomolecular motors that exist in our cells convert chemical fuel into mechanical work, and single molecules exhibit hysteresis when manipulated using optical tweezers. To what extent can the laws of thermodynamics be scaled down to apply to individual microscopic systems, and what new features emerge at the nanoscale? I will describe some of the challenges and recent progress – both theoretical and experimental – associated with addressing these questions. Along the way, my talk will touch on apparent “violations” of the second law, the thermodynamic arrow of time, Maxwell’s demon, and quantum thermodynamics.

*\* Refreshments served in PAS 218 at 2:30 PM – 3:00 PM \**

