COLLOQUIUM

ASU Department of Physics
Arizona State University

Thursday February 13, 2025

Refreshments at 3:15PM outside PSF 101
Colloquium from 3:30PM – 4:30PM in PSF 101

Nanothermodynamics: There's Plenty of Room on the Inside

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Arizona State University

Abstract:

This title is taken from Feynman's 1959 talk "There's plenty of room at the bottom" where he gave "an invitation to enter a new field of physics": the study of man-made nanostructures. We investigate the complementary field of nanothermodynamics: the study of naturally occurring subsystems inside larger systems. In the first half of my talk, I will review the foundations of nanothermodynamics and some of its applications. Examples include simplified explanations for measured non-classical critical scaling near ferromagnetic transitions, thermal and dynamic behavior near liquid-glass transitions, and the 1/f-like noise in metal films, nanopores, and qubits. Then I will focus on two recent results. First, I will derive the stable solution of Ising's original (1925) model for finite chains of interacting spins, a solution that Ising could not have found 40 years before nanothermodynamics was introduced. Finally, I will confront Loschmidt's paradox for the arrow of time, showing that an intrinsically irreversible step is required for maximum entropy and the second law of thermodynamics, not only in the thermodynamic limit but also in systems as small as N=2 spins.

Biography:

Ralph Chamberlin earned his BS in physics from the University of Utah (1978), researching milli-Kelvin physics with Orest Symko, and his PhD from UCLA (1984), where he developed fast SQUID magnetometers to study spin glass dynamics under Ray Orbach. After postdoc work at UPenn with Paul Chaikin on low-dimensional superconductors, he joined ASU in 1986. His research spans experiments, theory, and simulations to explore material properties, pioneering concepts like stretched-exponential relaxation, stable nanothermodynamics, and mesoscopic mean-field theory. He seeks intuitive models that better match observations, tackling phenomena like non-classical critical scaling, liquid-glass transitions, and 1/f noise. His discoveries include a new solution to Gibbs' paradox and insights into time's arrow in small systems. Applied impacts range from managing "hot spots" in materials to understanding how thermal fluctuations affect magnetic memory.