DEPARTMENT OF PHYSICS AND ASTRONOMY

(Special Seminar)

Quantum Many-Body Physics in the Noisy Era

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Quantum condensed matter has traditionally focused on ground states and equilibrium properties of spatially extended systems, such as electrons and spins in crystalline materials. However, the advent of noisy-intermediate-scale-quantum (NISQ) devices has sparked interest in the largely uncharted frontier of many-body open quantum systems, where condensed matter physics meets quantum information science. In this colloquium, I will first discuss how the foundational principles of locality and symmetry allow us to define topological phases in both closed and open quantum systems. Remarkably, we have uncovered hidden structures unique to open systems, revealing how decoherence—often deemed an obstacle—can bypass the strong constraints imposed by unitarity. I will show how this enabled our discovery of a novel class of many-body quantum phases that cannot exist under unitary dynamics. Building on these insights, I will present a systematic classification of topological order in open quantum systems and briefly introduce the first practical proposal for a topological quantum memory below four spatial dimensions. The talk will conclude with a forward-looking perspective on how embracing, rather than avoiding, environmental interactions opens exciting new possibilities in interacting quantum matter.

Monday, February 17, at 10:30 AM,
CSP Conference Room 322, Physics Building

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