DEPARTMENT OF
PHYSICS &
ASTRONOMY

Physics & Astronomy Colloquium

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Texas Tech University

3:30 - 4:30 p.m. | Tuesday, September 8
Science Building 234

Quantum Matter in a New Light: From Quantum Wires to Quantum Machines

Low-dimensional quantum systems display collective behavior fundamentally different from that of ordinary matter. Electrons can separate into distinct spin and charge excitations; insulators can conduct along their boundaries; superconducting systems can host non-Abelian Majorana modes; and quantum critical systems can exhibit emergent symmetries and supersymmetries. While traditional experimental probes can sometimes offer glimpses of this behavior, many of these predictions remain difficult to probe experimentally.

Recent experimental technologies, particularly those developed for quantum computing, are providing new tools to probe and simulate these systems. In this talk, I will describe our efforts to exploit these emerging capabilities to reveal quantum many-body physics. I will first discuss how strong light-matter coupling can be used to generate and reveal quantum correlations in one-dimensional electronic systems and how superconducting circuits can be used to probe and simulate many-body quantum states. I will then turn to quantum-computing platforms themselves, including quantum annealers and digital quantum computers, as platforms for studying coherent many-body dynamics. In turn, these simulations offer invaluable feedback about the coherence properties of the emerging NISQ (noisy intermediate-scale quantum) technology landscape. Along the way, I will highlight contributions from students and collaborators who have made this work possible.

I will conclude by discussing future directions aimed at attacking longstanding questions in quantum many-body physics: how can emergent behavior and symmetries be directly probed? How can we approach strongly interacting systems when a simple quasiparticle description is no longer available? I will describe how fluorescence spectroscopy may provide signatures of emergent symmetries and quantum critical behavior. I will also point to theoretical and quantum-simulation approaches that may help us understand many-body dynamics beyond the quasiparticle paradigm.

Refreshments at 3 p.m. | SC 103