Physics Seminar: Andrew Lucas
Wednesday, October 9 · 2:00 – 3:00pm

Location: 313

Title: Theory of metastable states in many-body quantum systems

Abstract: Classical metastability is an important physical theory, which also has a rigorous mathematical formulation within the framework of Markov chains. The WKB approximation forms one basis for a simple and predictive quantum theory of metastability for few-body systems. However, the standard paradigm for many-body quantum metastability relies on non-rigorous path integral calculations, which do not provide unambiguous answers to basic questions, such as what the lifetime of the metastable state actually means in a unitary quantum theory. I present a simple and (usually) checkable definition of metastability in many-body quantum systems on the lattice: a state is metastable when all sufficiently local operators either stabilize or raise the average energy of the state. I will then outline the proof of two important facts: (1) all short-range metastable states are eigenstates of a 'perturbatively close' Hamiltonian, and (2) if a metastable state is the eigenstate of a 'perturbatively close' Hamiltonian, then local correlation functions decay on non-perturbatively long time scales in the (locally rotated) metastable state. I will also sketch how to obtain lower bounds on the false vacuum lifetime in certain simple lattice models, which (nearly) match the longstanding path integral prediction. This new framework provides a mathematically clear way to understand an old problem of quantum metastability and quantum nucleation theory, and also leads to unexpected connections with more recent models of slow thermalization and quantum scarring.