Chez Pierre

Presents ...

Monday, April 28, 2025
12:00 pm - 1:00 pm
Duboc Room – 4-331

Chez Pierre Seminar

Tim Hsieh, Perimeter Institute

"Markov Length: A Diagnostic for Mixed State Quantum Phases and Fault Tolerance "

Advances in controllably open quantum systems have enabled both a vast landscape of non-equilibrium mixed state phases of matter and fault tolerant quantum memories. We propose Markov length, the length scale with which the conditional mutual information (CMI) decays exponentially, as an essential quantity characterizing both mixed-state phases and fault tolerant thresholds. For a state evolving under a local Lindbladian, we argue that if its Markov length remains finite along the evolution, then it remains in the same phase, meaning there exists another quasi-local Lindbladian evolution that can reverse the former one. The Markov length thus plays the role of the energy gap for ground state phases. We also establish a correspondence between the fault tolerance of local stabilizer codes experiencing measurement and physical errors and the mixed state phases of decohered resource states in one higher dimension. This motivates a diagnostic of fault-tolerance, which we refer to as the spacetime Markov length, determined by the decay of the CMI of repeated syndrome measurement outcomes in spacetime. The diagnostic is independent of the decoder, and its divergence signals the intrinsic breakdown of fault tolerance.