Harvard Quantum Initiative
IN SCIENCE AND ENGINEERING

Quantum Colloquium

Wednesday, November 29, 4:00 pm
Jefferson 250

Prof. Andrew Daley

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"Fast scrambling transitions in quantum simulators"

Whether discussing interacting many-body physics with cold atoms, quantum metrology, or quantum computing, there are important questions around how large an entangled many-body state we can usefully and reliably prepare in analogue quantum simulators subject to decoherence. Given that information spreading and entanglement growth are limited by Lieb-Robinson bounds, the useful system size will typically grow only linearly with the system size. However, for systems with long-range interactions (e.g., atoms in cavities) or movable tweezer arrays, we can engineer so-called fast scrambling many-body quantum systems, where information is spread and entanglement is built up on a timescale that grows logarithmically with the system size.

I will give an overview of our recent work exploring these implementations of fast scrambling, in systems with sparse coupling models or effective hypercube geometries. We explore the requirements for fast scrambling, also identifying a dynamical transition marking the onset of scrambling in quantum circuits or tweezer arrays with different levels of long-range connectivity. In particular, we show that as a function of the interaction range for circuits of different structures, the tripartite mutual information exhibits a scaling collapse around a critical point between two clearly defined regimes of different dynamical behaviour. I will discuss how these transitions can be observed in neutral atom arrays, and give some perspectives for the realisation of useful entangled states using these dynamics.

Student Presentation will begin at 4:00 PM.
Guest Presentation will begin at 4:30 PM.
Refreshments will be provided.