Department of Physics and Physical Oceanography

"Entanglement and computational complexity for 1D quantum many-body systems"

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The Hilbert space dimension of quantum-many body systems grows exponentially with the system size, which makes the systems difficult to handle for theorists and computationally powerful. Fortunately, nature does usually not explore this monstrous number of degrees of freedom and we have a chance to describe quantum systems of interest with much smaller sets of effective degrees of freedom. A very precise and efficient description for systems with one spatial dimension is based on so-called matrix product states (MPS). With such a reduced parametrization, the computation cost, needed to achieve a certain accuracy, is determined by entanglement properties (quantum non-locality) in the system.

I will give an introduction to the notion of entanglement entropies and their scaling behavior in quantum many-body systems. I will then employ entanglement entropies to bound the required computation costs in MPS simulations. This will lead us to the amazing conclusion that typical 1D quantum many-body systems can be simulated efficiently on classical computers, both for zero and finite temperatures, and for both gapless and critical systems. Finally, I will give examples of applications to strongly-correlated systems.

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2:00 PM

DeLoach Hall, Room 212