Speaker: Dr. Thorsten Wahl

Time: 11:00am-12:00pm

Location: Whitaker Biomedical Engineering 1103

Title: Pushing the Quantum Barrier with Tensor Networks

Abstract: Condensed Matter Physics and Quantum Computation have benefited each other in many ways. Concepts from Quantum Information Theory have led to revolutionary new insights into the properties of quantum matter and enabled its numerical description with unprecedented accuracies. In turn, research on exotic quantum many-particle phenomena is driven to a large extent by the quest for the constituents of future quantum devices, most notably, a universal quantum computer. In my talk, I will illustrate that tensor networks (TNs) can be used to overcome the exponential scaling problem of quantum many-particle systems in many relevant cases. I will show how TNs gave us insights into the phenomenon of many-body localization (perfect heat insulation) that are currently impossible with any other method. I will present important connections to Quantum Computation and how TNs also allow us to systematically benchmark small quantum computers with classical machines.

Bio: I carried out my PhD in the group of Ignacio Cirac, Max Planck Institute of Quantum Optics, Garching, Germany. Contrary to previous expectations, I demonstrated that tensor networks (TNs) can also describe chiral topological systems accurately. Later, I used TNs for the simulation of Lattice Gauge Theories in two space dimensions at finite fermion density. During my previous postdoctoral appointment at Oxford, I worked with Steven Simon on the application of TNs to the phenomenon of many-body localization (MBL). This gave rise to the first simulations of optical lattice experiments observing MBL in higher dimensions. At Oxford and during my current appointment at Cambridge, I used similar ideas to analytically classify many important manifestations of MBL, such as (symmetry-protected) topological MBL and topologically ordered time crystals. Recently, I started to apply TNs to problems in Quantum Computation, proving the first non-trivial upper bound on the classical simulation time of quantum circuits.