PhD THESIS DEFENSE: Investigating Quantum Many-Body Systems with Tensor Networks, Machine Learning and Quantum Computers

KORBINIAN KOTTMANN

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We perform quantum simulation on classical and quantum computers and set up a machine learning framework in which we can map out phase diagrams of known and unknown quantum manybody systems in an unsupervised fashion. The classical simulations are done with state-of-the-art tensor network methods in one and two spatial dimensions. For one dimensional systems, we utilize matrix product states (MPS) that have many practical advantages and can be optimized using the efficient density matrix enormalization grou (DMRG) algorithm. The data for two dimensional systems is obtained from entangle projected pair states (PEPS) optimized via imaginary time evolution. Data in form o

observables, entanglement spectra, or parts of the State vectors from these simulations, i then fed into a deep learning (DL) pipeline where we perform anomaly detection to map ou the phase diagram. We extend this notion to quantum computers and introduce quantu variational anomaly detection. Here, we ?rst simulate the ground state and then process it i a quantum machine learning (QML) manner. Both simulation and QML routines are performe on the same device, which we demonstrate both in realistic simulation and on a physica quantum computer hosted by IBM

Thesis Directors: Prof Dr. Antonio Acin and Prof. Dr. Maciej Lewenstein
Hosted by: Prof. Dr. Antonio Acin and Prof. Dr. Maciej Lewenstein