The Hebrew University of Jerusalem , Symposium on Quantum Measurement

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"Measuring Entanglement and Quantum States Efficiently"

One of the principal features distinguishing classical from quantum many-body systems is that quantum systems require exponentially many parameters in the system size to fully specify the state, compared to only linearly many for classical systems. Put to use constructively, the exponential complexity enables the construction of information processing devices fundamentally superior to any classical device. At the same time, however, this "curse of dimensionality" makes engineering tasks such as verifying that the quantum processing device functions as intended -- a daunting challenge. Here I show that one can do exponentially better than direct state tomography for a wide range of quantum states, in particular those that are well approximated by a matrix product state ansatz. Furthermore, I demonstrate that the extraction of complex functions of the quantum state, such as entanglement can be achieved very efficiently if one sacrifices the desire to know exact value instead being satisfied with very good upper and lower bounds. I will present both theoretical methods and the results of experiments in which these methods have been applied.