清华大学高等研究院

Institute for Advanced Study, Tsinghua University

学术报告

Title: **Studying quantum many-body physics using quantum complexity theory**

Speaker: **Yichen Huang** (***California Institute of Technology***)

Time: **3:30pm, Friday, 2016-09-23**

Venue: **Conference Hall 322, Science Building, Tsinghua University**

Abstract

Heuristic studies of quantum many-body systems yield various folklores relating the spectral gap, correlation, entanglement, and simulability of the system. Are these relations true in general? Can they be refined for certain important class of models? Quantum complexity theory can provide unique insights or useful tools for these questions. In this talk, I will present two such examples.

First, we study the relationship between entanglement and classically representing ground states of (translationally invariant) local Hamiltonians. While in one spatial dimension area law (a notion of limited entanglement) implies efficient classical representations, we show that this implication is not generally true in two and higher dimensions assuming a mild conjecture in quantum complexity theory (QMA\neq NP). This result is in contrast to physicists' common belief that area law implies efficient tensor network representations.

Second, we obtain a tight bound on the correlation in ground states of frustration-free Hamiltonians in terms of the spectral gap. This bound rules out a large class of critical phenomena in such systems. Frustration-free Hamiltonians are quantum analog of satisfying instances of 3SAT formula in classical complexity theory. The proof uses detectability lemma—a technical tool originally motivated for the quantum PCP conjecture.