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Testing quantum systems in the high-complexity regime

Abstract:

From carefully crafted quantum algorithms to information-theoretic security in cryptography, a quantum computer can achieve impressive feats with no classical analogue. Can their correct realization be verified? When the power of the device greatly surpasses that of the user, what means of control remain available to the user? In the talk I will focus on a concrete realization of this question, which is the problem of testing high-dimensional entanglement. I will describe how classical techniques, coming in particular from the proof of the PCP theorem, can be extended to the quantum setting. This extension leads to powerful quantum tests as well as a new perspective on classic constructions. Time permitting I will present applications to interactive proofs, to approximate representation testing, and to norm embeddings. The main technical result in the talk is (an extension of) joint work with Ji, Natarajan, Wright and Yuen, "Quantum soundness of testing tensor codes," arXiv:2111.08131, to appear in FOCS'21.