Lecture 0

Some references related to the lectures

0.1 General references

- This survey [GHL+15] is generally about Hamiltonian complexity.
- This survey [AAV13] is more focused on the quantum PCP conjecture, but it also has discussions around the local Hamiltonain problem, entanglement in ground states, etc.

0.2 QMA and the Local Hamiltonian problem

- For rigorous defintions of the complexity classes BQP and QMA, I recommend the book [VW+16] (Section 3). There is also a definition of the local Hamiltonian problem and a sketch of the proof of QMA-completeness (Section 3.3.1). Other complete problems for QMA are presented.
- The proof of QMA completeness of the 5-local Hamiltonian problem appears in Kitaev's book [KSV02], which is a great introductory reference for quantum computing and complexity. For the 2-local Hamiltonian problem, including a relatively pedagogical introduction to perturbation theory, see the original paper [KKR06].
- I can also recommend the article by Oliveira and Terhal [OT08] on 2D geometrically local Hamiltonians.
- Finally, there is the quite extensive classification by Harrow and Montanaro [CM16] (note that there are some follow-up works with improvements).

Bibliography

[AAV13] Dorit Aharonov, Itai Arad, and Thomas Vidick. Guest column: the quantum PCP conjecture. *Acm sigact news*, 44(2):47–79, 2013.

[CM16] Toby Cubitt and Ashley Montanaro. Complexity classification of local hamiltonian problems. *SIAM Journal on Computing*, 45(2):268–316, 2016.

[GHL+15] Sevag Gharibian, Yichen Huang, Zeph Landau, Seung Woo Shin, et al. Quantum hamiltonian complexity. *Foundations and Trends® in Theoretical Computer Science*, 10(3):159–282, 2015.

[KKR06] Julia Kempe, Alexei Kitaev, and Oded Regev. The complexity of the local hamiltonian problem. *Siam journal on computing*, 35(5):1070–1097, 2006.

[KSV02] Alexei Yu Kitaev, Alexander Shen, and Mikhail N Vyalyi. *Classical and quantum computation*. Number 47. American Mathematical Soc., 2002.

[OT08] Roberto Oliveira and Barbara M Terhal. The complexity of quantum spin systems on a two-dimensional square lattice. *Quantum Information & Computation*, 8(10):900–924, 2008.

[VW+16] Thomas Vidick, John Watrous, et al. Quantum proofs. *Foundations and Trends® in Theoretical Computer Science*, 11(1-2):1–215, 2016.