Universal computation by multiparticle quantum walk with improved error bounds

Zak Webb

Institute for Quantum Computing, University of Waterloo
Department of Physics & Astronomy, University of Waterloo
Department of Computer Science, University of Texas at Austin

Abstract

We prove that approximating the ground energy of the antiferromagnetic XY model on a simple graph at fixed magnetization is QMA-complete. This strengthens a previous result considering a generalization of the XY model defined on graphs with self-loops.

XY model on a graph

The XY model is usually defined on a lattice, with $XX+YY$ terms between adjacent vertices. The model on an arbitrary graph is the natural generalization of this. Given a simple graph G with vertex set $V(G)$ and edge set $E(G)$, the Hamiltonian is then

$$O_G = \sum_{\{i,j\}\in E(G)} X_i X_j + Y_i Y_j.$$

References

[1] Andrew M. Childs, *Universal computation by quantum walk*, Physical Review Letters **102** (2009), no. 18, 180501, arXiv:0806.1972.

[2] Andrew M. Childs, David Gosset, and Zak Webb, *Universal computation by multiparticle quantum walk*, Science **339** (2013), no. 6121, 791–794, arXiv:1205.3782.

[3] Zak Webb, *The computational power of many-body systems*, Ph.D. thesis, University of Waterloo, 2016.