

Abstract Submitted  
for the MAR11 Meeting of  
The American Physical Society

**Numerical investigations of quantum walks with hard-core bosons and the graph isomorphism problem**<sup>1</sup> MARK WELLONS, JOHN GAMBLE, ERIC BACH, MARK FRIESEN, ROBERT JOYNT, KENNETH RUDINGER, DONG ZHOU, SUSAN COPPERSMITH, University of Wisconsin-Madison — Gamble et al. investigated quantum walks of two hard-core bosons on a class of highly symmetric graphs called strongly regular graphs (SRGs) and showed that these walks will distinguish nonisomorphic graphs from the same family. However, J. Smith (arXiv:1004.0206) has shown that pairs of nonisomorphic graphs exist that cannot be distinguished by such quantum walks. Here we construct explicit counterexample graph pairs for 2 and 3-particle interacting and non-interacting walks. We also describe an algorithm that, given  $k$  particles, generates two graphs indistinguishable by a  $k$ -boson quantum walk. We find that these indistinguishable graph pairs generated by our algorithm scale in size quadratically with the number of particles. It follows that distinguishing graphs via simulating quantum walks with classical computers will likely require exponential time in the size of the graph, while leaving open the possibility that a quantum computer could distinguish the graphs in polynomial time.

<sup>1</sup>This work was supported by ARO and DOD (W911NF-09-1-0439) and NSF (CCF-0635355). J.K.G. acknowledges support from the NSF.

Mark Wellons  
Department of Materials Science and Engineering,  
University of Wisconsin-Madison

Date submitted: 02 Dec 2010

Electronic form version 1.4