

Abstract Submitted  
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**Two-particle quantum walks applied to the graph isomorphism problem**<sup>1</sup> JOHN KING GAMBLE, MARK FRIESEN, DONG ZHOU, ROBERT JOYNT, S.N. COPPERSMITH, University of Wisconsin-Madison — We show that an algorithm based on the dynamics of interacting quantum particles is more powerful than the corresponding algorithm for non-interacting particles. Specifically, our algorithm attempts to determine whether two graphs are isomorphic. We focus on strongly regular graphs (SRGs), a class of graphs with particularly high symmetry. By studying the dynamical evolution of two-particle quantum walks on pairs of non-isomorphic SRG's, we show that interacting particles can distinguish non-isomorphic graphs that noninteracting particles cannot. First, we prove that quantum walks of two noninteracting particles cannot distinguish pairs of non-isomorphic SRG's. Next, we demonstrate numerically that two interacting bosons are more powerful, in that their quantum walks distinguish all non-isomorphic pairs of SRGs we tried, including those with up to 64 vertices. Finally, we find a set of operators that determine these evolutions.

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