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Quantum Random Walks of Non-Interacting Bosons on Strongly Regular Graphs[1] KENNETH RUDINGER, JOHN KING GAMBLE, MARK WELLONS, MARK FRIESEN, DONG ZHOU, ERIC BACH, ROBERT JOYNT, S.N. COPPERSMITH, University of Wisconsin- Madison — We investigate the quantum dynamics of particles on graphs ("quantum walks"), with the aim of developing quantum algorithms for determining if two graphs are isomorphic and show that there are fundamental differences between the distinguishing power of two-particle and three-particle non-interacting quantum walks. We investigate quantum walks on strongly regular graphs (SRGs), a class of graphs with high symmetry. We show analytically that the two-particle walk always fails to distinguish non-isomorphic members of the same SRG family. We show numerically that the three-boson walk is able to distinguish 99.6% of 70,712 SRG comparisons made and that this distinguishing power comes from different multiplicities of certain graph substructures in non-isomorphic graphs. We identify certain distinguishing substructures and examine ones that appear in the four-boson walk, discovering they are able to distinguish almost all of the graphs that the three-boson walk failed on. This indicates a positive correlation between number of bosons in the walk and distinguishing power.

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