Quantum walks in noisy environment

L. Fedichkin[1,2,3]

1. Institute of Physics and Technology, Russian Academy of Sciences, Moscow, Russia, melnikov@phystech.edu

2. NIX, Moscow, Russia, leonid@phystech.edu

3. Moscow Institute of Physics and Technology, Dolgoprudny, Moscow Region, Russia

Quantum walks are known to be faster than classical when they propagate stochastically on certain graphs. For some graphs the speed-up is polynomial, e.g., for lines and cycles, as also shown in Ref. [1]. We present results on mixing times for quantum walks subjected to decoherence due to interaction with noisy environment. Quantum walks of identical interacting particles, i.e. electrons with Coulomb repulsion, can be used to develop new ways for quantum information processing. These tools include, e.g., new algorithms for quantum computation and new quantum-enhanced machine learning methods. We consider also a quantum system of two indistinguishable particles in a cycle graph. The nonunitary quantum walk dynamics of this system can lead to entanglement given some physical interaction between particles, e.g., mutual repulsion. Here we show how one can define qudits by using the freedom of dividing the graph into two subgraphs [2]. The studied quantum walk dynamics of two indistinguishable particles can hence be used for the preparation of a two-qudit entangled state of two distinguishable subsystems [3]. Entangled states of qudits can be obtained by only using the free quantum evolution of identical particles, without relying on any additional manipulations with particles.

[1] D. Solenov and L. Fedichkin. "Continuous-time quantum walks on a cycle graph". Phys. Rev. A, **73**, 012313, 2006.

[2] A.A. Melnikov and L.E. Fedichkin. "Quantum walks of interacting fermions on a cycle graph". Sci. Rep., **6**, 34226, 2016.

[3] A.A. Melnikov and L.E. Fedichkin. " Fermionic entanglement via quantum walks in quantum dots". In AIP Conference Proceedings **1936**, 020025, 2018.