Abstract Submitted
for the MAR14 Meeting of
The American Physical Society

Renormalization for Quantum Walks[1] STEFAN FALKNER, STEFAN BOETTCHER, Emory University, RENATO PORTUGAL, National Laboratory for Scientific Computing — Quantum walks have been studied extensively on regular lattices over the last 20 years. Generally, two remarkable differences to the classical random walk emerge: the quantum walk spreads faster and can also be partly localized, even in the unbiased case [1]. But so far, only translational invariant lattices allow analytical insights into the underlying mechanisms. We propose a renormalization group treatment for the quantum walk to study its behavior on self-similar graphs [2]. It allows us to obtain large system sizes numerically and to gain insights by analyzing a set of recursion equations asymptotically. On the dual Sierpinsky gasket, we find a rich phenomenology for the spreading in a system without translational invariance. The quantum interference localizes the walk such that the access probability declines as a power law from the initial site, fully localizing the walk in the infinite system limit. But, for finite systems, a small fraction of the wave function spreads faster than the corresponding classical random walk through the entire system.

[1] N. Inui, et. al., Phys. Rev. E 72.5 (2005)
[2] S. Boettcher, et. al., arXiv:1311.3369
[3] A. Ambainis, et al., Proceedings of the thirty-third annual ACM symposium on Theory of computing. ACM, 2001

[1]NFS-DMR #1207431

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Date submitted: 15 Nov 2013 Electronic form version 1.4