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Quantum Ultra-Walks: Walks on a Line with Spatial Disorder[1]
STEFAN BOETTCHER[2], STEFAN FALKNER[3], Pysics Department, Emory University — We discuss the model of a heterogeneous discrete-time walk on a line with spatial disorder in the form of a set of ultrametric barriers. Simulations show that such an quantum ultra-walk spreads with a walk exponent d_w that ranges from ballistic ($d_w = 1$) to complete confinement ($d_w = \infty$) for increasing separation $1 \leq 1/\epsilon < \infty$ in barrier heights. We develop a formalism by which the classical random walk as well as the quantum walk can be treated in parallel using a coined walk with internal degrees of freedom. For the random walk, this amounts to a 2^{nd}-order Markov process with a stochastic coin, better know as an (anti-)persistent walk. The exact analysis, based on the real-space renormalization group (RG), reproduces the results of the well-known model[4] of "ultradiffusion," $d_w = 1 - \log_2 \epsilon$ for $0 < \epsilon \leq 1/2$. However, while the evaluation of the RG fixed-points proceeds virtually identical, for the corresponding quantum walk with a unitary coin[5] it fails to reproduce the numerical results. A new way to analyze the RG is indicated.

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http://aad.informatik.uni-freiburg.de/people/falkner/
[4]J. Phys. A **19**(1986)L269
[5]Phys. Rev. A **90**(2014)032324, http://arxiv.org/abs/1311.3369

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