Nonlinear Disordered Discrete Time Quantum Walks

S. Flach

Center for Theoretical Physics of Complex Systems
Institute for Basic Science, Daejeon, South Korea

Discrete quantum walks (DQW) are a main tool in quantum computing research. At the same time, they are fascinating mathematical models on lattices with unitary operators involving only nearest neighbor coupling, and thus with a speedup in certain comptutations up to two orders of magnitude as compared to Hamiltonian based dynamics. I will introduce the translationally invariant DQW and its massive Dirac two-band structure. I will then introduce disorder and demonstrate the existence of, and control over Anderson localization [1]. Finally I will generalize the disordered DQW by adding nonlinear terms to the unitary operations. As a result, wave packet dynamics is characterized by a slow subdiffusive destruction of Anderson localization [2]. I will show that we can drive this process to unprecedented times as compared to previous studies. This will allow us to surpass the current computational horizon by a factor of up to 10^3 and check whether the neverending subdiffusion IS keeping its universality beyond the hold horizons, or whether a slowing down effect will be seen as claimed in some publications.

[1] I. Vakulchyk, M. V. Fistul, P. Qin and S. Flach, Phys. Rev. B in print; arXiv:1708.08194.
[2] I. Vakuchyk, M.V. Fistul and S. Flach, in preparation.