CO.CO.MAT

Tamás Kiss
(Wigner Research Center for Physics, Budapest, Hungary)

Dynamical properties of quantum walks on lattices

Quantum walks provide a conceptually simple framework, applicable in quantum information theory e.g. for designing algorithms. They can also serve as a model for physical phenomena such as transport. In a series of recent experiments [1] several aspects of quantum walks have been demonstrated.
An important property of quantum walks on regular lattices is the return probability to the origin, characterized by the Polya number [2]. In sharp contrast to the classical case, where the symmetric walk on the 2D regular square lattice is always recurrent, quantum walks on such a lattice exhibit a variety of related phenomena: localization (trapping) at the origin, recurrence without localization and initial state dependent escape [3]. The dimensionality of the lattice together with its degree play a special role in determining recurrence, this we show for a walk on a triangular (honeycomb) lattice [4].
Quantum walks are governed by a unitary, thus deterministic time evolution. Randomly removing edges of a graph while keeping a possibility for dynamical changes, i. e. dynamical percolation is a way to introduce classical noise to the system, thus making the time evolution open. We present a method to analytically solve the asymptotic dynamics of a coined, discrete time quantum walk for a general percolation graph structure [5]. We find that a rich variety of asymptotic behavior occurs for a finite 1D chain: beyond the trivial totally mixed state, quasi periodic oscillations and steady states can emerge. The asymptotically available states depend on the choice of coin operator, initial state and topology of the underlying graph. For 2D lattices simulation of the long time behavior of quantum walks on percolation lattices would be a very hard problem. We present exact analytical methods to determine the asymptotic states.

[1] M. Karski et al., Science 325, 174 (2009); H. Schmitz et al., Phys. Rev. Lett. 103, 090504 (2009); F. Zähringer et al., Phys. Rev. Lett. 104, 100503 (2010); A. Schreiber et al., Phys. Rev. Lett. 104, 050502 (2010); M. A. Broome et al., Phys. Rev. Lett. 104, 153602 (2010); A. Peruzzo et al., Science 329, 1500 (2010); A. Schreiber et al., Phys. Rev. Lett. 106, 180403 (2011) A. Schreiber et al., Science 336, 55 (2012); M. Genschke et al., Phys. Rev. Lett. 110, 190601 (2013)
[2] M. Stefanak, I. Jex, T Kiss, Phys. Rev. Lett. 100, 020501 (2008)
[3] M. Stefanak, T. Kiss, I. Jex, Phys. Rev. A. 78, 032306 (2008)
[4] B. Kollar, M. v Stefanak, T. Kiss, I. Jex, Phys. Rev. A 82, 012303 (2010)
[5] B. Kollar, T. Kiss, J. Novotny and I. Jex, Phys. Rev. Lett. 108, 230505 (2012)

5. Juli 2013, 15:30 Uhr

Universität Tübingen, Raum D4 A19
Auf der Morgenstelle 14, 72076 Tübingen