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Analytical and Numerical Approaches to the quantum optical implementation of Open Quantum Walks

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Open quantum walks (OQWs) have been introduced as a type of quantum walks which are entirely driven by the dissipative interaction with external environments and are defined in terms of discrete completely positive maps on graphs [1]. In my talk, I shall give a brief overview of the microscopic derivation of OQWs [2] and propose a single atom quantum maser scheme [3] that to implement OQWs.
The structure of the proposed scheme is as follows: We consider a low-intensity flow of two-level atoms through a high-quality single mode resonator (Q˜10ˆ12) [3]. We assume that the atom-field interaction time is much shorter than the cavity damping time so that the relaxation of the resonator field mode can be ignored while an atom is inside the cavity. While an atom flies through the cavity, the Jaynes-Cummings Hamiltonian describes the coupled field-atom system, and during the intervals between successive atoms, the evolution of the field is governed by the master equation of a damped harmonic oscillator. Using the small unitary rotations approach and rotating wave approximation the effective dynamics of the system is shown to be an OQW.

Keywords: Open quantum walks; quantum optics; quantum dynamics engineering.

References:

[1] S. Attal, F. Petruccione, C. Sabot and I. Sinayskiy, J. Stat. Phys. 147 (2012), 832.
[2] H.P. Breuer, F. Petruccione, The Theory of Open Quantum Systems (Oxford University Press, Oxford, 2002)
[3] P. Filipowicz, J. Javanainen, P. Meystre, Theory of a microscopic maser, Physical Review A 34(4) (1986) 3077

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