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Open Quantum Walks: Microscopic Derivation and Generalised Master Equation[1] FRANCESCO PETRUCCIONE, ILYA SINAYSKIY, University of KwaZulu-Natal and National Institute for Theoretical Physics, QUANTUM RESEARCH GROUP TEAM — Recently, a formalism for discrete time open quantum walks was introduced [S. Attal et al., J. Stat. Phys., 147 (2012) 832; S. Attal, F. Petruccione, I. Sinayskiy, Phys. Lett. A, 376 (2012) 1545]. This formalism is exclusively based on the non-unitary dynamics induced by the environment. This approach rests upon the implementation of appropriate completely positive maps. Open quantum walks include the classical random walk and through a realization procedure a connection to the Hadamard quantum walk is established. Open quantum walks allow for an unravelling in terms of quantum trajectories. It was shown [I. Sinayskiy and F. Petruccione, QIP 11 (2012) 1301] that open quantum walks can perform universal quantum computation and can be used for quantum state engineering. Here, we present the microscopic derivation of open quantum walks. A walk on a graph is considered and transitions between vertices are mediated by the interaction of the walker with a shared bosonic environment. The reduced dynamics of the walker is shown to be described in terms of a generalised Markovian master equation. The time discretization of the master equation gives raise to an open quantum walk. Based on the class of microscopic models considered here possible physical implementations are discussed.

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