Decoherence in the quantum walk on the line with two entangled particles

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The discrete-time quantum walk, the quantum version of classical random walks, were first introduced in 1993 [1] and have since then been a topic of research within the context of quantum information and computation [2]. Some of the algorithms in quantum information has been shown to have a successful implementation using quantum walks. Several systems have been proposed as candidates to implement quantum walks. These proposals include atoms traps in optical lattice, cavity quantum electrodynamics and nuclear magnetic resonance in solid substrates. However, all these proposed implementations face the obstacle of decoherence due to environmental noise and imperfection. Decoherence in the quantum walks has been considered recently for example in Refs [3-5]. Numerical simulations of the effect of different kinds of measurements have shown that the quantum walk properties are highly sensitive to decoherent events. So far decoherence in quantum walk has been discussed with one particle. However the decoherence in a quantum walk with two or more entangled particles may contain rich physics more than single particle. Two particles in a system can be interacting or non-interacting. For more particles quantum dynamics will live in a composite Hilbert space. The particles can be considered separable or non-separable in Hilbert space. The quantum walk definition is very easy for separable systems but for non-separable systems may be entangled. In this case maximally entangled coins are considered to define discrete-time quantum walk process. In this study we consider a quantum walk on the line with two separable and entangled particles. Firstly we will give brief introduction for discrete and continuous time quantum walk formalism with one and multi-particles. Secondly we consider two unitary operators to represent our quantum equivalence of a coin and then we have two walkers. There are many features that can be explored including the notion of superposition and entangled states. Entanglement can be studied in the coin degree of freedom as well as in the particle degree of freedom. In this part we will present numerical results of the decoherence in quantum walk for a several decoherence mechanisms such as absorption traps, broken links and different boundary conditions. We will discuss the decoherence for different coin operators and the results are compared.