Recurrence in Quantum Stochastic Walks

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Interplay between quantum interference and classical randomness can enhance performance of various quantum information tasks. We analyze recurrence phenomena in the discrete-time quantum stochastic walk on a line, which is a quantum stochastic process that interpolates between quantum and classical walk dynamics [1]. Surprisingly, we find that introducing classical randomness can reduce the recurrence probability — despite the fact that the classical random walk returns with certainty — and we identify the conditions under which this intriguing phenomenon occurs [2]. Numerical evaluation of the first-return generating function [3] allows us to investigate the asymptotics of the return probability as the step number approaches infinity. This provides strong evidence that the suppression of recurrence probability is not a transient effect but a robust feature of the underlying quantum-classical interplay in the asymptotic limit. Our results show that for certain tasks discrete-time quantum stochastic walks outperform both classical random walks and unitary quantum walks.

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