

Abstract

The quantum random walk has been much studied recently, largely due to its highly nonclassical behavior. In this paper, we study one possible route to classical behavior for the discrete quantum walk on the line: the presence of decoherence in the quantum “coin” which drives the walk. We find exact analytical expressions for the time dependence of the first two moments of position, and show that in the long-time limit the variance grows linearly with time, unlike the unitary walk. We compare this to the results of direct numerical stimulation, and see how the form of the position distribution changes from the unitary to the usual classical result as we increase the strength of the decoherence.