TOPOLOGICAL SIGNATURES IN TWO-DIMENSIONAL CONTINUOUS-TIME QUANTUM WALKS*

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Quantum walks are promising candidates for quantum information processing. In particular, both discrete-time and continuous-time quantum walks have been proven to be universal for quantum computation, and these approaches have been instrumental in finding new algorithms that are more efficient than their classical counterparts. Recently topological phases in two-dimensional (2D) systems have been shown to be simulatable by discrete-time quantum walks; such phases have been proposed for fault-tolerant quantum computation and for quantum memories. Topological phases have also attracted extensive attention in solid-state physics for their unusual and potentially useful electronic properties. In this work, we investigate 2D continuous-time quantum walks driven by Rashba and Dresselhaus spin-orbit Hamiltonians to explore the influence of topology on the resulting time-dependent probability distributions. We find that the spin-orbit interactions strongly influence the characteristics of the quantum walk, even under circumstances when the Hamiltonian does not support topological states. In the presence of underlying topology, we discuss the relationship between the existence of edge states and the dynamics of the quantum walker.

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