Graduate Lecture on Quantum Walks and Topology



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Quantum randomness is intrinsically different from classical stochasticity since it is affected by interference and entanglement. Both make quantum walks promising candidates for the implementation of quantum computational algorithms and as a sensitive detector of interference. We present the basics of the implementation of a so-called **discrete-time quantum walk** that uses the momentum of ultra-cold rubidium atoms as the walk space and two internal atomic states as the "coin" degree of freedom [1]. This realization is based on the **quantum kicked rotor** under resonant conditions [2]. We demonstrate the distinctive features of a quantum walk, contrasting them to a classical walk. By manipulating either the walk or coin operator we show how the walk dynamics can be biased and even reversed. Our quantum walk provides a platform for a wide range of applications such as quantum search [3], the investigation of decoherence [4], and the observation of **topological phases** [5]. For the latter, we give a short introduction to the basic model of topology in quantum physics, the co-called SSH model.

References

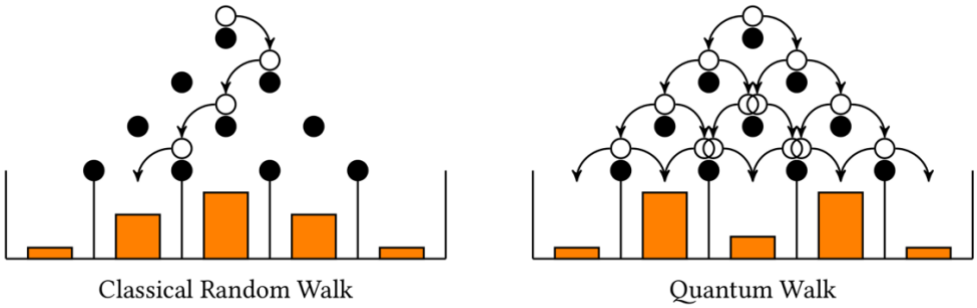
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