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Disordered quantum walks in a momentum-space lattice FANGZHAO AN, ERIC MEIER, BRYCE GADWAY, University of Illinois at Urbana-Champaign — Anderson's theorem says that in one dimension the transport of quantum particles is strongly suppressed by small amounts of random disorder. This picture changes drastically for correlated or time-varying disorder, allowing for ballistic or diffusive transport. To study disordered transport in a versatile way, we experimentally engineer arbitrary tight binding models for cold atoms based on their momentum-space evolution in a driven optical lattice. We first study the dynamics of atoms undergoing quantum walks in quasiperiodic disorder (Aubry-André model) at the single-site level, directly observing coherent delocalization for weak disorder and a transition to Anderson localization for strong disorder. Second, we study the effects of annealed disorder, or time-varying disorder that mimics coupling to a thermal bath. For increasing "temperature," we observe a crossover from ballistic quantum spreading to classical diffusion. Finally, we present results from applying binary disorder in the random dimer model, which is predicted to violate Anderson localization in one dimension. The techniques we present open a path towards studying transport in arbitrary types of correlated disorder, as well as studying the influence of disorder on topological systems.

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