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Localization of quantum particles with long-range hopping in finite-sized lattices[1] JOSHUA T CANTIN, Univ of British Columbia, TIANRUI XU, Univ of California, Berkeley, ROMAN V KREMS, Univ of British Columbia
— Non-interacting particles with long-range hopping are known to be delocalized in disordered systems of infinite size. It is thus natural to assume that such particles can traverse any finite-sized lattice. We show that this is not true. Particles with long-range hopping can localize in lattices of *finite* size, even macroscopically finite. This leads to a rather unusual phenomenon: quantum particles can transverse a disordered lattice of size $10A$, but not a lattice of size A. As evidence for this, we demonstrate spatial localization in dynamical calculations at long-times, inverse participation ratio distributions characteristic of localized systems, and log-normal fluctuations of the wavefunction. We map out the phase diagram for a particle with long-range hopping in a 3D lattice as a function of on-site disorder strength and filling fraction. Using scaling arguments, we determine the size-dependence of the localization-diffusion crossover line as a function of the system size, which predicts localization in macroscopically finite systems.

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