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Spin Transport in Ultracold Rydberg Atoms JACOB HOLLINGSWORTH, RICK MUKHERJEE, THOMAS KILLIAN, KADEN HAZZARD, Rice University — We devise a scheme to use ultracold Rydberg atoms to study models of transport where Rydberg excitations play the role of tunneling particles. In contrast to previous schemes, where "tunnelings" between atoms separated by a distance r often scale as $1/r^3$, ours scale as $1/r^6$, for which the physics is more similar to short-ranged hopping models. We theoretically demonstrate that current experiments exist in a regime that allows significant transport well within the experimental lifetime - several microns in a microsecond, and derive the experimental parameters for strontium atoms that are necessary to access this regime. We also show how disorder may be introduced and controlled precisely via the depth of an applied optical lattice. We explore the dynamics, looking for signatures of ballistic, diffusive, and localized behavior as a function of the types and strength of disorder applied.

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