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Dynamics of a single hole in the $t-J$ model FABIAN GRUSDT, MARTON KANASZ-NAGY, Department of Physics, Harvard University, Cambridge, Massachusetts 02138, USA, ANNABELLE BOHRDT, Department of Physics, Walter Schottky Institute, and Institute for Advanced Study, Technical University of Munich, 85748 Garching, Germany, EUGENE DEMLER, Department of Physics, Harvard University, Cambridge, Massachusetts 02138, USA — The realization of quantum-gas microscopes for ultracold fermions in optical lattices allows to investigate the dynamics of a single hole in an anti-ferromagnetic environment in-situ. We study this problem theoretically using exact numerical methods and semi-analytical approaches. In one dimension the coupling of the hole to the spin-environment is extremely weak – a manifestation of spin-charge separation – and we show that the dispersion relation of the magnetic polaron is closely related to the spinon dispersion. In two dimensions, in contrast, the dynamics of the hole is strongly modified by the surrounding spins. To describe this case analytically, we introduce a strong-coupling theory, valid in the limit when the hole-hopping is dominant, and show that a simple picture of the magnetic polaron dispersion can be obtained.

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