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Spin Transport in a Mott Insulator of Ultracold Fermions MATTHEW NICHOLS, Massachusetts Institute of Technology, LAWRENCE CHEUK, Harvard University, MELIH OKAN, THOMAS HARTKE, ENRIQUE MENDEZ, SENTHIL TODADRI, Massachusetts Institute of Technology, EHSAN KHATAMI, San Jose State University, HAO ZHANG, MARTIN ZWIERLEIN, Massachusetts Institute of Technology — Strongly correlated materials such as the high- $T_{\rm c}$ superconducting cuprates are expected to feature unconventional transport properties, where charge, spin, and heat conduction are decoupled. However, the measurement of spin transport in such materials is – in contrast to charge transport - highly challenging. In this talk, we report on a study of spin transport in the two-dimensional Fermi-Hubbard model using a quantum gas microscope of ultracold ⁴⁰K atoms trapped in a square optical lattice. By applying a spin-dependent potential gradient to a homogeneous, Mott-insulating sample at half-filling, we are able to observe, in real time, how the spin dynamics evolve in linear response. By varying the relative strength of the on-site interactions, we find that spin transport is driven by super-exchange and doublon-hole-assisted tunneling in the strongly interacting regime. For a wide range of experimental parameters, the spin dynamics are found to be diffusive in nature, and we extract both the spin diffusion coefficient and the spin conductivity. Because theoretical calculations of these transport coefficients are notoriously difficult due to strong correlations present in the system, these measurements present a valuable benchmark for future theoretical developments.

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