Abstract Submitted
for the DAMOP18 Meeting of
The American Physical Society

Bad Metallic Transport in a Cold Atom Fermi-Hubbard System[1]

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Probing the charge transport properties of quantum materials can reveal their unique microscopic properties. Weakly interacting systems such as Fermi liquids are well described by semiclassical Boltzmann transport, but strong interactions blur the particle-like behavior of charge carriers causing this picture to break down. Transport in strongly interacting quantum systems is poorly understood, but exhibits interesting phenomenology in many real materials. In our work, we experimentally study charge conductivity in the Fermi-Hubbard model. Using a quantum gas microscope, we impose a density modulation on a uniform system of ultracold ^{6}Li in a 2D optical lattice and observe this modulation decay due to charge diffusion. We find that the decay can be described by a hydrodynamic model and extract the momentum relaxation rate and diffusion constant for a range of temperatures. We determine the conductivity from the diffusion constant using the Nernst-Einstein relation. We observe that the resistivity scales linearly with temperature and shows no sign of saturation for temperatures ranging from near the super-exchange energy scale to the bandwidth. These anomalous behaviors are characteristic of bad metals.

[1]This work was supported by the NSF (grant no. DMR- 1607277), the David and Lucile Packard Foundation (grant no. 2016-65128), and the AFOSR Young Investigator Research Program (grant no. FA9550-16-1-0269).

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Date submitted: 26 Jan 2018 Electronic form version 1.4