Transport in Ultracold Atomic Materials: a Study of Band Structure Singularities, Dispersion, and a Window into Full-Counting Statistics

D M Stamper-Kurn[1,2]

[1] *Department of Physics, University of California, 366 Physics North Hall #7300, Berkeley CA, USA. Contact Phone: +15105209618*
[2] *Materials Sciences Division, Lawrence Berkeley National Laboratory, Berkeley CA, USA*
Contact Email: dmsk@berkeley.edu

Ultracold atomic gases allow us to study many-body systems, with strong analogies to condensed-matter physics, within new settings and with great flexibility and precision. I will discuss three experiments on quantum gases that relate to current transport in solid-state materials. In the first, we focus on singularities in band structure that occur generically at interband touching points. We reveal that transport through these singularities leads to unitary state rotations that reveal the geometric structure surrounding the singular point. Second, we examine the effects of geometric frustration on bulk transport and measure the group velocity of a quantum gas placed within the nominally flat band of a kagome lattice. We observe a dramatic renormalization of band structure caused by atomic interactions. Third, we use an optical cavity to conduct precise and real-time measurements of a gas as it undergoes the non-equilibrium process of evaporative cooling. We examine the two-time correlation in the atom number to identify regimes of sub- and super-linear evolution. This experiment touches on the subject of full counting statistics and its previous study in the realm of mesoscopic electronics.