复旦大学物理系 Colloquium

Time: 14:00, Tuesday, 2024.12.03

Location: C108, Jiangwan Physics Building

Imaging charge carrier motion through phase transitions in graphene

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Abstract: The paths that charge carriers follow as they traverse a material are heavily influenced by the local electronic phase of the material. This electronic phase is, in turn, governed by particle interactions, which depend on several factors, including carrier density, temperature, and magnetic field. In this talk, I will present how scanning tunneling potentiometry (STP) can be employed to map the flow of charge carriers through graphene as the quasiparticles transition between different electronic phases and transport regimes. I will begin by demonstrating how STP measurements can uncover the electrochemical potential profile created by carrier motion within a current-biased sample. These measurements are performed using conventional scanning tunneling microscopy (STM), which probes the sample in situ while it carries an electrical current. Next, I will discuss how an STM tip can be utilized to create electrostatic barriers within a sample by injecting charge into the substrate. By performing subsequent STP measurements, we can directly observe how charge carriers navigate these barriers under varying temperatures and magnetic fields. At higher temperatures, our results reveal that electrons enter a viscous, hydrodynamic phase, where their motion is characterized by minimal scattering even in the presence of barriers. In contrast, under strong magnetic fields, our measurements show that quasiparticles adopt trochoid-like trajectories, forming localized bound states around defects as the system transitions into the quantum Hall regime.

Biography: Prof. Brar is the Van Vleck Associate Professor of Physics at the University of Wisconsin – Madison. Previously he was a Kavli NanoScience postdoctoral fellow at Caltech, where he worked with Prof. Harry Atwater to develop tunable thermal emission devices powered by graphene plasmonic resonators. He received his PhD in 2010 from UC-Berkeley, where he worked with Prof. Mike Crommie to perform scanned probe measurements on 2D materials. His career in condensed matter physics started in the lab of Prof. Mildred Dresselhause at MIT, where he worked as and undergraduate researcher before graduating with degrees in Math and Physics in 2004.

His research interests include developing new scanned probe techniques and using them to image many-body phenomena in highly correlated materials. He also studies laser-based space propulsion, and non-equilibrium thermal emission devices.