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Correlation effects and thermoelectricity in twisted bilayer graphene

Twisted bilayer graphene (TBLG) is a new and versatile platform to realize effects of strong electron-electron interaction as the misorientation angle between the graphene lattices profoundly affects the electronic structure of the combined system. While the layers behave independently at large angles (> 5 degrees), new electronic bands emerge when the angle is decreased, including nearly flat dispersion at the magic angle of 1.1 degree that has been shown the harbour superconductivity, magnetism and other many-body phases. In addition to direct electrical transport, thermoelectric properties are also highly sensitive to electronic correlations, and often manifest in departure from the well-established Mott semiclassical framework. I shall present the results of measurement of thermoelectric power in TBLG over a wide range of mis-orientation angles in high quality van der Waals stacks of twisted bilayer graphene. Thermoelectricity is a sensitive probe to electronic band structure and in TBLG at large angles (> 5 degrees) is expectedly determined by independent electronic structures in the two graphene layers. Even at moderate angles (~ 2 – 5 degrees), the thermoelectricity can be described by the semiclassical Mott relation, even in the presence of strain and topological phases at low energies. At low angles (< 2 degree), however, a strong departure from the semiclassical description is observed which is most pronounced at the half-filling of the underlying Moire lattice and persists up to temperatures as high as 40 K. In accordance with the strong enhancement in the electronic interactions at half filling, these experiments provide a new route towards probing the novel interaction-driven effects in TBLG.

Arindam Ghosh is from the Department of Physics at the Indian Institute of Science in Bangalore, India. His research interest involves fundamental understanding of physics and device concepts in multiple two-dimensional (2D) electron systems, with emphasis on transport, optical and thermal properties of layered membranes. The emphasis of his research lies in ultra-sensitive optical detection, tunable thermoelectric designs, and power efficient memory devices for neuromorphic applications. Prof. Ghosh has guided nearly twenty PhD students so far, and serves on the Editorial/Advisory board of several international journals from Springer, IoP and ACS and conferences. He has been the recipient of several recognitions and fellowships including the Swarnajayanti Fellowship, IBM-IUSSTF (Indo-US Science and Technology Forum) fellowship in Nanotechnology, the Shanti Swarup Bhatnagar Prize, Oxford Instruments Young NanoScientist Award, P.K. Aiyenger Memorial Award, the J. C. Bose National fellowship and the Infosys prize 2020.