Observation of excess entropy and breakdown of semiclassical description of thermoelectricity in twisted bilayer graphene

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The flatbands formed in Moiré systems with twisted bilayer graphene (tBLG) have emerged as an ideal platform for studying many novel concepts of condensed matter physics due to the enhanced interaction effects [1,2]. It not only causes superconductivity [2], Mott insulating states [1], and quantum anomalous Hall effect [3] close to the magic angle (θ ~1.1^0), but also unconventional metallic states that are claimed to exhibit non-Fermi liquid (NFL) excitations [4]. However, unlike superconductivity and correlation-induced gap in the density of states, unambiguous signatures of NFL effects in such metals remain experimentally elusive. Here we report on both resistivity and thermopower (S) measurements in tBLG for a range of twist angle between θ ~ 1.0-1.7^0. At larger θ, we observe an emergent violation of the semiclassical Mott relation in the form of excess S close to half-filling that vanishes for $\theta \geq 2$. The excess S (2μV/K at low temperature T ~10 K at 1.6^0) persists up to 40 K and is accompanied by metallic T-linear resistivity with transport scattering rate of near-Planckian magnitude. Closer to magic angle, the excess S was also observed for the fractional band filling ($\upsilon = 0.5$). The combination of non-trivial electrical transport and violation of Mott relation provides compelling evidence of NFL physics intrinsic to tBLG.

References

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