Transport signatures of Van Hove singularities in mesoscopic twisted bilayer graphene

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Magic-angle twisted bilayer graphene exhibits quasi-flat low-energy bands with Van Hove singularities close to the Fermi level. These singularities play an important role in the exotic phenomena observed in this material, such as superconductivity and magnetism, by amplifying electronic correlation effects. In this work, we study the correspondence of four-terminal conductance and the Fermi surface topology as a function of the twist angle, pressure, and energy in mesoscopic, ballistic samples of small-angle twisted bilayer graphene. We establish a correspondence between features in the wide-junction conductance and the presence of van Hove singularities in the density of states. Moreover, we identify additional transport features, such as a large, pressure-tunable minimal conductance, conductance peaks coinciding with non-singular band crossings, and unusually large conductance oscillations as a function of the system size. Our results suggest that twisted bilayer graphene close the magic angle is a unique system featuring simultaneously large conductance due to the quasi-flat bands, strong quantum nonlinearity due to the Van Hove singularities and high sensitivity to external parameters, which could be utilized in high-frequency device applications and sensitive detectors.