Vanishing conductivity at the Dirac point in graphene/PbI_2 heterostructure

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Abstract

The integration of graphene with other two-dimensional materials to create van der Waals (vdW) heterostructures has opened up exciting possibilities for engineering novel electronic properties. In this work, we investigate quantum transport in heterostructures combining graphene and semiconductor PbI_2, which has a commensurate lattice with graphene. We show disappearing longitudinal resistance at the Dirac point under magnetic fields above 4 T, showing the presence of a ballistic channel surviving the transition from -2 to 2 filling fractions. We also observe a fractional conductance plateau at 2/3 and a Moiré superlattice structure. We propose that this system form a Moiré quasicrystal with long-range ballistic channels that exist in a wide range of gate voltages and magnetic fields. Our findings highlight the potential of 2D lead iodide as a new building block for vdW heterostructures, offering a platform for the development of advanced materials with tailored electronic properties.

Figures

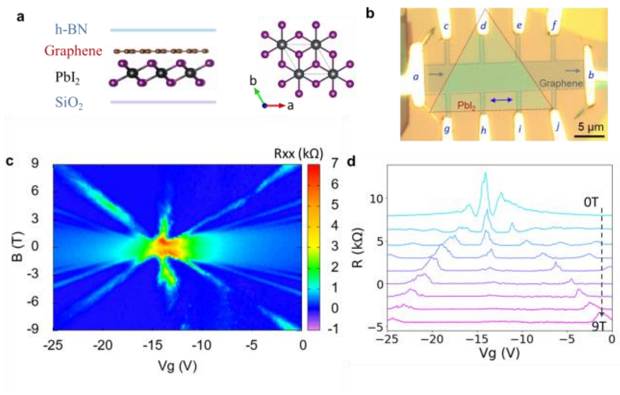

Figure 1: a) Schematic cross-section of the architecture (left), the top view of PbI_2 lattice structure (right) b) an optical microscope image of the graphene/PbI2 Hall bar. c) and d) shows Landau-level fan diagram for this sample and the dissapearing longitudinal resistance at the Dirac point.

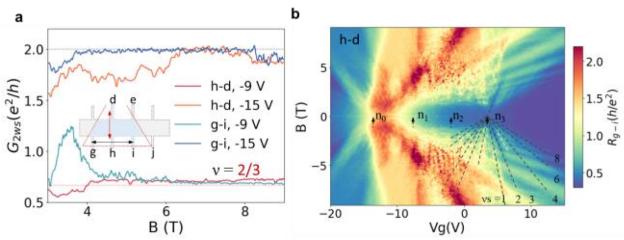

Figure 2: a) Two-terminal conductance shows the fractional quantized plateau ν = 2/3 on the electron side and ν = 2 on the hole side. b) Two-terminal resistance as a function of ν and B, showing Wannier diagram.