COHERENT JETTING FROM A GATE-DEFINED CHANNEL IN BILAYER GRAPHENE

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The quest to precisely control the valley degree of freedom to store, transport and readout binary information has been an important drive in valleytronics for more than a decade [1,2].

Using scanning gate microscopy, we image valley-polarized jets emanating from a gate-defined constriction in bilayer graphene at a mutual angle of 60°. The jets become visible via their interference pattern, and we observe no significant reduction of the conductance along the jets. We find that the angular distribution of the jets originates from a dispersion-related collimation of electron trajectories due to the trigonally warped bandstructure of bilayer graphene. The momentum distribution in the lowest-energy modes of the constriction enhances this collimation further and selectively activates the jets. This is in strong contrast to the small-angle scattering origin of electron branching observed in similar measurements on Ga(Al)As heterostructures [3, 4]. For arbitrary orientations of the channel with respect to the crystallographic orientation of the bilayer graphene, the jets may appear deformed. However, the angular distribution of the jets is a universal feature arising from the trigonally warped bilayer graphene dispersion and is stable against varying channel orientations, except for angles of 30°.

The general origin of the jets makes our observation relevant for carrier transport in all two-dimensional materials with a trigonally warped bandstructure, and opens new avenues for the design of novel quantum devices in various van-der Waals heterostructures, including bi- and multi-layer graphene [5], MoS_2 [6] and many more.

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