Fabry-Perot oscillations in bilayer graphene pn junctions

Klaus Ensslin

ETH Zürich, Switzerland

Interference of particles is a manifestation of the wave nature of matter. A well-known realization is the Fabry-Pérot interferometer, where a photon bounces back and forth between two coplanar semitransparent mirrors. Partial waves transmitted after a distinct number of reflections within this cavity interfere and give rise to an oscillatory intensity of the transmitted beam as the mirror separation or the particle energy is varied. In solid-state physics, graphene has proven to be a suitable material for probing electron interference at cryogenic temperatures. However, in single-layer graphene (SLG) the realization of FP interferometers is challenging. The absence of a band gap and the Klein tunneling hamper the efficiency of sharp potential steps between the n- and p-type regions, which play the role of the interferometer mirrors. Theory suggests that smooth barriers enhance the visibility of interference due to Klein collimation. Recently, ultraclean suspended SLG devices have shown FP interference with stunning contrast using cavity sizes of more than 1 µm. Here we report the experimental observation of Fabry-Pérot interference in the conductance of a gate-defined cavity in a dual-gated bilayer graphene device. The high quality of the bilayer graphene flake, combined with the device's electrical robustness provided by the encapsulation between two hexagonal boron nitride layers, allows us to observe ballistic phase-coherent transport through a 1-µm-long cavity. We confirm the origin of the observed interference pattern by comparing to tight-binding calculations accounting for the gate-tunable band gap. The good agreement between experiment and theory, free of tuning parameters, further verifies that a gap opens in our device. The gap is shown to destroy the perfect reflection for electrons traversing the barrier with normal incidence (anti-Klein tunneling). The broken anti-Klein tunneling implies that the Berry phase, which is found to vary with the gate voltages, is always involved in the Fabry-Pérot oscillations regardless of the magnetic field, in sharp contrast with single-layer graphene.