Transport spectroscopy of epitaxial graphene on SiC using quantum capacitances

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What distinguishes graphene from conventional two-dimensional systems is its relativistic energy band structure referred to as the Dirac cone. Using a high-mobility gated epitaxial graphene device, we report transport spectroscopy that exploits interplay between interface-state capacitance and graphene quantum capacitance reflecting the Dirac cone [1]. This technique enables us to map out the energy structure of the relativistic graphene Landau levels (LLs) and thus to deduce disorder-induced LL broadening with simple transport measurements.

The sample is a top-gated Hall bar fabricated from graphene epitaxially grown on SiC. Figure 1(a) shows the longitudinal resistance R_{xx} vs. gate voltage V_g and magnetic field B, showing the robust quantum Hall state at ν = 2. The trajectories of R_{xx} peaks at ν = 4, and 8 in the V_g-B plane are curved and those at ν = 0, 4, and 8 are unequally spaced, in contrast to R_{xx} mappings for conventional two-dimensional systems, which show linear and equidistant trajectories of R_{xx} peaks. The observed features can be explained by our model describing the interplay between graphene and nearby interface states, which are inevitably included in devices fabricated from epitaxial graphene grown with usual conditions. Filling factors calculated vs. V_g and B nicely reproduce the positions of experimentally observed R_{xx} peaks [Fig. 1(b)]. This indicates that the R_{xx} mapping serves as spectroscopy of the relativistic LLs. More importantly, this enables us to deduce the energy broadening of the extended state in zero-energy LL (~ 16 meV) that has been unrevealed for epitaxial graphene.

[1] K. Takase *et al.*, Phys. Rev B **86**, 165435 (2012).

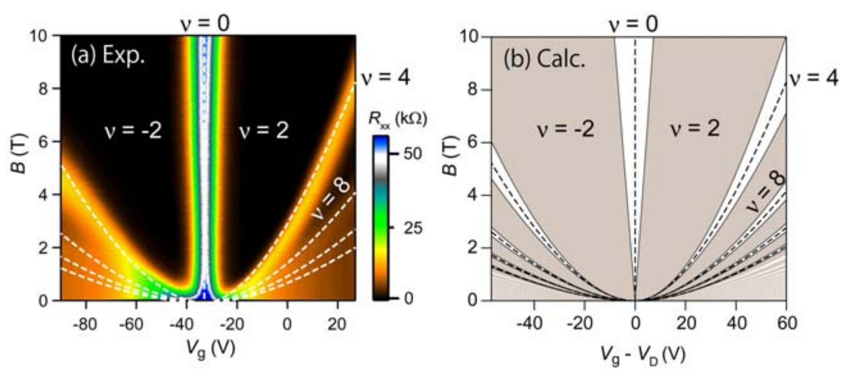

Fig. 1 (a) R_{xx} vs. V_g and B. (b) Filling factors calculated vs. V_g and B.