Fractional Quantum Hall States in Hybrid Graphene

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Introduction

The isolation of graphene has led to the observation of new sets of integer and fractional quantum Hall (QH) states not found in conventional two-dimensional electron gasses. Monolayer, bilayer, and trilayer graphene each have shown distinct versions of the QH effect, which differ in the Landau energy-level spacing and hierarchy, field-dependence of the energy gaps, the degeneracy of the ground state, the Berry phase, and the symmetry-breaking of degenerate states. While examinations of each of these new QH states have occurred in the past few years, yielding insights into both the QH effect and the physics of graphene, there have been few studies [1, 2] of what happens when these differing QH effects are combined in a single device that links mono, bi-, and trilayers into a hybrid graphene structure.

Experimental

Clean-interface hybrid graphene was fabricated through standard exfoliation techniques and transferred to hexagonal boron nitride substrates to improve carrier mobility. Measurements on these samples, focusing on transport sourced and drained though the bilayer section of a mono-bilayer flake, were performed at NHMFL's DC field facilities, where the 35 T resistive magnet was used to create both broken-symmetry integer QH states and fractional QH states.

Results and Discussion

Similar to homogenous bilayer graphene, measurements on this hybrid flake displayed an 8-fold degenerate Landau level around the charge neutrality point. As shown in Fig.1 for the electron side of the transport, at the highest accessible fields both the 8-fold degeneracy of integer QH states is completely lifted and signatures of fractional QH states form. These fractional states have only recently been observed and begun to be characterized in homogenous bilayer graphene samples [3, 4]. Their presence in this hybrid samples is both a manifestation of the high mobility of the sample and the first evidence that hybrid graphene structures can support fractional quasiparticles.

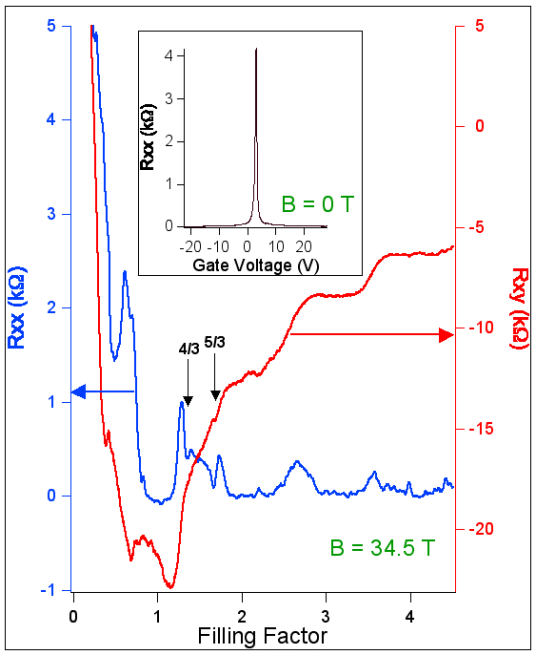

Fig.1 Broken-symmetry integer QH and fractional QH of predominantly bilayer hybrid graphene on boron nitride. The inset shows the zero-field Dirac peak.

Conclusions

In contrast to previous measurements of monolayer sections of hybrid graphene samples, where a Landau level structure distinct from homogenous monolayer graphene was observed. The symmetry breaking and fractional states of predominantly bilayer graphene appear to be qualitatively unperturbed by the presence of monolayer.

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References

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