Tunable Fractional Quantum Hall Phases In Bilayer Graphene

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Introduction

Under strong magnetic fields, a two dimensional electron gas can form correlated many-body states via strong Coulomb interactions, giving rise to the fractional quantum Hall effect (FQHE). In addition to electron spin, the existence of a valley degree of freedom in graphene allows the formation of FQHE states within an SU(4) symmetry space. In bilayer graphene (BLG), the gate electric field and magnetic field can drive transitions between different spin and valley orderings including different FQHE phases, making it an ideal system to study phase transitions between different topologically ordered states.

Using the recently developed van der Waals transfer technique, we fabricated high quality BLG devices encapsulated in hexagonal boron nitride. We demonstrated different FQHE phases in the device tunable with magnetic and electric field.

Experimental

Dual-gated bilayer graphene devices encapsulated in hexagonal boron nitride were measured in the 31 tesla resistive magnet in cell 9 at the NHMFL in a sample-in-vapor He^3 refrigerator.

Results and Discussion

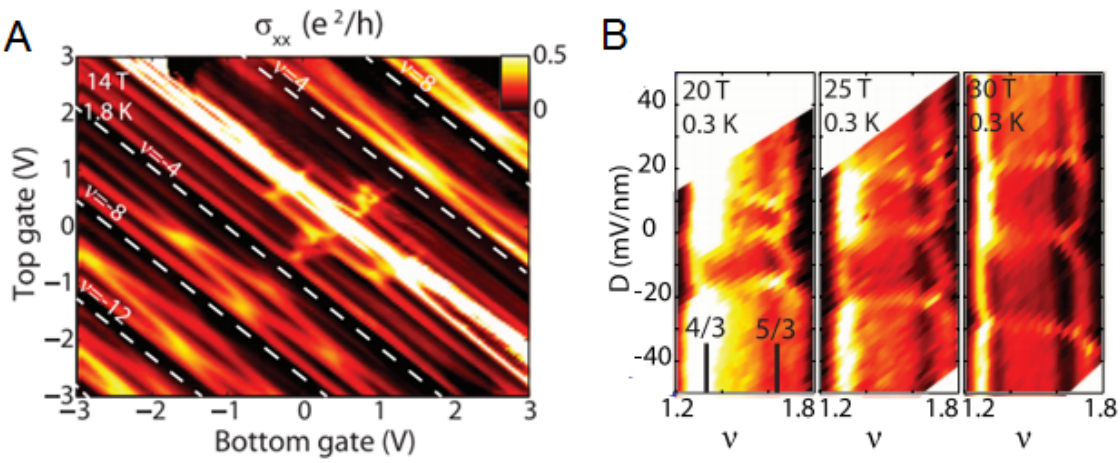

Fig. 1

Fig. 1A shows longitudinal conductance as a function of top and bottom gate voltages at B = 14 T and T = 1.8 K. All broken-symmetry integer states are visible (multiple of 4 filling factors are marked with white dashed lines), indicative of high device quality. Fig. 1B shows longitudinal conductance as a function of filling factor (in the range of 1.2 < ν < 1.8) and displacement field (in the range of –50 < D < 50 mV/nm) at 300 mK for three different magnetic fields. Different FQHE phases have been clearly demonstrated, which are tunable with magnetic and displacement field.

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References

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