Quantum Hall Effect in graphene in a pulsed magnetic field

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Introduction

The quantum hall effect (QHE) has been widely studied in monolayer graphene. A robust cyclotron gap of thousands of Kelvin at high magnetic field makes it an ideal test ground for new experimental techniques. Pulsed magnetic fields, Wcapable of reaching peak magnetic fields tens of Tesla higher than their DC counterpart, have not been a common tool in transport measurements on 2 dimensional (2d) systems due to several technical issues. Here, we demonstrate proof of concept with QHE measurements in monolayer graphene under a pulsed field magnet.

Methods

We fabricated the monolayer graphene device in a Hall bar geometry. To ensure high electron mobility, the graphene is encapsulated in hBN and cladded in single crystal graphite gates. The carrier density in the graphene sheet can be electrostatically tuned by the graphite gates. To measure the QHE in the sample, we used the 65 T pulsed magnet in NHMFL at LANL, with the sample mounted in a cryostat capable of reaching 0.3 K. To combat the effects of vibrational noise, a large current of 10 uA is driven through the sample to increase our measurable QHE signal size. To subtract the EMV background of an individual pulsed measurement, we take difference between two individual pulsed measurements where the bias current is applied in opposite directions.

Results and Discussion

Fig.1 shows the Hall resistance Rxy measured up to 60 T, which is well quantized at expected values of 1/2, 1/6 and 1/10 of h/e^2 for ν = 2, 6, 10 QH states. Minima in the longitudinal resistance Rxx appear at approximately the same field as the plateaus in Rxy. Broken symmetry states are not observed, most likely due to the large current applied locally heating the sample causing breakdown of the fractional Quantum Hall States.

Conclusions

The QHE in monolayer graphene is observed with a pulsed field magnet up to 60 T with precise quantization of v = 2 near 45 T. The precise quantization of the Hall resistance demonstrates that pulsed field magnet are a practicable and promising tool for future transport measurements on 2d systems.

Acknowledgements

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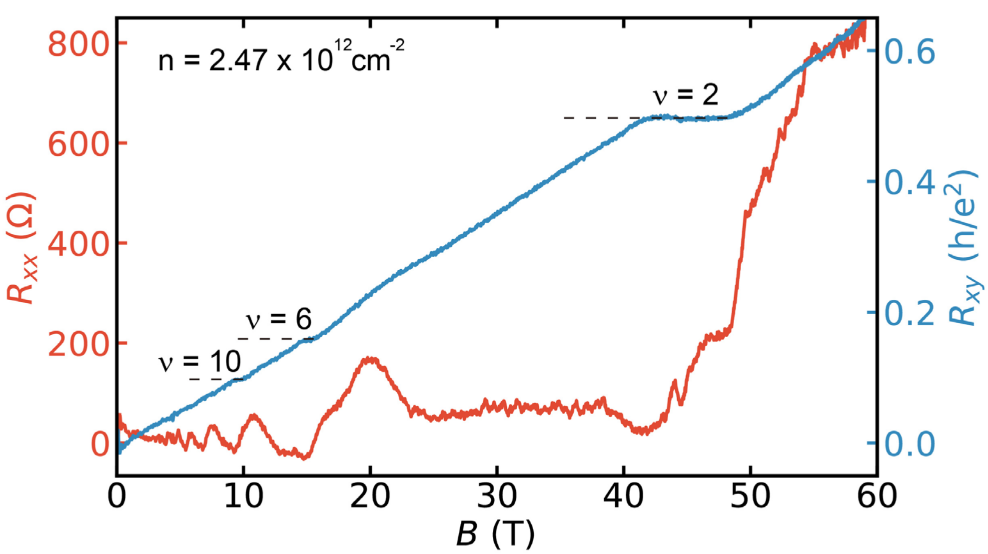

Fig.1 Longitudinal and Hall resistance versus magnetic field for a carrier density n = 2.47 x 10^{12} cm^{-2} at 4 K.