Giant Interaction-Induced Gap in Dual-Gated ABC-Stacked Trilayer Graphene

Y. Lee, J. Velasco Jr., D. Tran, W. Bao, L. Jing, K. Myhro, C.N.Lau (Univ. California, Riverside); F. Zhang (Univ. Pennsylvania); Dmitry Smirnov (FSU, NHMFL)

Introduction

Graphene, with its anomalous "half-integer" quantum Hall effect, (QHE) has emerged as a new platform for new physics in low dimensions and special symmetry groups such as SU(4). Bilayer graphene and trilayer graphene (TLG) have also attracted significant attention, as their charge carriers are massive Dirac fermions with many predicted novel phenomena. In particular, TLG offers an exciting platform with unique band structures: ABC-stacked TLG has extremely large density of states near the charge neutrality point, and is unstable towards electronic interactions, thus hosting interaction-induced states with spontaneous symmetry breaking. Though TLG has attracted more attention recently, the nature of such broken symmetry state in TLG and their evolutions under electric and magnetic fields remain experimentally unexplored.

Experiment Results

Using low temperature transport measurements, we investigate high mobility dual-gated ABC TLG devices in the QH regime. At the charge neutrality point, we observe a giant interaction-induced gap Δ~41meV, suggesting a spontaneous layer antiferromagnetic ground state with broken time reversal symmetry. This state is suppressed by a critical temperature T_c~30K, by an in-plane magnetic field, and by an interlayer potential $U_\perp$ that facilitates a single-particle gap. The most likely candidate for this state is the layer antiferromagnetic state, where electrons n the top and bottom layers have opposite spin polarization[1].

Acknowledgements

We acknowledge the support by DMEA H94003-10-2-1003, NSF DMR/1106358 and the FAME center. YL acknowledges the support by DOE. Work at the NHMFL was performed under NSF Cooperative Agreement No. DMR-1157490, the State of Florida, and the U.S. Department of Energy.

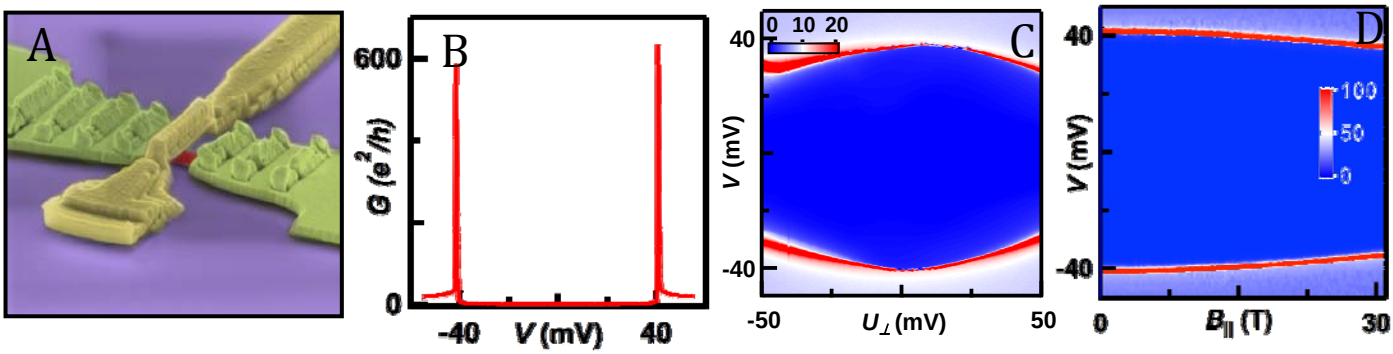

Fig. 1. Transport data from dual-gated suspended trilayer graphene device. (A). Device image. (B). *G(V)* at *n*= $U_\perp$=0 and *T*=300 mK, showing a gap of ~41 meV. (c). *G(V, $U_\perp$).* The gapped region (dark blue) is reduced by interlayer potential $U_\perp$. (d). *G($B_\parallel$)* at n=$U_\perp$=0. The gap is reduced by large $B_\parallel$.

References

[1] Y. Lee, D. Tran, K. Myhro, J. Velasco Jr., N. Gilgren, C. N. Lau, Y. BarlasJ.M. Poumirol, D. Smirnov F. Guinea, in preparation (2013).