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Unusual Renormalization Flow in Strongly Insulating Monolayer Epitaxial Graphene on SiC

By changing the measurement temperature *T*, one can effectively change the sample size in order to study the *T*-driven flow (or renormalization group (RG) flow) [1] of a two-dimensional material in the complex conductivity plane. Previously we have shown that the RG flow in a disordered monolayer graphene device grown on SiC, the RG flow can be well approximated by the semi-circle, showing evidence for floating up of the *N*=0 Landau level at low magnetic fields *B* [2]. In order to further study this, we have measured a disordered graphene device which shows strongly insulating behavior over a wide range of *B* and *T* in order to study the RG flow (Fig. 1). In the high *B* regime, we observe cusp-like RG flow towards ($\sigma_{xy} = e^2/h$, $\sigma_{xx} = e^2/h$) where σ_{xy} and σ_{xx} are Hall conductivity and diagonal conductivity respectively (Fig. 2). Interestingly, such features, indicative of a fixed-temperature phase transition (Fig. 3), have never been observed before and cannot be explained by existing RG models based on a modular symmetry group [3]. Therefore, our results suggest the need for new theoretical models and experimental study leading to an understanding of strongly disordered two-dimensional materials such as graphene, few-layer black phosphorus, WS_2, and so on.

References

[1] H. P. Wei, D. C. Tsui, A. M. M. Pruisken Phys. Rev. B, 33 (1985) 1488
[2] L.-I. Huang, Y. Yang, R. E. Elmquist, S.-T. Lo, F.-H. Liu and C.-T. Liang, RSC Adv., 6 (2016) 71977
[3] C. P. Burgess and B. P. Dolan, *Phys. Rev. B*, 76 (2007) 113406

Figures

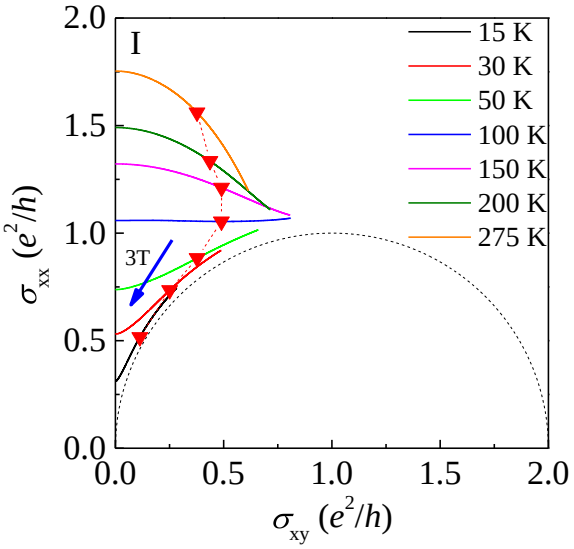

Figure 1: (a) Conductivity σ_{xx} plotted against σ_{xy}. The dotted curves denote the theoretical prediction of semicircle σ_{xy}-σ_{xx} relation for the 0-2 transition. Each group of triangle markers connected by dashed lines denotes the data for the same magnetic field (*B*= 3 T). The arrows indicate the flow line to the low temperature extreme at fixed magnetic fields.

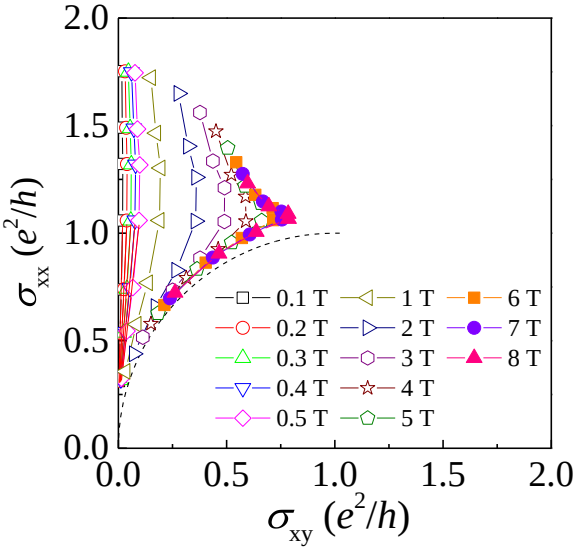

Figure 2: Detailed RG flow over a wide range of *T*. The dotted curve represents half of the semi circle.

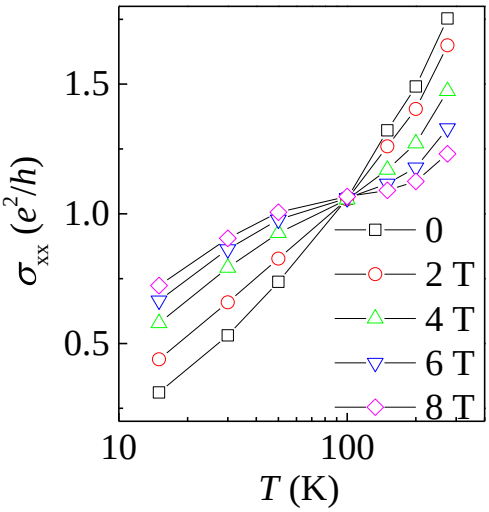

Figure 3: Temperature dependence of the diagonal conductivity in the range 15 K ≤ *T* ≤ 275 K. The crossing point occurs at *T* = (97 ± 1)K.