Multifractal Conductance Fluctuations in high quality Graphene devices

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Multifractality, characterized by an infinite number of scaling exponents, is ubiquitous in classical systems. Since the pioneering work of Mandelbrot [1], the detection and analysis of multifractal scaling in such systems have enhanced our understanding of several complex phenomena such as turbulent flows. In quantum condensed-matter systems, signatures of multifractality are rare and have been found in the scaling of eigenfunctions, or in the structure of the wave functions at critical point [2]. We report the first observation of multifractality in the transport coefficients in a quantum condensed matter system [3]. We show that, in high-mobility SLG-FETs, the universal conductance fluctuations (UCF) [Figure 1], as a function of the magnetic field, are multifractal [3]. Our observation of strong multifractality in only a narrow region near the Dirac point and at very low temperatures suggest towards strong localization-delocalization transition in SLG near the Dirac point as the origin of the multifractility in UCF. We also investigate scaling properties of conductance fluctuations in the quantum Hall regime during plateau-to-plateau transitions, and observe strong multifractality near the Anderson transition. Our experiments and results suggest that the multifractality of the wave functions of Anderson localization transition reflects in transport parameters, and hence provide us with a tool to probe into the underlying multifractality of the critical wavefunctions governing Anderson transition.

References

[1] Benoit B. Mandelberot. The Fractal Geometry of Nature. Freeman: San Francisco, 1982.
[2] G. Parisi and U. Frisch. Turbulance and Predictibility of Geophysical Fluid Dynamics, North-Holland, Amsterdam, 1985.
[3] K. R. Amin, S. S. Ray, N. Pal, R. Pandit, A. Bid, Communications Physics 1, Article no. 1, 2018

Figures

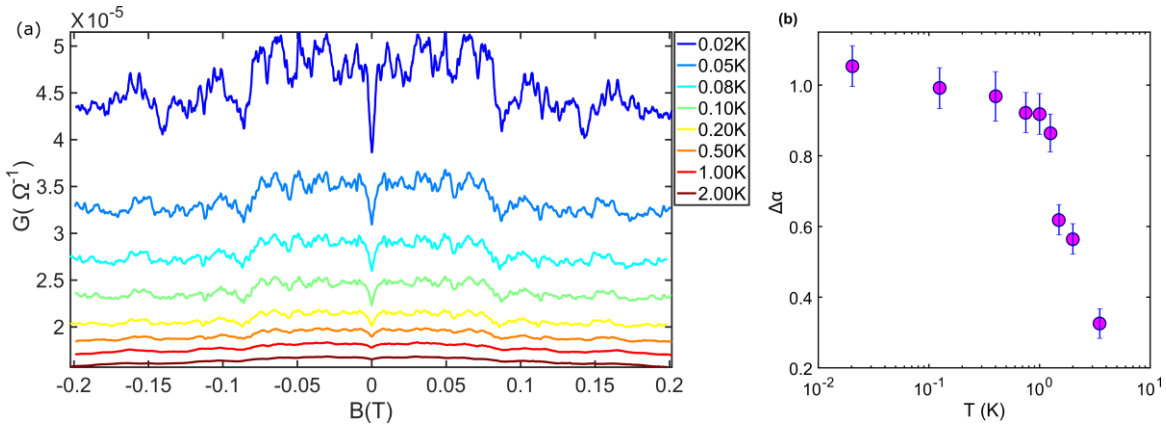

Figure 1: (a) Universal conductance fluctuations measured in a high-mobility single layer graphene device, at different temperatures. (b) Plot of strength of multifractality, characterized by width of singularity spectrum ($\delta\alpha$) versus temperature, extracted from plots shown in (a).