Log-normal carrier localization in strongly gapped bilayer graphene

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Bilayer graphene is a remarkable platform for quantum transport phenomena, enabled by its peculiar symmetry properties, and also the simultaneous yet independent tunability of the band gap and Fermi energy. The tunability of the band gap is not only important for novel device applications, but also for investigating the insulating state of bilayer graphene in a controlled manner. In this work, we probe strongly gapped bilayer graphene devices for statistical properties of the conductance with varying Fermi energy located deep inside the mid-gap regime. We find that the logarithm of the Fermi energy-dependent conductance in the strongly insulating state exhibits a normal distribution. Such log-normal spectral distribution of conductance is a unique signature of strong carrier localization, often considered in the context of single parameter scaling within the Anderson localization framework, which had eluded direct experimental observation so far. Our results suggest a non-trivial nature of carrier localization in bilayer graphene in the large bandgap limit.