Carries-exciton coupling at 2D Perovskite/graphene interface

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Quantum transport properties and carriers-exciton coupling in molecularly thin 2D perovskite/Graphene heterostructure are experimentally investigated by Shubnikov-de Hass (SdH) oscillation and photo-resistance spectroscopy. We find strong charge transfer between the perovskite and graphene which induces a hole carrier density in graphene up to ~ 2.79×1013 cm-2. The perovskite layer also lowers the effective mass of graphene from ~0.12 me to ~ 0.08 me. Despite of the efficient charge transfer process, the graphene exhibits the carrier mobility ~550 cm2V-1s-1. Under illumination, shifts in the photo-resistance spectrum and SdH oscillation are observed, implying that the excitons in perovskite are strongly coupled to landau levels in graphene as a result of the carrier-exciton interaction. This strong interaction is enabled by the high hole density in graphene with a typical distance between holes comparable to the exciton size. The sign of the photo-resistance SdH oscillations corresponds to a reduction of the hole density in graphene under illumination. We find that the graphene/2D perovskite system provides a new platform for exploring the carrier-exciton interaction when Landau levels are quantized.

Figures

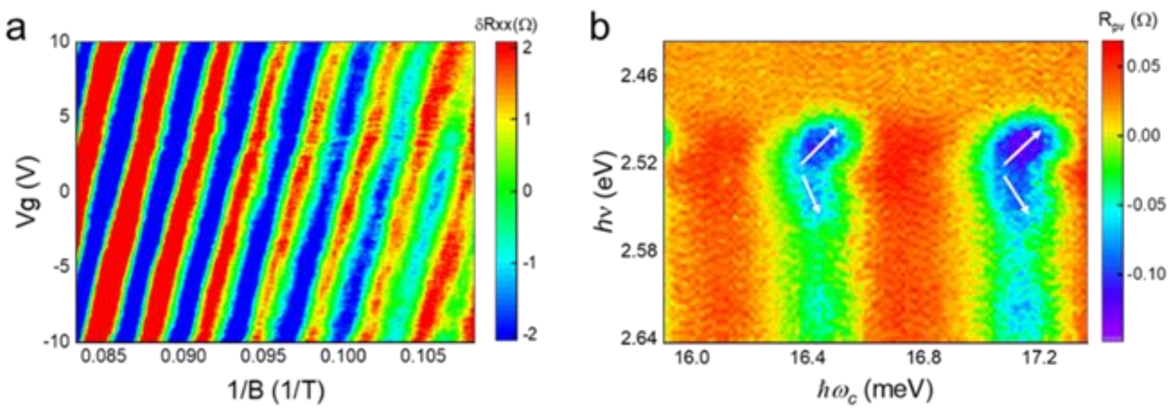

Figure 1: (a) The Shubnikov-de Hass (SdH) oscillation peaks shift with the gate voltage, showing that graphene, in the perovskite/graphene stack, is hole doped with carrier density ~ 2.79×1013 cm-2 (approximately 1 hole per 100 graphene carbon atoms). (b) The photo-resistance spectrum and SdH oscillation shift under illumination in the perovskite/graphene stack. A splitting of the photo-resistance spectrum is observed for certain values of the magnetic field repeating periodically with the period of SdH oscillations. The energy value of the shift is comparable to the spacing between Landau levels in graphene, indicating the excitons in perovskite are strongly coupled to quantized graphene Landau levels.