Ballistic transport in graphene on WSe_2

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Abstract

Proximity-induced spin-orbit coupling (SOC) was shown to be strong in graphene on transition metal dichalcogenides (TMDCs), and a band splitting induced by both Rashba and valley-Zeeman SOC terms is expected in such a system [1]. Here we employ the transverse magnetic focusing (TMF) technique [2] to study the effects of enhanced SOC in monolayer graphene on WSe_2, including the SOC-driven band splitting and electron dynamics, where the ballistic motion of electrons was used, instead of the spin relaxation due to electron scattering in most previous studies. We clearly observed a splitting in the first focusing peak whose evolution in carrier density and magnetic field can be well fitted theoretically by an overall SOC strength of ~13 meV, while no splitting the second focusing peak indicates an interband scattering at the sample edge [3]. Temperature dependence analysis further shows the possible suppression of the electron-electron scattering in the system. We will further discuss potential impact of this study especially in utilizing ballistic transport effects in graphene systems for spintronic applications.

References

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[3] Usaj, G. & Balseiro, C. A., *Phys. Rev. B* **70**, 041301 (2004).
[4] Rao, Q. et al., submitted (arXiv: 2303.01018).

Figures

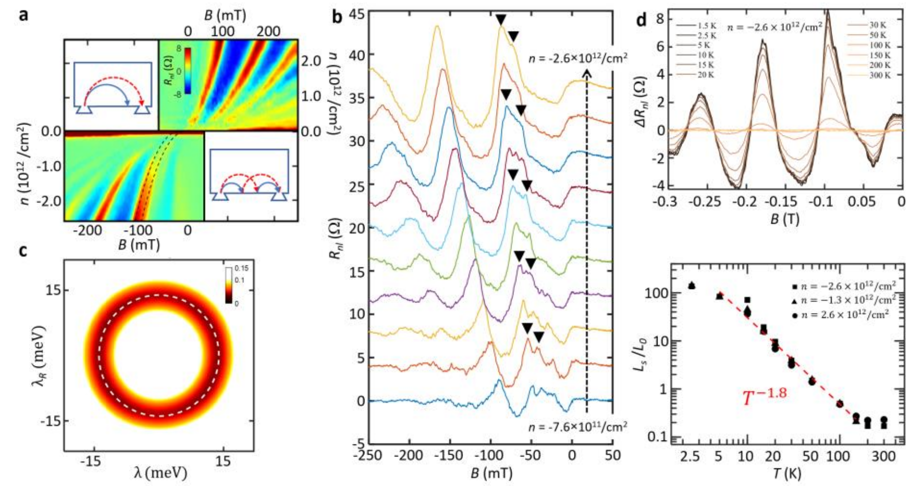

Figure 1: TMF study on monolayer graphene on WSe_2. **a**, Color-scale map of TMF signal measured at 1.5 K. The broken lines show the theoretically calculated focusing peaks when the overall SOC strength is 13.9 meV. Inset: carrier trajectories for the first and second focusing peaks (top left and bottom right, respectively). **b**, 1D cuts of the data shown in **a**. The black down-triangles mark some of the two split peaks for guidance. **c**, The color-scale map of the average difference of spin-split peak positions derived from theory and experiment, as a function of valley-Zeeman SOC (λ) and Rashba SOC strength (λ_R). **d**, Temperature dependence of the TMF spectra at n=-2.6×10^{12} cm^{-2} and the relative scattering lengths as a function of temperature plotted in a log scale, which follows the $T^{-1.8}$ dependence, indicated by the dashed red line.