Twist angle dependent proximity-induced spin-orbit coupling in graphene/WSe_2 heterostructures

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In recent years, effects of strong proximity-induced spin-orbit coupling (SOC) in single layer graphene (SLG) on transition metal dichalcogenides (TMDCs) like WSe_2 have been detected [1]. Additionally, theoretical calculations predicted a strong dependence of the proximity-induced SOC in relation to the twist angle between graphene and TMDCs [2, 3]. In our work, we fabricated SLG/WSe_2/h-BN heterostructures with defined twist angles between SLG and WSe_2 layers. The fact that 2D materials like graphene and WSe_2 very often break along zigzag or armchair edges was used to align and estimate the rotation angles between the flakes [4]. Since we cannot distinguish between zigzag or armchair edges we consider both cases. Strong SOC causes weak anti-localization [1], which we used to determine the strength of the Rasbha type SOC (λ_R) and the valley-Zeeman type SOC (λ_{VZ}). We found a strong twist angle dependence of the proximity-induced SOC. A sample with an angle around 15° shows a much stronger SOC in both cases, for λ_R as well as for λ_{VZ}, compared to the other samples, with twist angles different to 15°. For those samples with a twist angle near 0° or 30° (zigzag-armchair problem), we found the SOC parameter to be almost equal and much smaller compared to the sample with 15° twist. This is in qualitative agreement with theoretical predictions [2, 3].

References

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Figures

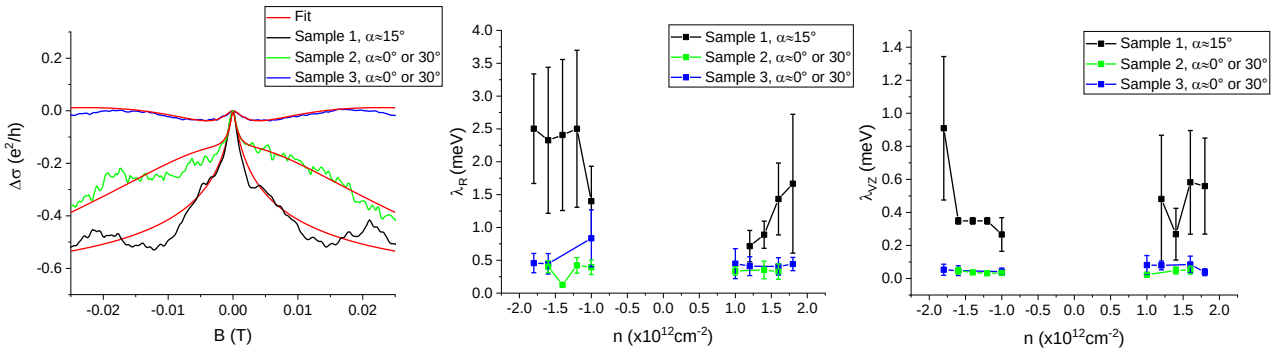

Figure 1: Weak anti-localization effect measured for three different with different twist angles (left). Comparison of λ_R (center) and λ_{VZ} (right) for three different samples with different twist angles.