Effective Mass and Landau Level Zeeman Splitting in Monolayer and Bilayer $MoSe_2$

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Introduction

Magnetotransport in high-quality, transition metal dichalcogenides (TMDs) samples can be used to probe the energy-moment um dependence at the band extrema [1], the Landau level (LL) structure, and assess the impact of electron-electron interaction, as recently demonstrated for holes in WSe_2 [2].

Experimental

We fabricated high-mobility, dual-gated *h*-BN encapsulated mono-, and bilayer $MoSe_2$ samples, using palladium bottom contacts, which remain Ohmic at low-temperatures [**Fig. 1(a)**]. We explored magnetotransport in magnetic fields up to B = 35 T and temperatures down to T = 0.3 K using the NHMFL DC Field facility.

Results and Discussion

We probed the temperature-dependent magnetotransport in both mono- and bilayer $MoSe_2$. From the temperature dependence of the Shubnikov-de Haas (SdH) oscillations amplitude, we extracted an electron effective mass of $0.8m_e$ for both mono- and bilayer samples; m_e is the bare electron mass. **Figure 1(b)** shows R_{xx} vs B data measured at various T values, at constant electron density (n) in a bilayer sample. Similarly to studies in WSe_2 [2], we observe predominantly even or odd filling factors (FFs) depending on the n value, an observation explained by an interaction-enhanced Zeeman splitting with reducing density. A quantitative determination of the effective g-factor (g^*) as function of n is possible using FF sequence parity data, and the spin-polarization field (B_p) [**Fig. 1(c)**]. A comparison between the measured g* for mono- and bilayer $MoSe_2$ samples, and quantum Monte Carlo (QMC) spin susceptibility calculations [3] allows us to determine the band g-factor value, g_b = 2.2.

Conclusions

Magnetotransport studies of mono- and bilayer $MoSe_2$ clarify the LL structure of K-valley electrons in $MoSe_2$, and highlight the role of interactions in this large effective mass 2D system [4].

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References

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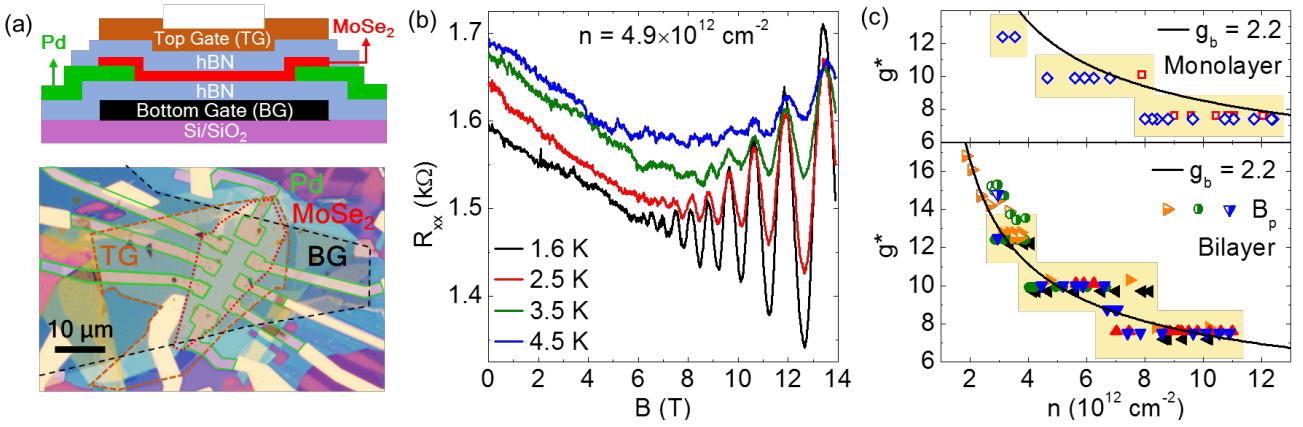

Fig.1 (a) Schematic cross-section and optical micrograph of a dual-gated, hBN-encapsulated $MoSe_2$ device. Outlines of different colors mark the $MoSe_2$ flake (red), Pd contacts (green), top (orange) and bottom (black) graphite gates. (b) R_{xx} vs B measured at various T values in Bilayer $MoSe_2$, and at $n = 4.9\times10^{12}$ cm^{-2}, displaying a reduction in the oscillations' amplitude (ΔR_{xx}) with increasing T. The ΔR_{xx} vs T data are used to extract the effective mass $m^* = 0.8m_e$. (c) g^* vs n in monolayer, (upper panel) and bilayer (lower panel) $MoSe_2$, and fit to the QMC calculations [3] using g_b = 2.2 (solid line). The shaded regions indicate the g^* error bar. Different symbols (symbol orientations) label different samples (cooldowns).