Spin Polarized Transport in Monolayer WSe_2 Quantum Structures

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Challenges associated with obtaining high quality electrical contacts to semiconducting transition metal dichalcogenides have hindered the progress of studying these materials using transport techniques, especially at low temperature and in the low carrier density regime.

Here, we first present a device structure and fabrication method for achieving low resistance ohmic contacts that relies on the independent tunability of the carrier density in the contact regions. We demonstrate that these low resistance ohmic contacts survive at temperatures as low as 10 mK and can successfully be used in transport measurements to probe a channel region down to the low carrier density regime.

We then present transport measurements of a gate-defined 1D channel in monolayer tungsten diselenide (WSe_2) and discuss the origins of an unexpected spin polarization at zero magnetic field.

Next, we report magneto-transport measurements of a WSe_2 heterostructure placed in a perpendicular magnetic field up to 8 T. We discuss the appearance of a Landau fan diagram in which we observe fully spin polarized hole transport at low filling factors all the way down to a filling factor of $\nu = 1$ (Fig. 1). Finally, we discuss the observed behavior of the Landau levels at higher densities, reflecting the spin-orbit coupling effects in monolayer WSe_2.

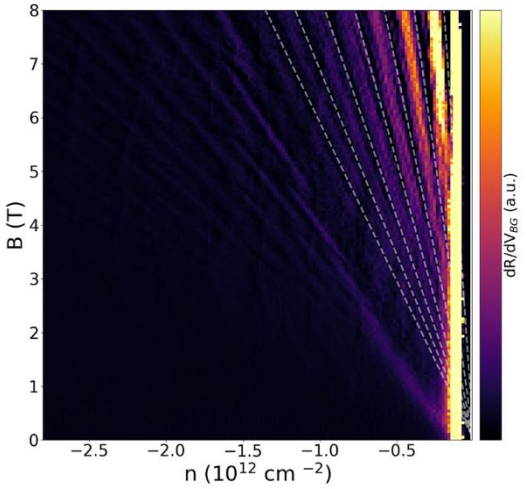

Fig. 1. Differential resistance of a WSe_2 monolayer as a function of magnetic field and carrier density revealing a Landau fan. Dashed lines indicate the first filled Landau level to the sixth.