Fully Spin Polarized Hole Transport at Low Filling Factors in Monolayer WSe_2

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One of the most promising and exciting family of two-dimensional (2D) materials is the semiconducting transition metal dichalcogenides (TMDs) [1]. Due to their 2D nature, charge carriers present in TMDs act as a 2D hole gas (2DHG) where applying a magnetic field leads to the Quantum Hall Effect [2]. Additionally, their lack of inversion symmetry at the monolayer limit and the presence of transition metals leads to opposite spins being locked to opposite valleys, also known as spin-valley locking, a phenomenon that can be leveraged for many quantum technologies [3].

Here, we introduce a device fabrication technique and architecture that enables the realization of low resistance ohmic contacts while maintaining a low carrier density in monolayer WSe2 [4-5]. We then present magnetotransport measurements of this device and discuss the appearance of an unusual Landau fan diagram in which we observe fully spin polarized hole transport at low filling factors all the way to $\nu = 1$. We conclude by showing next generation devices that will allow greater tunability in the quantum Hall regime.

References

[1] K. F. Mak, et al., Phy. Rev. Lett. **105,** 136805 (2010)

[2] R. Pisoni, (2019), Quantum transport in few-layer MoS_2 [PhD thesis]

[3] X. Liu and M. C. Hersam, Nat. Rev. Matter. **4,** 669 (2019)

[4] J. Boddison-Chouinard, et al., npj 2D Mater. Appl. **7,** 50 (2023)

[5] J. Boddison-Chouinard, et al., Appl. Phys. Lett. **119**, 133104 (2021)