Spin/Valley Pumping and Long-Distance Spin Transport in Monolayer TMD semiconductors

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Monolayers of transition metal dichalcogenides (TMD) are ideal semiconductor materials to control both spin and valley degrees of freedom either electrically or optically. Nevertheless, optical excitation mostly generates excitons species with inherently short lifetime and spin/valley relaxation time. In this presentation we will show that we can strongly polarize (up to 75%) the resident electrons in n-doped WSe_2 and WS_2 monolayers by using a circularly polarized continuous wave laser [1]. Then, using a spatially-resolved optical pump-probe experiment (see Figure 1), we measure the lateral transport of spin/valley polarized electrons over very long distances (tens of micrometers) [2]. These results highlight the key role played by the spin-valley locking effect in TMD monolayers on the pumping efficiency and the polarized electron transport.

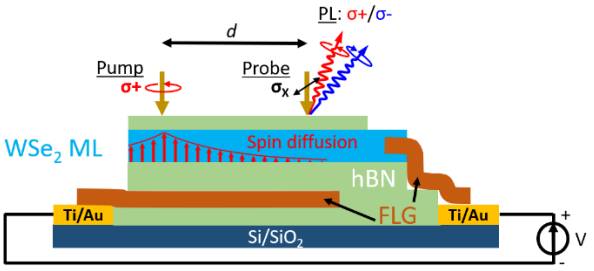

Figure 1: Sketch of a charge tunable WSe_2 ML (not to scale). Two laser spots (pump and probe) separated by a distance d, are focused on the sample. The pump is circularly polarized (σ+) and dynamically polarizes the resident electrons in the K' valley with spin up. This spin/valley polarization diffuses over long distances and is detected by a linearly polarized (σ_X) probe.

[1] C. Robert et al., Nature Communications 12, 5455 (2021).
[2] L. Ren et al., Physical Review Letters 129, 027402 (2022)

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