Spin-valley transport enabled by 2D magnetic materials

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Two-dimensional (2D) magnetic materials have attracted great attention for their magnetic, electrical, and physical properties that can open new paths for the design of nanoscale spintronic and valleytronic devices [1]. Bilayer CrI_3 outstands for its antiferromagnetic ground state with weak interlayer coupling which allows to switch the magnetic ground state by applying an external electric field [2]. In addition, the possibility to interface 2D magnetic materials with other 2D materials such as transition metal dichalcogenides has opened new possibilities for the observation of new and exciting physical phenomena.
We present two proof-of-concept devices, a double split-gate device based on bilayer CrI_3 (Fig. 1a) [3] and a valleytronic device based on $CrBr_3$-encapsulated WSe_2 (Fig. 1b) [4].
We investigate the proposed devices through a multiscale approach, combining ab-initio DFT calculations, maximally localized Wannier functions and non-equilibirum transport calculations. The transport through the devices is solved self-consistently with the electrostatics using the *in-house* NanoTCAD ViDES [5] device simulation code. The first device based on bilayer CrI3 in a double split-gate device which can both filter (> 99%) and select ON/OFF the spin current up to a ratio of ≈ 10^2 (Fig. 1a), while the second device based on $CrBr_3$-encapsulated WSe_2 shows an unprecedented valley splitting of ~ 100 meV, that can be tuned by the relative magnetization of the encapsulating layers (Fig. 1b).

References

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Figures

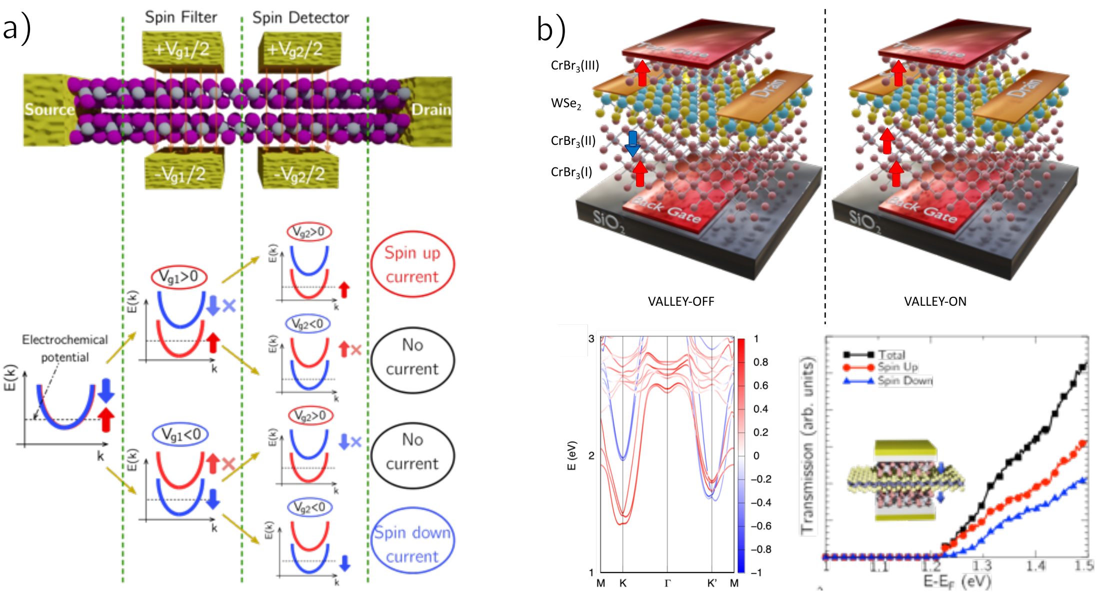

Figure 1: a) Bilayer CrI_3-based device. (Bottom) Pictorial sketch of the spin-polarized conduction band for different V_g. b) Schematics of the valleytronic device, conduction band valley splitting (bottom left) and spin-valley polarized transmission (bottom right).