2D materials for Spin and Valleytronics: Theoretical Perspective

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Abstract

The physics of graphene can be strongly enriched and manipulated by harvesting the large amount of possibilities of proximity effects with magnetic insulators, strong SOC materials (transition metal dichalcogenides-TMDC, topological insulators, etc). Simultaneously, the presence of extra quantum degrees of freedom (sublattice pseudospin, valley isospin) points towards new directions for information processing [1,2], extending the playground to valleytronics, multifunctional electronic devices or even disruptive quantum computing by harnessing all these degrees of freedom in combination with electromagnetic fields or other external fields (strain, chemical functionalization, etc) [3,4].

In this talk, we will present the foundations of spin transport for Dirac fermions propagating in supported graphene devices or interfaced with strong SOC materials. The role of "valley and sublattice pseudospins" in tailoring the spin dephasing and relaxation mechanisms will be explained as well as the impact of strong SOC proximity effects on spin lifetime anisotropy, weak antilocalization and SHE, in the context of recent experiments [4-6].

References

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Figures

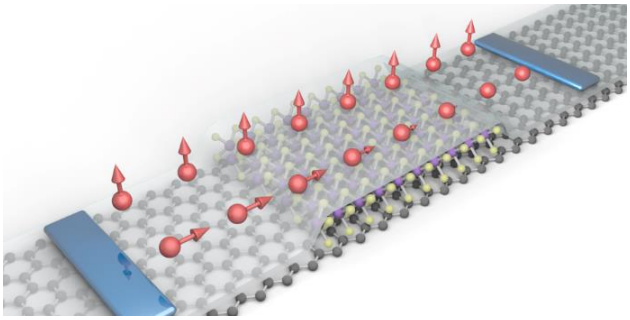

Figure 1: Schematic of spin transport tuning by proximity effect in graphene/TMDC heterostructures

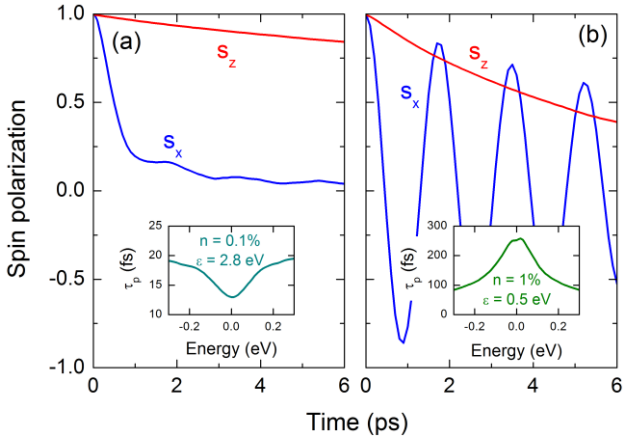

Figure 2: Time dependent spin evolution of wavepackets initially injected with in-plane (Sx)

or out-of-plane (Sz) polarization, and for strong (a) or weak (d) electron-hole puddles disorder