GDR HOWDI 2022 MEETING:
PROXIMITY-INDUCED SPIN-ORBIT PHENOMENA IN GRAPHENE-BASED HETEROSTRUCTURES

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Van der Waals heterostructures consisting on the layered stacking of two-dimensional (2D) materials, enable atomic-scale tunability of electronic properties. They provide great advantages to develop compact hybrid heterostructures, that have led to the emergence of new phenomena not accessible in other platforms [1]. In the field of spintronics, graphene constitutes a promising 2D material because it enables the transport of spin signals over larger distances compared to other systems [2]. However, its low intrinsic spin-orbit coupling prevents spin signal manipulation, which has prevented the fast application of graphene for spintronic devices.

In this talk, I will describe two recent studies performed in graphene-based heterostructures, where we demonstrate that spin signals can be generated and manipulated by means of proximity effects induced by spin-orbit phenomena. In the first part, I will show how the imprinted spin texture in graphene interfaced with a transition metal dichalcogenide give rise to an anisotropic spin relaxation, where the spin lifetime for spins oriented out-of-plane is one order of magnitude larger than those oriented in-plane [3]. In the second part, I will show how such proximity-induced effects can be used to generate spin signals in graphene that can also be controlled by electrical gating with one of the highest efficiencies reported to date at room temperature [4]. These results provide the building blocks for development of ultra-compact devices made of two-dimensional materials.

References

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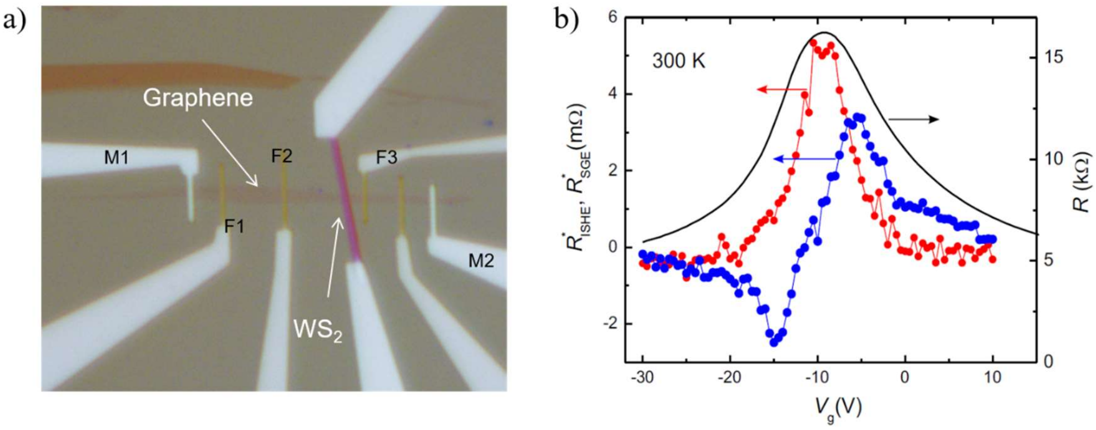

Figure 1: a) Optical micrograph of the graphene/WS_2 heterostructure used for studying anisotropic spin lifetime relaxation in graphene. F1, F2, F3 and M1,M2 are ferromagnetic and metallic contacts respectively. b) Electrical gating dependence of spin signals induced in graphene by proximity effects. Red and blue points display signal amplitudes due to the inverse spin Hall effect (ISHE) and the spin galvanic effect (SGE) respectively. Black line corresponds to the back-gate dependence of the graphene resistance.

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