Spin-valley coupling induce Spin Hall Effect in Graphene/Transition Metal Dichalcogenide heterostructures

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Spintronics, a field which aims at using the electron's spin for ultra-fast low-power electronic devices, has been limited by low spin relaxation times and by the absence of a reliable spin current source. A large spin-to-charge conversion is necessary for obtaining spintronic devices operating at low currents, and it is, therefore, necessary for power efficiency and for departing from charge-based logic and memories. In recent months, we measured a new source of spin current at room temperature, the spin Hall effect in Graphene/MoS2 heterostructure [1]. We expect that the spin Hall effect, combined with other unique phenomena of these heterostructures such as the spin lifetime anisotropy[2], could be used as a platform for solving some of the current spintronics challenges.

In this work, we developed a theory for explaining the spin Hall effect and the Rashba-Edelstein effect[3-4] in Graphene/MoS2 heterostructure. We compare this theory with a fully quantum mechanic calculation of the spin Hall conductivity and of the non-equilibrium spin density, computed through the Kubo Formula in a system consisting of millions of orbitals. We showed that predictions obtained previously can be explained within the framework of a valley-dependent spin Hall effect, which originates from an unique combination of spin-valley coupling and staggered potential present in these heterostructures. The effect of vacancies and other sources of local spin-orbit coupling will be briefly discussed, and perspective for future research will be also presented.

References

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Figures

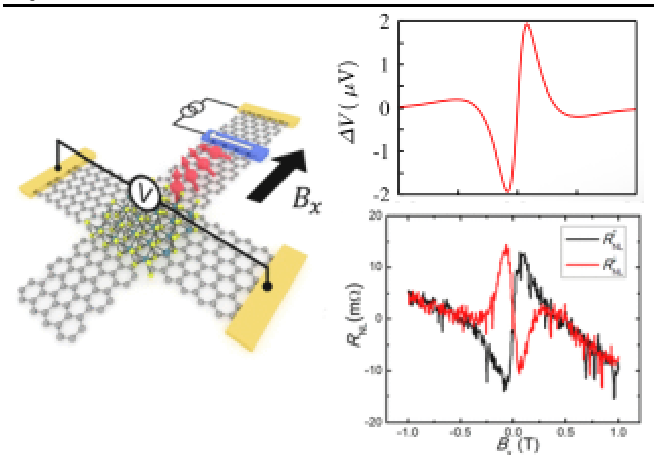

Figure 1: (Left)Experimental setup for measuring the Spin Hall effect. (Right) The predicted (Top) and measured (Botton) signal.