Quantum Colloquium

SPINTRONICS WITH 2D Materials

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The advent of 2D materials has revolutionized solid-state physics and solid-state-based technologies. The principal driving force for the expanding exploration of the 2D realm is the highly efficient control of the physical---mechanical, electrical, optical, magnetic, and spin---properties of atom-thick monolayers and their heterostructures exhibiting relatively weak but impactful van der Waals interactions. Spintronics, which aims at actively exploiting the spin of conduction electrons to introduce novel device concepts such as field-effect spin transistors, tunneling junctions based on magnetoresistance, spin-charge conversion, or spin torques, has made significant strides since the first spin injection experiments in graphene. Indeed, the fundamental aspects of spin physics in monolayers are rather firmly established. The next generation of 2D spintronics, what is the current focus of world-wide research, is based on van der Waals heterostructures, which offer tailor-made design platforms for designing novel spintronics phenomena. The main mechanism by which the electron spin properties are tuned in heterostructures is the proximity effect. For example, we can design a synthetic magnetic graphene by stacking it with a 2D ferromagnetic semiconductor. More than that, the effective magnetic properties of the itinerant electrons in graphene can be tuned by gating, straining, stacking, and twisting such a heterostructure. Similar tailor-made properties are exhibited by graphene stacked with 2D transitional-metal dichalcogenides, in which case graphene electrons acquire strong spin-orbit coupling. Combining ferromagnets and strong spin-orbit materials results in so exsotronic structures, with on-demand swappable spin interactions provided by gating or doping. In this talk, I will review the current stage of 2D spintronics and the directions in which the research in this field is moving, from fundamentals of proximity phenomena to potential applications involving spin-charge conversion and spin-orbit torques.

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Office Bldg West / Ground floor / Heinzel Seminar Room (I21.EG.101)

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