Spin-orbit coupling and magnetic proximity effects in layered heterostructures

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Assembling layered van der Waals heterostructures represents a procedure to engineer systems embedding novel emergent physical properties due to proximity effects. Specifically, graphene in vicinity to semiconducting transition metal dichalcogenides can borrow unique spin-momentum locking near the transition metal dichalcogenide valleys and modify its intrinsic spin-orbit coupling [1]. Applying transverse electric field permits to modify carrier level occupation and introduce a valve effect in bilayer graphene [2]. When building a three-layer stack with a semiconducting layer on top and a magnetic layer on bottom sandwiching bilayer graphene, the time-reversal symmetry is violated at bottom while the top graphene sheet experiences strong spin-orbit coupling. In this way one can build so-called ex-so-tic field effect devices [3]. An interesting class of transition metal dichalcogenides are superconducting atomically thin layers, e.g. 1T-TaS_2, in which the Peierls transition spontaneously breaks periodicity and leads to charge density waves. When graphene is in proximity to single layer 1T-TaS_2 the mutual proximity effects are observed. Graphene borrows strong spin-orbit coupling and depending on stacking it modifies the charge density wave in 1T-TaS_2 [4]. In this talk we discuss density functional theory calculations and effective tight-binding model with relevant spin-orbit coupling parameters describing low energy physics of proximitized graphene.

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