Spin and charge transport in graphene-based van der Waals heterostructures: towards twist and strain engineering of magnetic and topological properties

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Van der Waals (vdW) crystals offer a unique platform for the investigation of a wide range of topological and magnetic states. By stacking various two-dimensional (2D) crystals, one can engineer novel heterostructures that exhibit various proximity effects and emergent magnetic and topological phases. In addition, the spin and charge transport properties of vdW structures can be controlled by electrical gating, mechanical strain, and twist angle between layers.

I will discuss the effect of spin-orbital and magnetic proximity effects on electronic and topological properties of graphene and how they can be tuned by means of external fields, mechanical forces and twist-angle between graphene and other vdW crystals [1-4]. I will focus especially on our recent results obtained for graphene on semiconducting transition metal dichalcogenides and for graphene on CrI3 [4,5]. I will show, among others, that the twist angle leads to an additional component of nonequilibrium spin polarization and valley contrasting effects. Interestingly, we have found a specific twist angle between graphene and CrI3 monolayer that shifts the electronic states of graphene into the energy band gap of CrI3. In addition, by tuning the strain in the system, one can control the topological, magnetic and valley-contrasting transport properties of the structures.

References

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