Fascinating Magnetism and Spin Transport in 2D Materials and van der Waals Heterostructures

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In recent years, the realization of magnetic long-range order in atomically thin 2D materials has shown a big potential in spintronic applications in ultrathin magnets due to the possibility of manipulation of magnetism by external fields, strain or proximity effects in van der Waals heterostructures. Specifically, the family of metallic magnets Fe_nGeTe_2 (n=3, 4, 5) has attracted a huge attention due to their high Curie temperatures and intriguing properties. In this talk, I will review the status of this research field, highlighting our own research by ab initio density functional theory, calculations of interatomic exchange interaction parameters and Monte Carlo simulations. A particular emphasis will be given on the systematic study of the electronic structure and magnetism of Fe_nGeTe_2 magnets[1,2] along with some critical discussions on the importance of electron correlation with the aid of dynamical mean field theory[1], spin-orbit coupling and effects of transition metal doping[3,5]. Finally, some results on the spin-polarized quantum transport will be shown for $PtTe_2/Fe_4GeTe_2/PtTe_2$ van der Waals heterostructures. Moreover, I will present a study of spin transport through a ferromagnetic monolayer of 1T-VSe_2 with two structural polytypes (1T and 2H) of TaS_2 electrodes stacked in van der Waals heterostructures[6]. The 1T-device shows superior performance with lower Gilbert damping, reduced critical current density and voltage for magnetization switching, compared to the 2H-device, which requires significantly higher current and voltage.

References

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