Spin waves engineering in 2D van der Waals materials

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The recent isolation of two-dimensional (2D) magnets offers tantalizing opportunities for spintronics and magnonics at the limit of miniaturization.[1] Among the key advantages of atomically-thin materials are their flexibility, which provides an exciting avenue to control their properties by strain engineering, and the more efficient tuning of their properties with respect to their bulk counterparts. In this presentation we will provide an overview of our recent results on this fascinating topic. First, we will focus on the magnetic properties, magnon dispersion and spin dynamics of the air-stable 2D magnetic semiconductor CrSBr (T_C = 146 K)[2] and will investigate their evolution under mechanical strain and Coulomb screening using first-principles.[3] Our results provide a deep microscopic analysis of the competing interactions that stabilize the long-range ferromagnetic order and the orientation of the spin in the monolayer.[4]
Then, we will apply our approach to some of the derivatives of the family of transition-metal phosphorus trichalcogenides and we will show the possibility of tuning spin wave transport by atomic-layer substitution, building a so-called Janus single-layer.[5] Finally, we will introduce novel hybrid molecular/2D heterostructures using sublimable organic molecules to show, as a proof-of-concept, the potential of a chemical approach for magnon spintronics applications.

References

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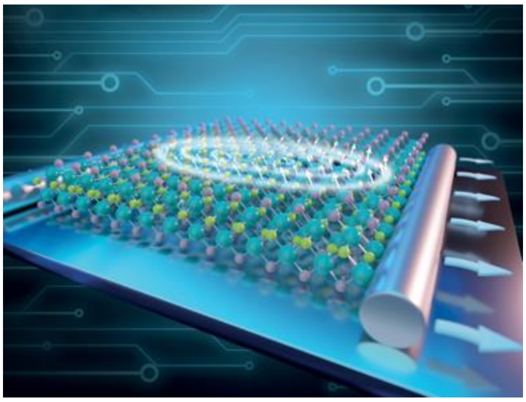
Figures



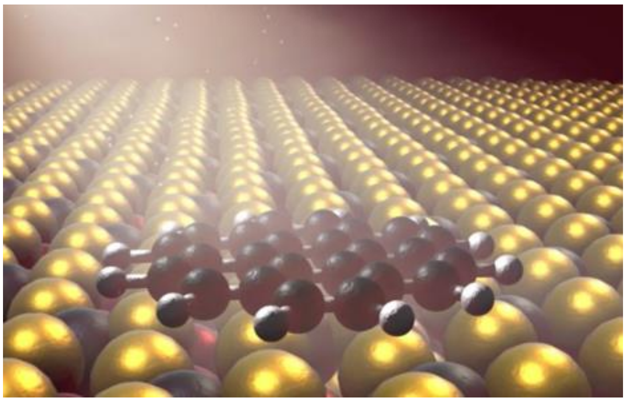


Figure 1: *Artistic representation of (left) strain-engineering of spin waves in single-layer CrSBr and (right) a coronene molecule on the surface of a 2D magnetic material.*