2D Magnetic Materials

Alberto Morpurgo
University of Geneva
Alberto.Morpurgo@unige.ch

In this talk, I will discuss our research on 2D magnetic materials and heterostructures. After a short introduction of the physical systems and of the general questions investigated in this domain of research, I will present results obtained in my group on atomically thin multilayers of different ferromagnetic semiconductors such as CrI3, CrCl3 (layered antiferromagnets), MnPS3 (antiferromagnetic within individual layers), and CrBr3 (ferromagnetic semiconductors). We use atomically thin crystals of these materials to form tunnel barriers and we obtain information from the measurement of their tunneling resistance as a function of temperature and magnetic field. Examples of observed phenomena and of properties that we extract include: i) a giant tunneling magnetoresistance in CrI3; ii) a thorough characterization of the magnetic phase diagram of CrCl3 multilayers; iii) the observation of a spin-flop transition in MnPS3 persisting to the ultimate thickness of an individual monolayer, and iv) the demonstration that the tunneling magnetoresistance of ferromagnetic CrBr3 barriers depends on magnetic field and temperature only through the magnetization (from well above to well below the Curie temperature). A key conclusion drawn from our work is that measurements of the temperature and magnetic field dependence of the tunneling magnetoresistance allow precise information about the magnetic state of atomically thin crystals to be obtained, something impossible to do with most conventional experimental techniques, not sufficiently sensitive when used on such a small amount of material.

References

- Z. Wang et al., Nature Communications 9, 2516 (2018) - Very Large Tunneling Magnetoreistance in Layered Magnetic Semiconductor CrI3
- Z. Wang et al., Nature Nanotechnology 14, 1117 (2019), Determining the phase diagram of atomically thin layered antiferromagnet CrCl3
- M. Gibertini et al., Nature Nanotechnology 14, 408 (2019), Magnetic 2D materials and heterostructures
- L. Thiel et al., Science 364, 973 (2019), Probing magnetism in 2D materials at the nanoscale with single spin microscopy
- G. Long et al., Nano Letters 20, 2452 (2020), Persistence of Magnetism in atomically thin MnPS3 crystals
- Z. Wang et al., arXiv :2106.13930, Magnetization dependent tunneling conductance of ferromagnetic barriers