Spin textures and DMI in 2D magnetic heterostructures

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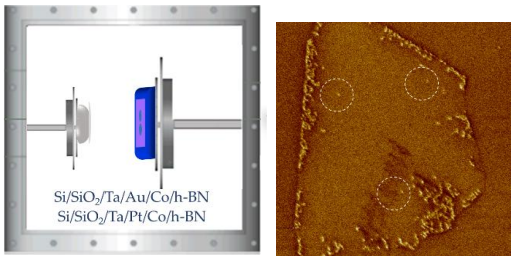
I will show 2 different kinds of systems in which we probe the appearance of the DMI: Co/hBN heterostructures [1] and Fe_xGeTe_2 compounds [2]. I will discuss on a novel fabrication process combining UHV growth and exfoliation to ensure clean interfaces, imaging of magnetic textures and Brillouin Light Scattering experiments for DMI measurements.

In Co/hBN heterostructures, DMI and PMA were measured on series of Co films grown on Pt or Au and covered with hBN or Cu. Clean Co/ hBN interfaces were obtained by exfoliating hBN and transferring it onto the Co film in situ in the ultra-high-vacuum evaporation chamber. By comparing hBN and Cu-covered samples, the DMI induced by the Co/hBN interface was extracted and found to be comparable in strength to that of the Pt/Co interface. The strong DMI despite the weak spin−orbit interaction in hBN supports a Rashba-like origin in agreement with recent theoretical results. Upon combination of it with Pt/Co in Pt/Co/hBN heterostructures, even stronger PMA and DMI are found which stabilizes skyrmions at 300K without magnetic field.

a)



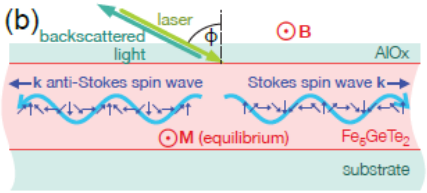
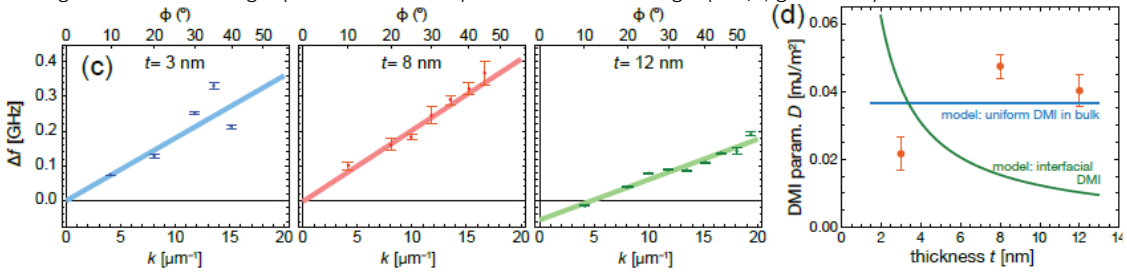


Figure: a) Schematic drawing of the mechanical exfoliation in UHV chamber and magnetic textures in a Pt/Co(1.9 nm)/hBN sample imaged by magnetic force microscopy (MFM) at zero magnetic field. The lateral size of studied hBN flakes on cobalt thin films is around 30 μm, and the thickness around 40 nm– Fe_5GeTe_2 films b) Schematic of the BLS geometry; c) Stokes/Anti-Stokes frequency difference, Δf , versus wave vector k for three films (points taken at B = 211, 250, and 130 mT, respectively); d) Extracted D versus sample thickness t (points) and fits assuming a uniform bulk origin (constant blue line) and an interfacial origin ($\propto$ 1/t, green line).



Among the vdW ferromagnets of interest to spintronics, the Fe_xGeTe_2 family stands out due to their high Curie temperature. In literature, the observation of homo-chiral textures indicates a significant DMI despite the presumed inversion-symmetric crystal structures of Fe_xGeTe_2 incompatible with DMI. Nevertheless, several experimental studies suggest that the actual crystalline structure of Fe_xGeTe_2 may lack inversion symmetry due to Fe split-site ordering, Fe self-intercalation in the van der Waals gaps, ordered Te vacancies, and asymmetric Fe vacancy distribution. To study the possible DMI, we performed BLS measurement in epitaxial Fe_5GeTe_2 films with nominally symmetric interfaces. We measured a significant DMI, with a consistent sign between different films films. The values exhibit a weak variation with thickness indicating a bulk origin for the DMI. Our measurements are consistent with a partial ordering of the Fe split sites during film growth, a mechanism supported by published ab initio calculations showing that such ordering induces DMI.

References [1] Banan El-Kerdi, et al, Nano Letters 8, 3202–3208 (2023)

[2] João Sampaio et al., Nano Lett, 25, 39, 14341–14347 (2025)

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