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Homochiral magnetic structures at surfaces[1]

STEFAN BLUGEL, Institut fur Festkorperforschung, Forschungszentrum Julich, D-52425 Julich, Germany

Electrons propagating in the vicinity of inversion asymmetric environments such as surfaces, interfaces, ultrathin films or nanostructures can give rise to an important antisymmetric exchange interaction, known as Dzyaloshinskii-Moriya (DM) interaction. Although this interaction, favoring spatially rotating spin structures, is in principle known for about 50 years, its consequences for the magnetic structure in low-dimensional magnets remained nearly unexplored and has been basically overlooked the past 20 years. Theoretical models considering isotropic exchange, magnetic anisotropy and the DM interaction display a rich phase diagram of complex magnetic phases on different length scales depending on the strength of the different contributions. Today, it is unknown how large is the strength of the DM interaction. Is this just a small perturbation to the collinear uniaxial ferro- or antiferromagnetic state, determined by exchange and magnetic anisotropy or is it strong enough to create new phases which had been overlooked? Surprisingly little first-principles calculations deal with the DM interaction. There might be several reasons for this: The investigation requires the treatment of non-collinear magnetism together with spin-orbit interactions of large magnetic structures in low-symmetry situations. We developed a perturbative strategy implemented into the FLAPW code `FLEUR` which can cope with this challenge. We show by first- principles calculations based on the vector-spin density formulation of the density- functional theory (DFT) that that there are circumstances whre the DM interaction is indeed sufficiently strong to compete with the interactions that favor collinear spin alignment causing magnetic phases of unique handedness e.g.homochiral magnetic phases such as a left rotation cycloidal spiral in Mn on W(110) [M. Bode *et al.*, Nature **447**, 190 (2007)] or favoring magnetic domain-walls with unique turning sense.

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