Helicity broken magnetic structures on metal surface

Blügel, Stefan[1]

[1] *Institut für Festkörperforschung, Forschungszentrum Jülich, D-52425 Jülich, Germany*

Electrons in the vicinity of magnetic surfaces are in a space asymmetric and time-inversion broken state. This causes a number of interesting phenomena[1-2], which had been little investigated. It bares similarities to semiconductor heterostructures, in which the Rashba spin-orbit effect allows the manipulation of spin-polarized electrons in a two-dimensional electron gas (2DEG) by an electric field. On surfaces this might be a tiny effect. We discuss circumstances under which the zero-field splitting of the surface band structure can be observed by current photoemission experiments. On magnetic metal surfaces an additional exchange splitting separates the zero-field split surface band structure. This permits the disentanglement of the surface magnetic structure[3] from the bulk one. Electrons propagating in the vicinity of the potential asymmetric environments such as of surfaces or interfaces or in ultrathin films or nanostructures can give rise to an important antisymmetric exchange interaction, known as Dzyaloshinsky-Moriya (DM) interaction. Although this interaction, favoring spatially rotating spin structures, is known for nearly 50 years, its consequences for the magnetic structure in low-dimensional magnets remained nearly unexplored. Theoretical models considering isotropic exchange, magnetic anisotropy and the DM interaction display a rich phase diagram of magnetic phases with complex magnetic phases depending on the strength of the different contributions. We show by first-principles calculations[4] based on the vector-spin density formulation of the density-functional theory (DFT) that the DM interaction is indeed sufficiently strong to compete with the interactions that favor collinear spin alignment. We[5] predict new magnetic phases in thin films which had been overlooked during the past 20 years.

[1] Yu. M. Koroteev, *et al.*, Phys. Rev. Lett. **93**, 046403 (2004).

[2] J.I. Pascual, G. Bihlmayer, Yu. M. Koroteev, H.-P. Rust, G. Ceballos, M. Hansmann, K. Horn, E. V. Chulkov, S. Blügel, P. M. Echenique, and Ph. Hofmann, Phys. Rev. Lett. **93**, 196802 (2004).

[3] O. Krupin, G. Bihlmayer, K. Starke, J. E. Prieto, K. Döbrich, S. Blügel, G. Kaindl, Phys. Rev. B. **71**, 201403 (2005).

[4] Ph. Kurz, F. Förster, L. Nordström, G. Bihlmayer, and S. Blügel, Phys. Rev. B **69**, 024415 (2004).

[5] M. Heide, G. Bihlmayer, S. Blügel, unpublished.