MAP-fis Essay Proposal, 2013-2014

(*please write in English*)

Supervisor

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Title

Multiscale studies of magnetic and electric effects in confined multiferroic materials

Area

(*Materials, Optics, Condensed Theory, High Energy Theory,....*);

Materials

Summary of Proposal

The Proposal aims to perform a multiscale experimental and theoretical study of the interplay of magnetic and electric degrees of freedom in materials in confined geometries (surfaces, 1-10 nm range particles and thin layers) and clean UHV conditions. It includes a combination of macroscopic, microscopy and element specific hyperfine local probing studies of Fe as magnetic and Barium Titanate or Rare-earth manganites as ferroelectric counterparts. Particularly, Fe on ferroelectric surface and also graphene-covered surfaces will be locally probed. Ab-initio density functional theory (DFT) combined with temperature dependent studies (statistical Monte-Carlo and complementary thermodynamic mean field and Landau theory methods) will be performed to improve the understanding of atomically specific effects of charge distribution, magnetic moment formation and hyperfine parameters. It is expected that this study can propose ways to improve magneto-electric couplings for the design of materials in device applications

(*continue if necessary*)

References

(*to allow students first look at topic*)

General references on main topic

[1] M. Fiebig, “Revival of the magnetoelectric effect”, Journal of Physics D: Applied Physics, vol. 38, no. 8, p. R123, 2005.

[2] W. Eerenstein, N. Mathur, and J. F. Scott, “Multiferroic and magnetoelectric materials”, Nature,

vol. 442, no. 7104, pp. 759-765, 2006.

[3] R. Ramesh and N. A. Spaldin, “Multiferroics: progress and prospects in thin films”, Nature materials, vol. 6, no. 1, pp. 21-29, 2007.

[4] C. A. Vaz, J. Hoffman, C. H. Ahn, and R. Ramesh, “Magnetoelectric coupling effects in multiferroic complex oxide composite structures,” Advanced Materials, vol. 22, no. 26-27, pp. 2900-2918, 2010.

[5] N. Nagaosa and Y. Tokura, “Emergent electromagnetism in solids,” Physica Scripta, vol. 2012, no. T146, p. 014020, 2012.