O 73: Mini-Symposium: Dzyaloshinskii-Moriya Interaction (DMI) in magnetic layered systems II

Time: Wednesday 13:30–15:30 Location: R3

Invited Talk O 73.1 Wed 13:30 R3

Theoretical insights into Dzyaloshinskii-Moriya interaction in nanostructures based on transition metals, oxides and 2D materials — •Mairbek Chshiev — Univ. Grenoble Alpes, CNRS, CEA, Spintec, Grenoble, France

Spin-orbit coupling (SOC) based phenomena at interfaces comprising ferromagnetic (FM) and nonmagnetic (NM) metals, oxides (O) and/or 2D materials have been of major interest [1,2]. Here we elucidate microscopic mechanisms of Dzyaloshinskii-Moriya interaction at FM/NM [3,4], FM/O [4,5] and FM/2D [6,7] interfaces. In particular, we show that while the DMI at FM/NM interfaces is governed by Fert-Levy model [3], in case of FM/O or FM/graphene interfaces the DMI is mainly due to Rashba SOC [4,6]. In addition, several approaches for DMI enhancement are presented [4] that allowed observation of room temperature skyrmions [5]. Possibility of controlling DMI by voltage (VCDMI) at NM/FM/O [4,8] or by hydrogenation at FM/graphene interfaces [7] are discussed as well. Finally, DMI mechanisms and potential of realizing skyrmion states in 2D magnets are discussed [9,10].

[1] B. Dieny and M. Chshiev, Rev. Mod. Phys. 89, 025008 (2017); [2] S. Roche et al, 2D Materials 2, 030202 (2015); [3] H. X. Yang et al, Phys. Rev. Lett. 115, 267210 (2015); [4] H. X. Yang et al, Sci. Rep. 8, 12356 (2018); [5] O. Boulle et al, Nat. Nanotech. 11, 449 (2016); [6] H. X. Yang et al, Nat. Mater. 17, 605 (2018); [7] B. Yang et al, Phys. Rev. B 101, 014406 (2020); [8] T. Srivastava et al, Nano Lett. 18, 4871 (2018) [9] J. Liang et al, Phys. Rev. B 101, 184401 (2020); [10] T.-E. Park et al, arXiv:1907.01425.

O 73.2 Wed 14:00 R3

Prospecting chiral multi-site interactions in prototypical magnetic systems — •Manuel dos Santos Dias[1], Sascha Brinker[1], and Samir Lounis[1,2] — [1]Peter Grünberg Institut and Institute for Advanced Simulation, Forschungszentrum Jülich and JARA, 52425 Jülich, Germany — [2]Faculty of Physics, University of Duisburg-Essen, 47053 Duisburg, Germany

Atomistic spin models can successfully explain the properties of magnetic materials once the relevant magnetic interactions are identified. Recently, new types of chiral interactions that generalize the Dzyaloshinskii-Moriya interaction have been proposed [1,2,3,4]. Here, we present a systematic construction of a generalized spin model containing isotropic and chiral multi-site interactions, motivated by a microscopic model, and their symmetry properties are established. We show that the chiral interactions arise solely from the spin-orbit interaction and that the multi-site interactions do not have to follow Moriya's rules, unlike the Dzyaloshinskii-Moriya interaction [1,4]. We then report on density functional theory calculations for prototypical magnetic systems, Cr, Mn, Fe and Co trimers and tetrameters on the Re(0001), Pt(001), Pt(111) and Au(111) surfaces. The multi-site interactions are substantial in magnitude and cannot be neglected when comparing the energy of different magnetic configurations.

[1] S. Brinker, M. dos Santos Dias and S. Lounis, New J Phys **21**, 083015 (2019); [2] A. Lászlóffy *et al.*, Phys Rev B **99**, 184430 (2019); [3] S. Grytsiuk *et al.*, Nat Commun **11**, 511 (2020); [4] S. Brinker, M. dos Santos Dias and S. Lounis, Phys Rev Research **2**, 033240 (2020)

O 73.3 Wed 14:20 R3

DMI in intercalated Pt/Co/graphene thin films: localization in reciprocal and real space — Maria Blanco-Rey[1,2], Mikhail Otrokov[3,4,2], Andres Arnau[4,1,2], and •Jorge I. Cerda[5] — [1]Universidad del Pais Vasco UPV/EHU, Spain — [2]Donostia International Physics Center DIPC, Spain — [3]Ikerbasque Foundation, Spain — [4]Centro de Fisica de Materiales CFM, CSIC-UPV/EHU, Spain — [5]Instituto de Ciencia de Materiales de Madrid ICMM, CSIC, Spain

The Dzyaloshinskii-Moriya interaction (DMI) of Pt(111)/Co and Pt(111)/Co/G films (G=graphene), with face-centered tetragonal Co, has been studied by first-principles calculations in two thickness regimes. For ultrathin Co we find that interlayer additivity of the DMI breaks down and the D-vectors acquire a sizable out-of-plane component. For 5ML Co, DMI localizes at the interfaces and is mainly contributed by the Pt/Co interface. Indeed, an spectral analysis in reciprocal space shows the largest DMI contributions at the crossings of highly-dispersive Pt substrate bands with Co-d bands. Interestingly, the Co/vaccum interface chirality, which is the same as in Pt/Co and smaller in energy by only one order of magnitude, is switched by the effect of graphene. We find that, to account for the DMI energy in this system, a model that includes at least second nearest-neighbour lateral Co-Co interactions is needed.

Invited Talk O 73.4 Wed 14:40 R3

Dzyaloshinskii-Moriya Interaction in magnetic layered systems — •Albert Fert — CNRS-Thales, Palaiseau, France

I will be the moderator of the mini-Symposium Dzyaloshinskii-Moriya Interaction (DMI) in magnetic layered systems. The DMIs are generated by the combination of the spin-orbit coupling and the breaking of inversion symmetry by the interfaces of the layered systems. There are related to the Rashba interactions generated by the same conditions. We will discuss the relation between DMI and Rashba in the different situations of metal/metal or metal/oxide interfaces and van der Waals interfaces.