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Hysteresis Design of Magnetic Materials for Efficient Energy Conversion

Tuesday, 12.April 2022, 9:00 s.t., TU Darmstadt, Zoom

Dr. Amalio Fernández-Pacheco

CSIC-Universität Zaragoza,

Institute of Nanoscience & Materials of Aragón,

Spain

New horizons in 3D nanomagnets: how to make them, probe them and exploit them

Abstract:

The expansion of magnetic nanostructures to three dimensions provides exciting opportunities to explore new physical phenomena, opening great prospects to create 3D spintronic devices for future technologies [1]. To fully access to the rich phenomenology predicted to emerge in three dimensions, I will present a new framework developed to 3D print magnetic materials at the nanoscale using focused electron beam induced deposition [2], which gives us unprecedented control to fabricate complex-shaped 3D magnetic structures with sub-100nm resolution. Making use of this tool, in combination with advanced magneto-optical and X-ray magnetic microscopy methods, we are studying the controlled motion of domain walls in 3D magnetic interconnectors, either via external fields [3] or geometrical effects [4]. I will also present recent studies where we have studied the resulting magnetoelectrical signals generated in these 3D devices, where the non-collinear configuration of magnetic states and electrical currents gives rise to abnormal signals different from those found in standard planar devices [5]. Finally, I will dedicate part of the seminar to show our recent works in 3D helical geometries formed by interlaced nanowires, where exchange and dipolar interactions are balanced to result in a very rich phenomenology. The freedom provided to control magnetic effects in this type of 3D geometries can be exploited to form chiral domain walls and topological spin defects at localized regions [6]. Furthermore, helical structures may also form strongly coupled domain wall pairs, which result in complex stray magnetic field configurations with topological features [7].

[1] A. Fernández-Pacheco et al, Nature Comm. 8, 1 (2017).

[2] L. Skoric, Nano Letters 20, 184 (2020).

[3] D. Sanz-Hernández et al, ACS Nano 11, 11066 (2017).

[4] L. Skoric et al, arXiv:2110.04636.

[5] F. Meng et al, ACS Nano 15, 6765 (2021).

[6] D. Sanz-Hernández et al, ACS Nano 14, 8084 (2020).

[7] C. Donnelly et al, Nature Nanotechnol. 17, 136 (2022)

About the speaker:

Amalio Fernández-Pacheco is Group Leader at the Institute of Nanoscience & Materials of Aragón, a mixed centre of the Spanish National Research Council (CSIC) and the University of Zaragoza.

Before this position, he spent a total of 12 years in UK universities. First, working at Imperial College London and the University of Cambridge, within the group of Russell Cowburn. And during the last years at the University of Glasgow, where he was an Associate Professor.

His research is focused on the advanced investigation of three dimensional magnetic nanostructures for applications in spintronics, combining primarily advanced nanofabrication, thin film deposition and magneto-optical and X-ray techniques.

Among his awards, he has been a Marie Curie Fellow, an EPSRC Early Career Fellow and a Winton Advanced Research Fellow. Since October 2021, he leads the ERC Consolidator Project 3D NANOMAG, dedicated to the advanced investigation of novel effects in three dimensional magnetic nanostructures.