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Hysteresis Design of Magnetic Materials for Efficient Energy Conversion

Tuesday, 14 February 2023, 9:00 s.t., TU Darmstadt, via Zoom and in person L2|01 77

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Zoom information:
Meeting-ID: 684 1265 8090
Kenncode: 563527

Curvilinear magnetism: from fundamentals to applications

Abstract:

Extending 2D structures into 3D space has become a general trend in multiple disciplines, including electronics, photonics, plasmonics, superconductivity and magnetism [1,2]. This approach provides means to modify conventional or to launch novel functionalities by tailoring curvature and 3D shape of magnetic thin films and nanowires [2,3]. In this talk, we will address fundamentals of curvature-induced effects in magnetism and review current application scenarios. In particular, we will demonstrate that curvature allows tailoring fundamental anisotropic and chiral magnetic interactions [4] and enables fundamentally new non-local chiral symmetry breaking effect [5]. Application potential of geometrically curved magnetic architectures is currently being explored as mechanically reshapeable magnetic field sensors for automotive applications, memory, spin-wave filters, high-speed racetrack memory devices as well as on-skin interactive electronics relying on thin films [6,7] as well as printed magnetic composites [8,9].

[1] P. Gentile et al., Electronic materials with nanoscale curved geometries. Nature Electronics (Review) 5, 551 (2022).
[2] D. Makarov et al., New Dimension in Magnetism and Superconductivity: 3D and Curvilinear Nanoarchitectures. Advanced Materials (Review) 34, 2101758 (2022).
[3] D. Makarov et al., Curvilinear micromagnetism: from fundamentals to applications (Springer, Zurich, 2022).
[4] O. Volkov et al., Experimental observation of exchange-driven chiral effects in curvilinear magnetism. Physical Review Letters 123, 077201 (2019).
[5] D. D. Sheka et al., Nonlocal chiral symmetry breaking in curvilinear magnetic shells. Communications Physics 3, 128 (2020).
[6] J. Ge et al., A bimodal soft electronic skin for tactile and touchless interaction in real time. Nature Communications 10, 4405 (2019).
[7] G. S. Canon Bermudez et al., Electronic-skin compasses for geomagnetic field driven artificial magnetoception and interactive electronics. Nature Electronics 1, 589 (2018).
[8] M. Ha et al., Printable and Stretchable Giant Magnetoresistive Sensors for Highly Compliant and Skin-Conformal Electronics. Advanced Materials 33, 2005521 (2021).
[9] R. Xu et al., Self-healable printed magnetic field sensors using alternating magnetic fields. Nature Communications 13, 6587 (2022).

About the speaker:

Denys Makarov received his Master Degree (2005) at the National University of Kyiv in Ukraine, followed by a Ph.D. in physics (2008) from the University of Konstanz in Germany. Currently, he is head of department “Intelligent materials and systems” at the Helmholtz-Zentrum Dresden-Rossendorf and leads the Helmholtz Innovation Lab FlexiSens. With his activities, Denys Makarov made a decisive contribution to the development of the field of curvilinear magnetism and stimulated research on spintronics on flexible, bendable and stretchable surfaces. Mechanically flexible and skin-conformal magnetic field sensors enable new application scenarios for human-machine interfaces, eMobility and medicine. These activities are supported via major national and European projects. Denys Makarov is Senior Member of the IEEE and Fellow of the Young Academy of Europe.