Generating different skyrmion types in ferromagnetic/ferrimagnetic bilayers

Loghman Jamilpanah,[1] Artur Braun,[1] Hans Josef Hug,[1,2] and Andrada-Oana Mandru[1]

[1] *Empa, Swiss Federal Laboratories for Materials Science and Technology, Dübendorf CH-8600, Switzerland*

[2] *Department of Physics, University of Basel, Basel CH-4056, Switzerland*

Magnetic skyrmions are particle-like objects with a whirling structure in an otherwise uniform magnetic medium. They have been proposed as bit carriers for computing and memory applications due to their small size and energy efficient movement [1]. However, their implementation requires overcoming some issues, such as maintaining a stable inter-skyrmion distance. For this challenge, using two distinct solitons for encoding the information has been suggested [2]. Recently, the coexistence of two skyrmion types in a ferromagnetic/ferrimagnetic/ferromagnetic trilayer has been demonstrated at room temperature [3], providing the opportunity for real device applications. Tuning the ferromagnetic layer thickness and therefore its magnetic anisotropy results in a fine tunning of the skyrmion type in these trilayers [4]. Here we demonstrate that two skyrmion types can coexist in a simplified system, i.e. a ferromagnetic/ferrimagnetic bilayer. We show that the skyrmion type can be controlled by tuning the magnetic anisotropy of the ferrimagnetic layer. The simpler geometry of the bilayers paves the way for local control of the skyrmion type via, for example, voltage-controlled magnetic anisotropy and opens new directions for 3D devices.

References:

[1] A. Fert, V. Cros, and J. Sampaio, Nat. Nanotechnol. 2013 83 8, 152 (2013).

[2] F. Zheng, F.N. Rybakov, A.B. Borisov, D. Song, S. Wang, Z.A. Li, H. Du, N.S. Kiselev, J. Caron, A. Kovács, M. Tian, Y. Zhang, S. Blügel, and R.E. Dunin-Borkowski, Nat. Nanotechnol. 2018 136 13, 451 (2018).

[3] A.-O. Mandru, O. Yildirim, R. Tomasello, P. Heistracher, M. Penedo, A. Giordano, D. Suess, G. Finocchio, and H.J. Hug, Nat. Commun. 11, 1 (2020).

[4] O. Yildirim, R. Tomasello, Y. Feng, G. Carlotti, S. Tacchi, P.M. Vaghefi, A. Giordano, T. Dutta, G. Finocchio, H.J. Hug, and A.O. Mandru, ACS Appl. Mater. Interfaces 14, 34010 (2022).

The authors acknowledge funding support from Empa internal research call.