



量子物理学・ナノサイエンス第 202 回セミナー

Multiscale study of skyrmions in ultra-thin films

講師 : Professor Bertrand Dupe
Johannes Gutenberg-Universitat Mainz

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概要

Due to their unique topological and dynamic properties, skyrmions in magnetic materials offer attractive perspectives for future spintronic applications [1]. Recently, it has been discovered that magnetic skyrmions of the Neel-type can occur at interfaces [2-4] due to strong Dzyaloshinskii-Moriya (DMI) interactions. We carried out first-principles calculations to study the stabilization mechanism of skyrmions in ultra-thin-film and multilayers [3,5]. We showed that the competition between the Heisenberg exchange beyond first nearest neighbor, the DM, the anisotropy and the Zeeman interactions are crucial to describe equilibrium properties of skyrmions at interfaces. Especially, such competitions may stabilize higher order skyrmionic states [6]. Here, we focus on the effects of these competing interactions on topologically protected excited states. As a test case, we use the simulation parameters corresponding to the Pd(fcc)/Fe/Ir(111) ultrathin film [2,3]. We simulate thermally activated excited states, e.g. skyrmions and antiskyrmions by exploring the B-T phase diagram [7] as well as their respective energy barriers with respect to the ferromagnetic state [8]. We show that competing magnetic interactions may enhance the stability of skyrmionic states. We also study the motion of these states under spin transfer torque [9].

- [1] A. Fert, et al., *Nature Nano.* **8**, 152 (2013).
- [2] N. Romming, et al., *Science* **341**, 636 (2013).
- [3] B. Dupe, et al., *Nature Comm.* **5**, 4030 (2014).
- [4] C. Moreau-Luchaire, et al., *Nature Nano.* **11**, 444 (2016).
- [5] B. Dupe, et al., *Nature Comm.* **7**, 11779 (2016).
- [6] B. Dupe, et al., *New Journal of Physics* **18**, 055015 (2016).
- [7] M. Bottcher, et al., submitted
- [8] S. von Malotki, et al., *Scientific Reports* **7**, 12299 (2017).
- [9] U. Ritzmann, et al., in preparation

連絡教員 物理学系 横山 毅人 (内線 2695)