第５３回トポロジカル物質科学セミナー
Topological Materials Science Seminar (53)

Multiscale study of skyrmions in ultra-thin films

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Abstract:

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].

References

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[8] S. von Malottki, et al., Scientific Reports 7, 12299 (2017).
[9] U. Ritzmann, et al., in preparation

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