

Dynamics of magnetic skyrmions in multiferroics

Masahito Mochizuki^{1,2}

¹Department of Physics and Mathematics, Aoyama Gakuin University, Kanagawa Japan

²Japan Science and Technology Agency, PRESTO, Kawaguchi, Japan
Email:mochizuki@phys.aoyama.ac.jp

Dynamics of magnetic skyrmions under external fields is an issue of vital importance both for fundamental science and technical application. Realization of skyrmions was discovered in an chiral magnetic "insulator" Cu_2OSeO_3 in 2012. Skyrmions in the insulator have turned out to exhibit a multiferroic nature with spin-induced ferroelectricity, and strong magnetoelectric coupling enables us to manipulate them by application of electric fields. We will discuss recent theoretical and experimental studies on multiferroic properties and dynamical magnetoelectric phenomena of the multiferroic skyrmions. The main topics are as follows.

(1) Electromagnons and microwave magnetoelectric effects [1,2,3,4]: In a multiferroic chiral magnet Cu_2OSeO_3 , resonant magnetic excitations are coupled to collective oscillation of electric polarization (so-called electromagnons), and thereby attain simultaneous activity to ac magnetic fields and ac electric fields. Because of interference between these magnetic and electric activation processes, this material hosts gigantic directional dichroism at microwave (gigahertz) frequencies. The absorption intensity of microwave differs by as much as 30%, depending on a sign of the microwave propagation vector.

(2) Creation of skyrmions by local application of electric fields [5]: Magnetoelectric coupling in multiferroic chiral magnets enables us electrical creation of isolated skyrmions on a thin-film specimen by local electric-field application, instead of electric-current injection, via an electrode tip. This method can be traced back to the mutual coupling between skyrmion spins and electric polarizations in multiferroics, and represents a unique technique for use in potential skyrmion-based memory devices without Joule-heating losses.

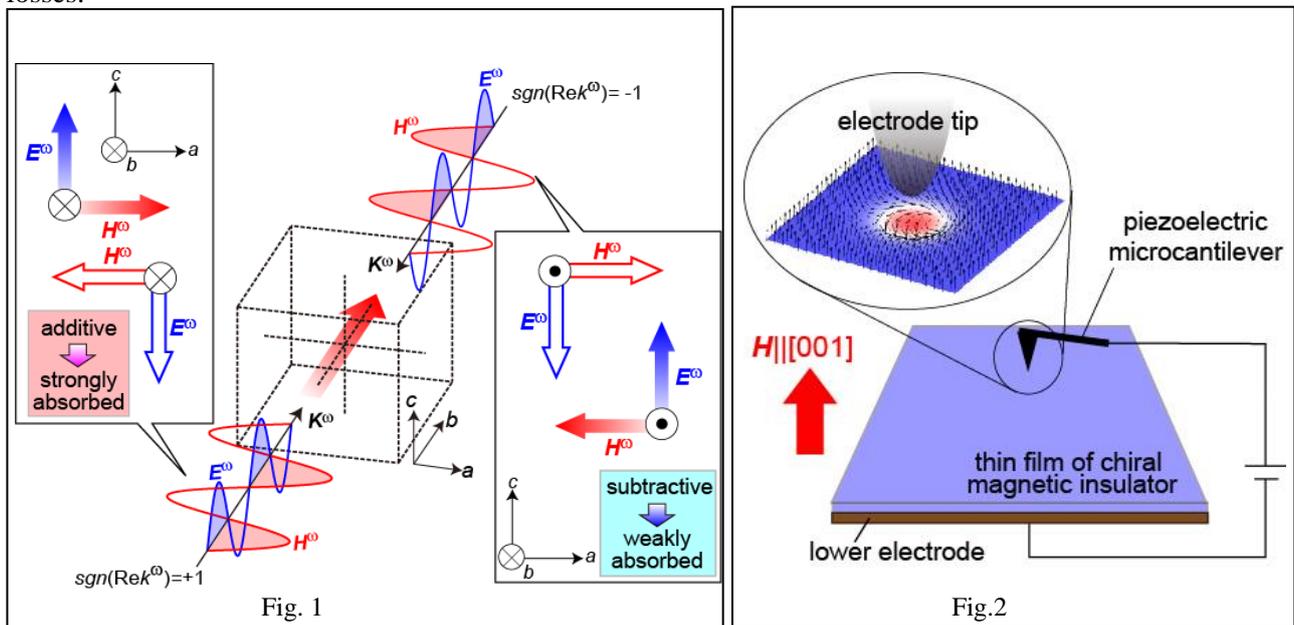


Fig.1. Schematic of microwave directional dichroism effect of chiral insulating magnet.

Fig.2 Schematic of skyrmion creation by local electric-field application on a thin-film sample of chiral multiferroics

1. M. Mochizuki, Phys. Rev. Lett. 108, 017601 (2012).
2. M. Mochizuki, and S. Seki, Physical Review B 87, 134403 (2013).
3. Y. Okamura, M. Mochizuki, et al., Nature Communications 4, 3391 (2013).
4. M. Mochizuki, Phys. Rev. Lett. 114, 197203 (2015).
5. M. Mochizuki and Y. Watanabe, Appl. Phys. Lett. 107, 082409 (2015).

Presentation Method (Invited/Regular Oral/Poster): Invited