

Thermal Hall effect and topological edge modes of magnons

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In electronic systems, various interesting phenomena such as spin Hall effect and topological insulators originate from Berry curvature of Bloch wavefunctions. We theoretically study analogous phenomena for magnons (spin waves). We propose that the dipolar interaction gives rise to nonzero Berry curvature [1-5]. In a thin-film ferromagnet, the Berry curvature is nonzero only when the magnetic field is out-of-plane. This Berry curvature gives rise to thermal Hall effect of magnons, and to a shift of wavepackets in reflection or refraction. Furthermore, in analogy to the quantum Hall effect for electrons, we can design topological magnon band structure. By introducing artificial spatial periodicity into the magnet, for example by fabricating nanostructures with two different magnets in a periodic structure or by making a periodic array of nanomagnets, we theoretically propose emergence of topological edge modes, analogous to those in electronic quantum Hall effect [6-7]. The edge modes are chiral, and propagate along the edge of the magnet in one way. We call this a topological magnonic crystal.

If the time allows, we also discuss our recent results on various Edelstein effects, which can be used for generating angular momenta in crystals without inversion symmetry [8,9].

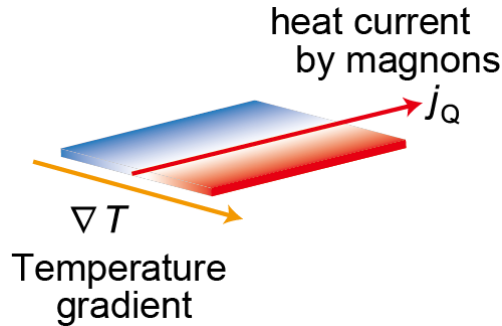


Figure 1 Thermal Hall effect

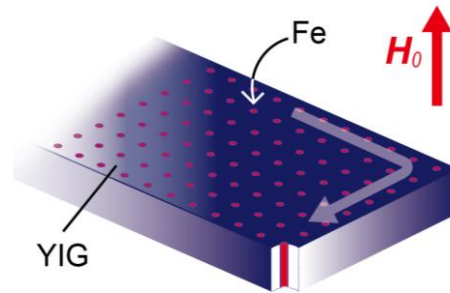


Figure 2 Topological magnonic crystal

- [1] R. Matsumoto, S. Murakami, Phys. Rev. Lett. 106,197202 (2011); Phys. Rev. B 84, 184406 (2011)
- [3] R. Matsumoto, Shindou, S. Murakami, Phys. Rev. Lett. B 89, 054420 (2014)
- [4] S. Murakami, A. Okamoto, J. Phys. Soc. Jpn. 86, 011010 (2017)
- [5] A. Okamoto, S. Murakami, to appear in Phys. Rev. B (2017).
- [6] R. Shindou, R. Matsumoto, J. Ohe, S. Murakami, Phys. Rev. B87, 174427 (2013)
- [7] R. Shindou, J. Ohe, R. Matsumoto, S. Murakami, E. Saitoh, Phys. Rev. B87, 174402 (2013).
- [8] T. Yoda, T. Yokoyama, S. Murakami, Sci. Rep. 5, 12024 (2015); arXiv:1706.07702.
- [9] M. Hamada, E. Minamitani, M. Hirayama, S. Murakami, preprint (2017)

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