量子物理学・ナノサイエンス第 441 回セミナー

Optical renormalization of collective magnetic excitations in quantum materials

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概　要

It has been proposed that magnetic waves in solids, i.e. spin waves or magnons, are promising information carriers for future information technology, enabling the processing of data at THz rates with limited energy dissipations. In this talk, I will briefly discuss how these excitations can be coupled to charges, highlighting recent progress involving processes at terahertz frequencies [1-2].
The main part of the talk will address the optical manipulation of magnons. I will show how resonant excitation of specific magnetic and electronic transitions drives the system into non-equilibrium states in which magnon modes, that are not directly excited, become activated and substantially modified. Two distinct physical scenarios will be discussed. In the first, optical excitation of electronic transitions modifies the magnetic anisotropy in a 20-nm-thick magnetic film, leading not only to the generation of coherent magnons but also to an on-demand frequency renormalization [3]. Both redshifts and blueshifts of the magnon frequency are achieved, reaching up to 40% of its equilibrium value at room temperature. In the second scenario, I will present an approach based on high-momentum magnons with wave vectors near the edges of the Brillouin zone, which can be resonantly driven using mid-infrared laser pulses. This excitation pathway activates distinct zone-center modes whose amplitudes and frequencies are strongly renormalized compared to their equilibrium values [4]. I will conclude by outlining future perspectives of this research direction, with the long-term goal of achieving arbitrary optical control over magnon dispersion relations in quantum materials.

References

[1] T. Mezger *et al*. Physical Review Letters **135**, 076702 (2025).
[2] M. Cimander *et al*. Nature Communications **17**, 1480 (2026).
[3] V. Wiechert *et al*. Nature Communications **17**, 145 (2026).
[4] C. Schoenfeld *et al*. Science Advances **11**, 25 (2025).

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