量子物理学・ナノサイエンス第 419 回セミナー

Nonlinear response of chiral phonons

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概　要

In chiral crystals, characteristic phonon modes reflecting their unique geometry emerge [1]. As a type of chiral phonon, these vibrations exhibit unique properties, such as the coupling of phonon angular momentum and group velocity [2], which are expected to manifest in their optical and transport phenomena. In this seminar, we will present an analysis of the nonlinear response of these unique chiral phonons to terahertz and infrared light, based on nonlinear response theory [3]. Our analysis of the photo-induced phonon angular momentum and current revealed that in chiral crystals, the angular momentum increases in proportion to the square of the relaxation time. This behavior is distinct from conventional resonance phenomena and demonstrates that chiral phonons can produce exceptionally large angular momentum compared to ordinary phonons. We will also show that chiral phonons contribute to the photo-induced Peltier effect through a different mechanism than the one previously proposed [4]. Manifesting this difference in the microscopic mechanism, the resulting energy current exhibits a distinct dependence on the relaxation time. Furthermore, we discovered a generally linear relationship between the generated angular momentum and the energy current. We will discuss these research findings in detail.

[1] J. Kishine, A. S. Ovchinnikov, & A. A. Tereshchenko, Phys. Rev. Lett. **125**, 245302 (2020).
[2] 岸根順一郎, 佐藤琢哉, 固体物理 **59**, 95 (2024).
[3] H. Ishizuka & M. Sato, *preprint* (arXiv:2505.05313).
[4] H. Ishizuka & M. Sato, Phys. Rev. B. **110**, L020303 (2024).

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