Experimentelle Physik 2

Seminar Festkörperphysik (CMP Seminar)

Aktuelle Probleme der Festkörperphysik für Studenten und Mitarbeiter
020236 Kolloquium/Seminar WS 24/25
Vorlesungszeit: 10.10.2024 – 17.04.2025

Thursday, 13.02.2025
12:10 - P1-02-110

Hybrid coherent control of magnons in a ferromagnetic phononic nanoresonator

Alexey Scherbakov

Experimentelle Physik 2, Technische Universität Dortmund, 44227 Dortmund Germany

Quantum dynamical processes are wave phenomena and, thus, are subject to interference. This fact forms a basis for coherent control - a method to manipulate quantum dynamics using temporally profiled optical excitation [1]. The most common approach is the excitation of a quantum system by a pair of laser pulses, whose relative delay determines the responses' phase relation and sets their constructive or destructive interference. One can also exploit another type of excitation and more complex profiling, but the interfering responses of a quantum system are traditionally induced by the excitations of the same origin. In the present work [2], we suggest an alternative scheme, in which coherent control of magnons in a ferromagnetic phononic nanoresonator involves their responses on the excitations of different types.

In the experiment, we watched the coherent response of the magnetic system of a metallic ferromagnetic nanograting to ultrafast optical excitation. A femtosecond laser pulse excites the spectrally isolated mode of the discrete magnon spectrum and simultaneously triggers its quasi-harmonic (with a finite lifetime) driving by localized coherent phonons. We control the phase relation of the magnon responses to these two distinct excitations by an external magnetic field and by varying the optical excitation density. As a result, we realize control of the magnon spectrum through their interference: destructive, constructive or its absence, when the magnon responses become orthogonal.

[1] D. Goswami, Optical pulse shaping approaches to coherent control, *Phys. Reports* **374**, 385 (2003).
[2] A. V. Scherbakov, A. D. Carr, T. L. Linnik, S. M. Kukhtaruk, A. D. Armour, A. Nadzeyka, A. W. Rushforth, A. V. Akimov, and M. Bayer, Hybrid coherent control of magnons in a ferromagnetic phononic resonator excited by laser pulses, *Phys. Rev. Research* **6**, L012019 (2024).