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Stuttgarter Physikalisches Kolloquium

Max-Planck-Institut für Festkörperforschung
Fachbereich Physik, Universität Stuttgart

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Hybrid

Login data will be announced by e-mail and on the colloquium webpage.

Dienstag, 23. April 2024 | **16.15 Uhr** | **Lecture Hall 2D5**

Max-Planck-Institut für Festkörperforschung, Heisenbergstraße 1, 70569 Stuttgart-Büsnau

Shaken, not stirred: phonon-driven ultrafast switching of order parameters

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Abstract

Vibrations of the crystal lattice have a significant impact on the orbital dynamics of the electrons, and through it, also on spins. Recently, ultrafast optical techniques have provided new insights into the spin-lattice coupling including angular momentum transfer from magnetization to phonons [1,2]. It should therefore be possible to realize the opposite process, by driving the lattice and thus controlling the magnetization, on the same (femtosecond) time scale.

Here I will show how the resonant excitation of circularly-polarized optical phonons in paramagnetic substrates can permanently reverse the magnetic state of the overlayer [3]. With the handedness of the phonons steering the direction of switching, such effect offers a selective and potentially universal method for ultrafast non-local control over magnetic order.

Moreover, a different behaviour, characterized by displacive modification of crystal potentials, is driven by linearly-polarized excitation. The magnetic switching was shown to create very peculiar quadrupolar spatial patterns [4], confirming the mechanism. The mechanism appears to be very universal, as observed in variety of systems [5]. The dynamics of the domain formation was shown to proceed via a strongly inhomogeneous magnetic state resulting in a self-organization of magnon-polarons [6] and formation of magneto-elastic solitons.

1. C. Dornes et al, Nature **565**, 209 (2019).
2. S.R. Tauchert et al, Nature **602**, 73 (2022).
3. C.S. Davies et al, Nature, in press (2024); arXiv:2305.11551.
4. A. Stupakiewicz et al, Nature Phys. **17**, 489 (2021).
5. M. Kwaaitaal et al, Nature Phot., in press (2024); arXiv:2305.11714.
6. M. Gidding et al, Nature Commun. **14**, 2208 (2023).