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Magnetophononics: ultrafast spin control through the lattice

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The interplay of the electronic and crystal structure determines the functional properties of materials. Consequently, a temporal intervention into this interaction possibly alters existing properties or create transient new ones, which non-existed previously. Here I present: How one can use the selective excitation of phonons, elementary stimuli of the crystal lattice, as a perturbative method to manipulate the magnetic properties of insulators. I will first introduce the general theoretical concept of phonon excitation towards the non-linear regime, also known as non-linear phononics [1], and its possible side effects onto crystal and electronic structure. In the following, I will discuss in detail two studies which utilize this approach in magnetic materials. The first example is the temporal light-induced modulation of the electric polarisation, which creates a magnetization even in materials with no existing spin structure. This transient state of broken space and partiy odd symmetry is multiferroic and comprises unexpected outcomes like a phonon Zeeman effect [2] and magnon excitation [3]. In the second example [4], I show how the phonon excitation and its related structural distortion modulates magnetic exchange interactions. For the specific case of Cr_2O_3 , the right tuning of induced distortions allow modulating the magnetic spin arrangement, which generates a new magnetic state. At the end of my talk will give an outlook and my perspective on future developments in this field.

References

- [1] M. Först, C. Manzoni, S. Kaiser, Y. Tomioka, Y. Tokura, R. Merlin, and A. Cavalleri, *Nature Phys.* 7, 854 (2011).
- [2] D. M. Juraschek, M. Fechner, A. V. Balatsky, and N. A. Spaldin, *Phys. Rev. Mat.* 1, 014401 (2017).
- [3] T. F. Nova, A. Cartella, A. Cantaluppi, M. Först, D. Bossini, R. V. Mikhaylovskiy, A. V. Kimel, R. Merlin, and A. Cavalleri, *Nature Phys.* 13, 132 (2016).
- [4] M. Fechner, A. Sukhov, L. Chotorlishvili, C. Kenel, J. Berakdar, and N. A. Spaldin, arXiv: 1707.03216, (2017).

Für diese Zeit steht eine Kinderbetreuung nach vorheriger Anmeldung zur Verfügung.

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