Experimentelle Physik 2

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Picosecond acoustics in VO_2, a material with an ultrafast insulator-metal transition

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In this talk, based on my PhD thesis, I will show you how we can use ultrafast laser-induced first-order phase transitions (PTs) in a field of picosecond acoustics. In picosecond acoustics, short sub-THz strain pulses with amplitudes up to 10^-3 are optically generated and used to detect and control various properties of solids on a nanometer scale. VO2 has been selected as an archetypical material with a first-order PT resulting in a band gap collapse and a change of lattice constants on a sub-picosecond timescale.

We have experimentally realized two key ideas. First, we used a large and sudden lattice change during the PT to generate high-amplitude picosecond strain pulses with low overall heating of the sample [1]. Second, we injected a picosecond acoustic pulse in VO_2 during the PT to control its transformation by timing the arrival of the strain pulse relative to the PT trigger [2]. These findings allow picosecond acoustics to be used in novel ways.

[1] Ia. A. Mogunov et al., Large non-thermal contribution to picosecond strain pulse generation using the photo-induced phase transition in VO_2. *Nat Commun* **11**, 1690 (2020).

[2] Ia. A. Mogunov et al., Ultrafast insulator-metal transition in VO_2 nanostructures assisted by picosecond strain pulses. *Phys. Rev. Appl.* **11**, 014054 (2019).