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Coherent optical control and nonlinear probing of strongly correlated materials

Mid-infrared optical pulses can resonantly drive selected vibrational modes in solids to deform their crystal structure [1, 2]. In strongly correlated materials, this method has been used to melt electronic and magnetic order, drive insulator-to-metal transitions, and transiently induce superconductivity [3, 4]. Free Electron Lasers have been key in identifying the lattice dynamics underlying these transitions.
In this lecture, I will first review nonlinear phononics and discuss its role in the phenomenon of light-induced superconductivity [5, 6, 7]. I will then present recent studies, in which resonant lattice excitation was used to control the polarization of ferroelectric materials on femtosecond timescales [8]. These studies are a first step toward ultrafast reversible switching. In the last part of the lecture, I will focus on highly nonlinear lattice dynamics and the applications of X-ray Free Electron Lasers in future research projects.

References:

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