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Theory of ultrafast dynamics in superconductors

Understanding the collective motion of electrons in solids and their interplay with lattice vibrations is a central goal of condensed matter physics. Time-domain spectroscopies with tailored laser pulses offer novel ways to manipulate emergent ordering phenomena in superconductors or charge-density waves. Here I will show recent progress in the theoretical description of ultrafast dynamics in superconductors. I will discuss collective Higgs modes that can be excited in optically pumped electron-phonon superconductors [1]. Motivated by experiments that control electrons via resonant driving of the crystal lattice, I will then show how light-enhanced superconductivity plays out in the time domain [2]. Finally, I will show how lasers can control competing superconducting and charge-density wave states [3].

[1] A. F. Kemper et al., Phys. Rev. B 92, 224517 (2015).

[2] M. A. Sentef et al., Phys. Rev. B 93, 144506 (2016).

[3] M. A. Sentef et al., Phys. Rev. Lett. 118, 087002 (2017).