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Driving superconducting collective modes with THz light pulses

The latest advances in time-resolved spectroscopic techniques, based on the generation of intense THz pulses, have paved intriguing new ways for the investigation of ultrafast collective phenomena in many complex systems. As an example, recent experiments showed the possibility to selectively excite electronic collective modes in broken-symmetry phases of matter, such as amplitude (Higgs) or phase (plasmon) fluctuations of the superconducting order parameter. Despite the great interest and the huge experimental progress, a general framework able to describe THz-driven collective excitations in ultrafast experiments is still lacking. In this talk I will present some recent advances in the theoretical modeling of the superconducting response at THz frequencies, shedding light on microscopic mechanism at the basis of the Higgs mode visibility in conventional superconductors and on the nonlinear excitation of Josephson plasma modes in superconducting cuprates.