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Ultrafast THz spectroscopy of extended systems

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In this presentation, I will discuss the use of THz ultrafast spectroscopy to investigate extended systems. Optical Pump – THz Probe spectroscopy (OPTPs) has been extensively used to investigate the carrier and lattice ultrafast dynamics in bulk and low-dimensional semiconductors and topological matter [1-5]. Free carriers, electron-phonon related phenomena, and low-energy collective oscillations of conduction charges show their fingerprint in the THz spectral range. Moreover, by lying close to the Fermi level, the charge carriers photoexcited by THz waves are closely connected to DC transport. Time domain detection allows the direct observation of the amplitude and phase of the THz pulse that has interacted with the material. From this information, the complex dielectric function of the material or its complex conductivity can be directly obtained, without the need for Kramers-Kronig relations. I will introduce different schemes for the generation and detection of THz pulses, the experimental configurations for measuring the charge-carriers dynamics, and the procedures routinely exploited to retrieve the pump-induced optical conductivity in the frequency domain from the THz fields acquired in the time domain. In this respect, I will go through some technical details that are usually barely mentioned in the literature. I will then give an overview of our recent results concerning the presence of large polaron and exciton in 3D and 2D perovskites, the coupling of native electron doping with far-infrared phonons in Sn-based perovskites and the ultrafast carrier dynamics in the HgPSe₃ layered semiconductor [6-9].

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