Terahertz strong-field interactions with matter in every phase: Electric and magnetic field effects

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Abstract

In recent years it has become routinely possible to generate terahertz pulses with microjoule energies. This has opened up nonlinear THz spectroscopy as a growing subfield. Here I'll review briefly how we generate THz fields through optical excitation of phonon-polariton modes in ferroelectric crystals, then I'll discuss nonlinear responses resulting from THz field driving of electrons, ions and dipoles, magnons, and localized electron spins. Some recent results include THz-induced insulator-to-metal phase transitions and associated structural phase transitions probed by femtosecond x-ray diffraction; THz-induced electroluminescence of quantum dots; two-dimensional THz spectroscopy of molecular rotations in the gas phase, in which the effects of THz superradiance are observed; and 2D THz spectroscopy of magnons, extending modern magnetic resonance into the THz frequency range. New prospects for THz coherent control over molecules and materials will be discussed.

About the Speaker

Keith Nelson is Haslam and Dewey Professor of MIT, he joined the faculty of the MIT Department of Chemistry in 1982 after completing his graduate study at Stanford University in 1981 and postdoctoral research 1981-1982 at UCLA. His interests are in time-resolved spectroscopy of condensed phase dynamical processes and in spectroscopy and coherent control of the elementary excitations that mediate those processes. His research includes optical generation and time-resolved monitoring of coherent phonons, excitons, magnons, and their respective polaritons; generation of strong THz-frequency fields and nonlinear THz spectroscopy; and study of far-from-equilibrium states of matter induced by mechanical and electromagnetic stimuli from millisecond to femtosecond time scales.