Sub-optical-cycle control of light and matter

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Many fundamental and ubiquitous physical phenomena have origin at the ultrafast timescale. The possibility to investigate various primary processes on their intrinsic timescales relies on the generation of ultrashort pulses with widely tunable carrier frequency, from ultraviolet to mid- and far-infrared. These optical waveforms allow the investigation of microscopic light-matter interactions in a wide variety of condensed material systems to unveil the deep origin of their optoelectronic properties.

A novel idea consist in exploiting the optical field itself to control the properties of crystals and nanostructures. With this approach, it becomes possible to access phenomena occurring within a oscillation of light as benchmarked by three experiments: i) optical response of semiconducting nanostructures by impulsively exciting a plasma frequency in mid-infrared range that establishes a plasmonic resonance; ii) quasi-instantaneous localization of electronic wavefunctions in GaAs by non-resonant bias with intense THz radiation; iii) ultrafast electron transport driven by the peak electric field of a single-cycle optical pulses focused on nanostructured gold circuits.