CFEL SCIENCE

SEMINAR

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CFEL-bldg. 99, seminar room II (EG.078)

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Extreme spectroscopies with semiconductors

Spectroscopy with terahertz (THz) fields is rapidly developing into a high precision instrument that is able to characterize and steer quantum processes in semiconductors. Unlike optical photons, weak THz fields induce internal transitions without changing the particle number within the semiconductor's electronic bands. Consequently, THz spectroscopy can directly probe different quasiparticles which optical spectroscopy (that changes the particle number) can probe only indirectly. However, present-day experiments can already utilize few-cycle THz pulses that are extremely strong; field strengths of 100MV/cm are not unheard of.

I will present a theory for such extreme excitations, and show that strong THz fields can create particles by generating optical polarization and electron densities via multiphoton absorption. The analysis explains corresponding experiments producing dynamical Bloch oscillations and high-harmonic generation (HHG). I will also discuss how the coherent interplay of different excitation paths induces strong dependence of the HHG on the carrier envelope phase of the THz pulse.

At the same time, the optical spectroscopy has been pushed to its extreme limits by utilizing the quantum-optical fluctuations of the light in the spectroscopy. This yields the concept of quantum(optical) spectroscopy where specific photon correlations are applied to directly excite the desired quasiparticle. This idea was central in detecting a new quasiparticle – the dropleton – that is a quantized liquid state containing a few electrons and holes confined inside a bubble. Also photon-density memory correlation was identified in a quantum-dot microcavity using quantum spectroscopy. I will shortly discuss the basic ideas of quantum spectroscopy and show how it also extends the THz spectroscopy toward new extremes.

Host: Franz X. Kärtner, CFEL UX seminar