CFEL SCIENCE

SEMINAR

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Topological effects in intense laser-solid interaction

Characteristic of topological condensed matter is the existence of edge modes along which transport is possible in a robust (i.e., “topologically protected”) manner. Via the so-called “bulk-boundary correspondence”, the presence of such topological edge states follows from topological invariants that are commonly defined for bulk. From the strong-field, attosecond physics perspective, several questions arise, for instance: What are the signatures of a topological phase in typical strong-field observables such as high-harmonic spectra? Can we “image” topological matter by all-optical means? Which features come from the bulk, which from the edges? Can we use lasers to make systems topologically nontrivial? Can we steer edge currents and bulk electrons on ultrafast time-scales?

In this talk, after a general introduction, we will first discuss the similarities and differences between strong-field physics with atoms and with solids. We then investigate theoretically how the harmonic emission changes when the illuminated condensed-matter system undergoes a topological phase transition. We start with two-band bulk systems (examples being the Su-Schrieffer-Heeger chain, the Haldane or the Qi-Wu-Zhang models) and derive an explicit equation for the velocity of the laser-driven electrons, including all topological terms that are often swept under the rug by approximations in treatments based on the semi-conductor Bloch equations. We continue with the difference between finite and bulk systems. We find that the presence of topologically protected edge currents in finite systems affect the laser-driven electron dynamics and thus harmonic generation.

Host: Jochen Küpper/ CFEL Molecular and Ultrafast Science Seminar