Ultrafast spectroscopy of molecules and solids with tunable few-optical-cycle light pulses

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The last two decades have witnessed truly spectacular developments in solid-state laser technology, which enable to generate reliably femtosecond pulses with high peak and average power. The combination of nonlinear optical techniques for frequency conversion and spectral broadening and linear techniques for dispersion control has allowed, on the one hand, to broadly tune these pulses, and on the other hand to shorten their duration down to a few cycles of the carrier wavelength, i.e. to the sub-10-fs regime. Such tunable few-optical-cycle pulses constitute an invaluable tool for ultrafast optical spectroscopy, which uses sequences of ultrashort light pulses to interrogate atoms, molecules and solids and to probe the primary light-induced events on the femtosecond timescale.
This series of lectures will provide a basic introduction to the methods for few-optical-cycle pulse generation and to ultrafast spectroscopy techniques and give significant examples of applications. The short course is organized as follows:

Lecture 1: Introduction to ultrafast optical spectroscopy; techniques for the generation of tunable few-optical-cycle pulses based on second and third-order nonlinear effects.

Lecture 2: Ultrafast spectroscopy techniques: from pump-probe to two-dimensional spectroscopy.

Lecture 3: examples of applications to molecules (photosynthetic complexes, visual pigments, DNA...) and solids (metal and semiconductor nanostructures, graphene and other two-dimensional materials).