Multiphoton Absorption Spectroscopy in Gases and Frequency Resolved Cross Correlation in XUV

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For the last decades, with the development of the IR femtosecond laser, number of techniques have emerged in order to fully characterize these specific pulses. We present here a new technique to measure the temporal properies of any source delivering picosecond to femtosecond pulse duration from IR to XUV. This technique is based on a cross-correlation between IR pump pulse and XUV probe pulse. In our particular case, the XUV probe pulse is composed of high harmonics generated from gases. The correlation is made through the interaction of the pump and the probe with a second gas. We observed that the absorption changes in a large spectral area for energies below the ionisation levels of gases when the IR and the XUV overlap and are synchronised. Our explanation is that this phenomenon is linked to a multiphoton transient absorption involving one XUV photon and several IR photons.

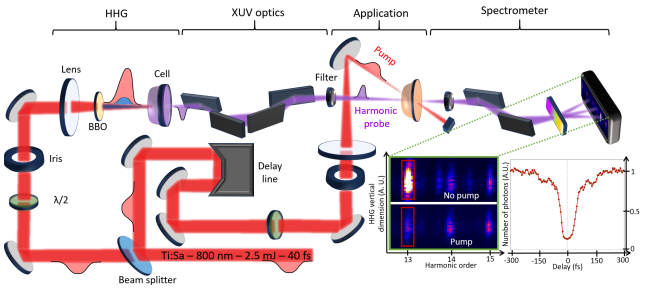

Figure 1: Top view of the IR pump-XUV probe experimental setup. Down left : spectrometer image of probe harmonics on a CCD camera, showing a series of harmonics measured after passing through 25 mbar Ne gas cell and with or without the presence of a 800 nm pump beam. Down right : vertical integration of the signal of the harmonic 13 in function of the delay

The absorption phenomenon therefore results from a coherent superposition of the IR and XUV pulses. Thereby, the interaction should provide temporal information on the longest pulse between the probe and the pump. With our technique, it becomes possible to obtain a cross-correlation trace, which provides the temporal intensity profile and the pulse duration of any XUV sources, as long as these probe pulses are longer than pump pulses. Moreover, these measurements have been made all together with spectra, giving in theory access to phase information using iterative phase-retrieval algorithms. We could be able to fully reconstruct XUV pulses from various picosecond down to a few femtoseconds timescale facilities. This would be vital for applications and especially for the ones using high harmonics and for which the phenomena, to be studied, can be resonant, based on different types of energy edges or related to energy levels to be probed in a system.