Photoionization dynamics probed by attosecond pulses

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With the advance of attosecond techniques, it is now possible to measure the electron dynamics following a photoionization event induced by a short XUV pulse. In this presentation, we describe results regarding both non-resonant and resonant photoionization dynamics in atomic systems. In the first case [1,2], we consider extremely fast dynamics, ~a few 10 attoseconds; the corresponding bandwidth is large, a few eV or tens of eV; in the second case [3,4], the dynamics is typically several femtoseconds; we are discussing resonant features of the order of a fraction of eV.

In 2010, a seminal experiment measured photoionization time delays in Ne using the streaking technique, with a single attosecond pulse and an infrared probe pulse. We here present experimental results on the same atomic system, with an interferometric technique called RABBIT (reconstruction of attosecond bursts by interference of two-photon transition). Our technique, which combines high spectral and temporal resolution allows us to disentangle 2s-ionization from shake up processes leading to ionization of a 2p electron and excitation from 2p to a 3p state. Excellent agreement with theory for the time delay difference between 2s and 2p ionization is obtained.

We will also present experiment results concerning the dynamics of photoionization wavepackets in the vicinity of a Fano resonance, e.g. 2s2p in helium [3,4]. Our phase and amplitude determination using the energy-resolved RABBIT technique allows us to represent the dynamics of the wavepacket using a time-frequency representation (Figure 2).

Figure 1: A-Photoionization time delay difference between electron wavepackets emitted from the 2s and 2p shells in neon. The spectra used are indicated in B. The square is the result from [1]. Adapted from [2]. The solid black curve indicate theoretical calculations.

Figure 2: Time-frequency representation of the electron wave packet emitted in the vicinity of the 2s2p autoionizing resonance in He.

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