# Attosecond electron dynamics near the ionization threshold in Ne

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**Synopsis** Attosecond pulses are suitable tools to unveil the ultrafast behaviour of electrons. We report results for photoionization of neon focusing the attention on the dynamics near the ionization threshold.

In recent years, attosecond spectroscopy has played a central role in exploring the electronic dynamics in atoms and molecules [1].

Electronic processes can be investigated using a two-color photoionization scheme from which it is possible to obtain information on the photoionization time delay (PTD) acquired by the electron undergoing the photoionization process [2].

A technique known as RABBITT (Reconstruction of Attosecond Beating By Interference of Two-photon Transitions) is commonly used to access the PTDs [3]. Photoionization occurs using synchronized XUV (extreme ultraviolet) and IR (infrared) pulses, which are delayed with respect to each other [4].

Usually, the XUV pulses are composed of a frequency comb of odd harmonics with photon energies above the ionization potential (IP) of the target medium. In the present case, one harmonic has a photon energy below the IP of neon, thus leading to excitation of an intermediate bound state before being ionized by absorbing an additional IR photon. The phase of the sideband oscillation generated through this XUV-excitation and IR-ionization process will be compared with the ones associated with the mechanism commonly considered, where both of the harmonics involved bring the electrons immediately to the continuum through direct ionization.

The time delays can be decomposed into a term inherent to the group delay of the different harmonics ($\tau_{GD}$) and an atomic time delay ($\tau_a$). It will be shown that the delay $\tau_a$ determined from one harmonic below and one above the ionization threshold largely deviates from the value expected for sidebands generated only above the threshold. The variation is attributed to excited states of neon that can be effectively populated by the harmonic of the XUV pulse train below the photoionization threshold.

Our experimental findings are supported by three different theoretical approaches: all-electron R-Matrix with Time Dependence (RMT), the single-active electron (SAE) approximation, and perturbation theory (PT).

Figure 1 depicts the experimental and theoretical sideband oscillations (SB) for SB14 (the harmonic 13 is below the ionization threshold of neon) and SB16 (both harmonics 15 and 17 are above the ionization threshold of neon), which are almost out of phase.

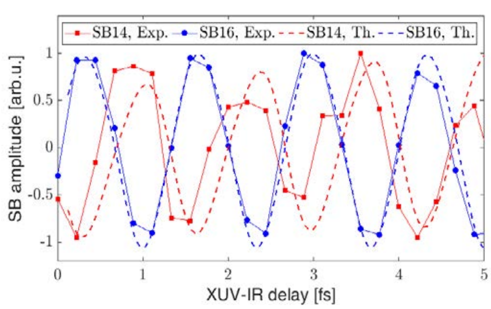


**Figure 1.** Comparison of experimental and theoretical sideband oscillations for the SB14 and SB16 case in neon. Laser pulses centered at 800 nm with duration of 30 fs are used in both cases.

## References

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