Assisted photoemission delays in Argon: current status and perspectives

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Photoionization by attosecond XUV pulses assisted by phase-locked IR laser-probe fields is a widely used experimental scheme to gain temporal information about subfemtosecond pulse structures and atomic dynamics. Recently, such experimental techniques have been applied to the study the delay in photoemission from different initial orbitals in neon [1] and argon [2,3]. Theoretical work has shown that the total atomic delay, τ_A, measured in experiments in which the probe is weak can be approximated as the sum of the one-photon Wigner-like delay, τ_W, plus a universal continuum-continuum delay, τ_{cc}, which is induced by the laser-probe field and the long-range ionic potential, so that $\tau_A = \tau_W + \tau_{cc}$.

We previously showed that electron correlation can change drastically τ_W without affecting τ_{cc} [4]. In this contribution we focus on the calculation of the single photon Wigner delay τ_W, introducing a new *ab initio* method for addressing atom-light interactions [5]. We use a close-coupling ansatz constructed on a multi-configurational Hartree-Fock description of localised states and *B*-spline expansions of the electron radial wave functions. The general many-electron problem is tackled using the ATSP2K libraries [6]. This method is combined with exterior complex scaling, thereby allowing for the computation of the complex partial amplitudes that encode the whole dynamics of the photoionization process.

The figure shows a comparison of various theoretical and experimental data. We discuss the two main effects governing the delays at these energies: the *3s* photoemission Cooper minimum, at ≈ 42 eV in the RPA calculations, and the doubly excited resonances included in our CC2 model. Both contributions arise purely from correlation effects. We discuss the limitations of current theoretical descriptions. Despite the agreement between our calculations and experiment, we show that extra studies have to be performed in order to provide reliable benchmark data that could be used by experimentalists to better understand the processes involved in the observations.

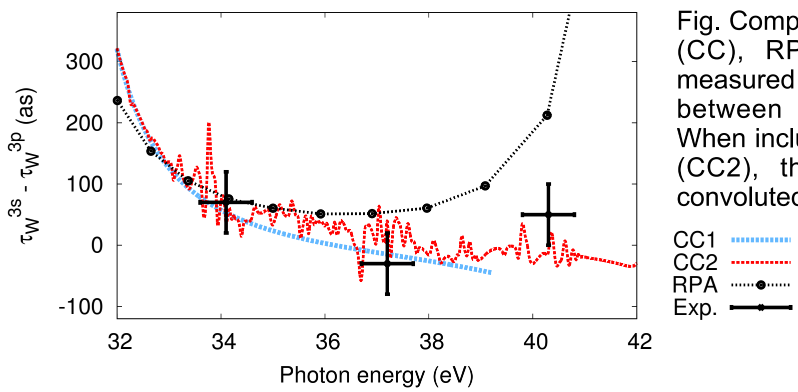

Fig. Comparison of our calculated delays (CC), RPA results of Ref. [3] and measured difference of Wigner delay between *3p* and *3s* photoemission. When including resonances in the model (CC2), the complex amplitudes are convoluted with an IR pulse envelope.

References:

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