Probing double ionisation at the attosecond timescale

D. Guénot[1], E.P. Mansson[1], C.L. Arnold[1], D. Kroon[1], S.L. Sorensen[1], M. Gisselbrecht[1], A. L'Huillier[1], J.M. Dahlström[2], and A.S. Kheifets[3]

[1] *Department of Physics, Lund University, SE-221 00 Lund, Sweden*
[2] *Department of Physics, Stockholm University, Sweden*
[3] *Research School of Physical Sciences, The Australian National University, Canberra ACT 0200, Australia*

Presenting Author: diego.guenot@fysik.lu.se

The development of ultrashort light pulses in the attosecond range allows scientists to explore the dynamics of electron correlation. The single ionization delay has been measured in various atoms using either the streaking technique or an interferometric technique ([1],[2]). Those studies triggered a lot of theoretical activities showing that the IR used to probe the ionized electrons changes their phase and therefore add an additional delay [3].

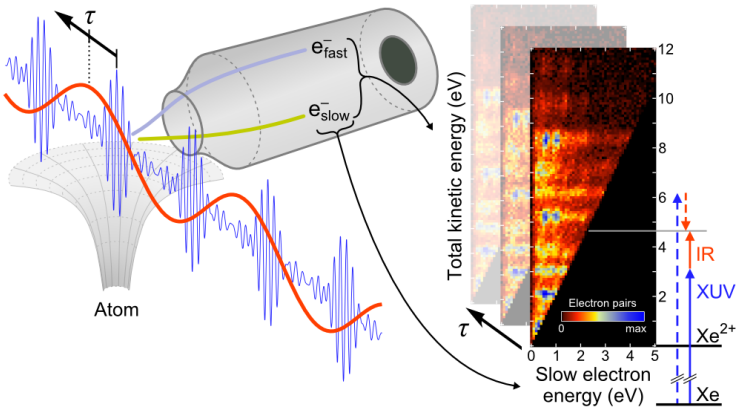

Figure 1: *Principle of the experiment.*

Recently the first time-resolved measurement of double ionization was performed in xenon using an interferometric technique combined with coincidence measurement (see fig.1). We measured a delay between double and single ionization of 55 ± 60 as [4] in excellent agreement with our theoretical calculations. Those calculations aimed at understanding the influence of the IR-field in the case of double ionization in order to extract the one-photon delay. Unfortunately the exact shape of the two electron wave packet in the continuum is not known. In this work we report the calculation of the IR-induced delay in double photo ionization using three different models for the wave function; the two screened coulomb wave function, the Wentzel–Kramers–Brillouin (WKB) wave function and the three coulomb wave function [5]:

$$\Psi^{2C}_{k_1,k_2}(r_1,r_2) = F_1(Z_{eff},k_1)\times F_1(Z_{eff},k_2), \quad (1)$$

$$\Psi^{WKB}_{k_1,k_2}(r_1,r_2) = Pe^{-i\frac{S}{\hbar}}, \quad (2)$$

$$\Psi^{3C}_{k_1,k_2}(r_1,r_2) = F_1(-1,k_1)\times F_1(-1,k_2)\times F_1(+1,k_{12}). \quad (3)$$

With k_1, k_2 the wave vectors of the two electrons, Z_{eff} the effective screening between the electrons, F_1 the coulomb wave function, P the amplitude probability and S the two-electrons action. The results obtained for the three different models are compared and discussed.

References

[1] M. Schultze *et al.*, Science 328, 1658 (2010)
[2] K.Klünder *et al.*, Phys. Rev. Lett. **106**, 143002 (2011)
[3] J. M. Dahlström *et al.*, Phys. Chem. Chem. Phys. **414**, 53 (2013)
[4] E. Mansson *et al.*, Nature physic **292**, 1689 (2013)
[5] D. Guénot *et al.*, in preparation