

Two-photon sequential double ionization of noble gases by circular polarized XUV radiation

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With the advent of free electron lasers (FELs) generating intense short pulses of XUV radiation, studies of sequential multiple ionization with analysis of the photoelectron angular distributions (PADs) and angular correlations became feasible. Experimental results as well as the corresponding theoretical predictions are limited so far to the case of linearly polarized radiation. The present theoretical work, where the PADs and correlations are considered for the sequential two-photon double ionization (2PDI) by circular polarized radiation, is motivated by the recent start-up of FERMI in Trieste (Italy) providing intense XUV pulses of variable polarization. The general statistical tensor approach within the stepwise model of the process developed and applied in [1,2] to the linearly polarized FEL is suitable for arbitrary polarization of the radiation. Similar to the previous studies we concentrate on the double ionization of the outer np^6 shell of the noble gases, Ne, Ar, Kr. In contrast to the case of linearly polarized radiation, the intermediate ionic $np^5\ ^2P_{1/2,3/2}$ states are oriented, not only aligned. The PAD for both, first- and second-step photoelectrons ($i = 1$ and $i = 2$, respectively) are presented as the sum of the Legendre polynomials

$$\frac{d\sigma_i}{d\Omega_i} = \frac{\sigma_i}{4\pi} \left(1 + \sum_{n=1,5} \beta_n^{(i)} P_n(\cos \vartheta_i) \right), \quad (1)$$

where $\beta_n^{(i)}$ are the asymmetry parameters, σ_i is the angle-integrated cross section and the angle of the photoemission ϑ_i is counted from the direction of the FEL beam. Eq. (1) takes into account the first-order nondipole corrections due to the interference between electric dipole (E1) and electric quadrupole (E2) photoionization amplitudes. The influence of the nondipole corrections, represented by terms with $n=\text{odd}$ in Eq. (1), was found less important than in the case of linearly polarized radiation [3].

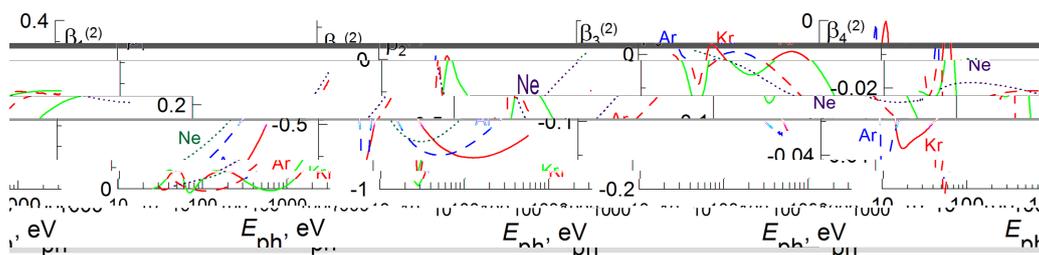


Figure 1: Asymmetry parameters in 2PDI of Ne, Ar and Kr for the $np^4\ ^3P$ term of the residual ion.

Figure 1 shows, as example, the asymmetry parameters $\beta_n^{(2)}$ in sequential 2PDI into the $np^4\ ^3P$ term of the residual ion ($\beta_5^{(2)}$ is small and not shown). Results for other terms of the residual ion, the angular correlation functions between the two photoelectrons and the general discussion will be presented at the conference.

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References

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