Asymmetric photoelectron emission from the krypton 4p shell in the vicinity of 3d resonant excitations

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A left-right asymmetry was observed experimentally for the outer s-shell photoelectrons of noble gases and of the H_2 molecule in our previous studies [1, 2] (see the cited articles for the definition of "left" and "right" as well as for the details of the experimental method). Recently, the angular distribution of $4p$ photoelectrons of Kr was measured with linearly polarized synchrotron radiation in the photon energy range ($90 - 94.4$ eV) of the $3d^{-1} \rightarrow np$ resonant excitations in order to determine the anisotropy parameters [3]. Now, also the left-right asymmetry parameters have been determined from the measured spectra of Ref. [3]. The experiment was performed at beamline BW3 of the DORIS III storage ring at HASYLAB (Hamburg, Germany). The emitted electrons were analyzed using the ESA-22D electrostatic electron spectrometer [4].

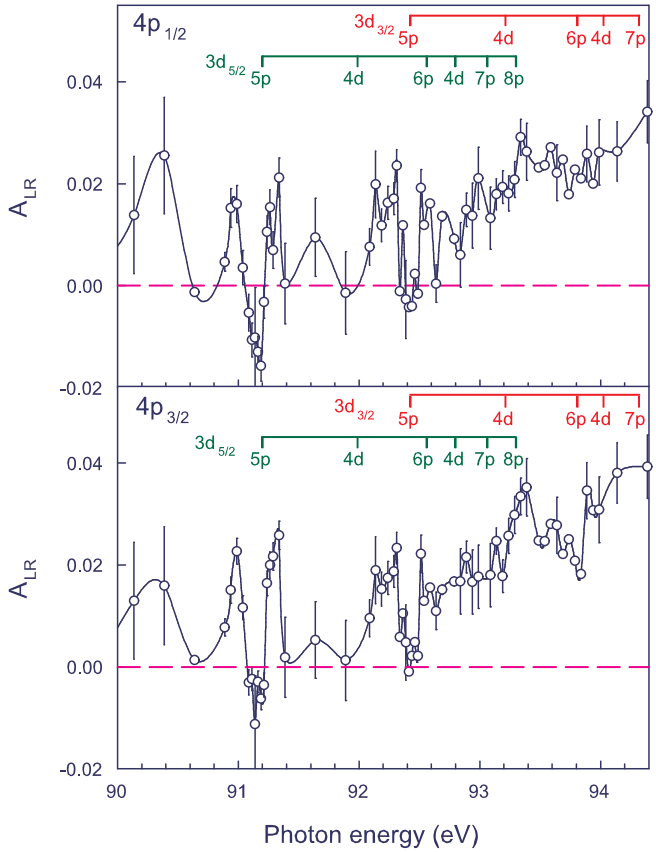

Figure 1: Experimental left-right asymmetry parameters for the Kr $4p_{1/2,3/2}$ photoelectrons (open circles with connecting line). The vertical bars with assignments show the resonance energies. The dashed lines represent the left-right asymmetry parameters predicted by quantum mechanics.

Fig. 1 shows the measured left-right asymmetry parameters (A_{LR}) of the two fine structure components of Kr $4p$ photoelectrons. The experimental data are compatible with zero at low energies.

The asymmetry parameters (A_{LR}) are increasing with increasing photon energies reaching a maximum value of 0.04, definitely different from zero when considering the error bars. Furthermore, the left-right asymmetry parameters oscillate around the $(3d_{3/2,5/2})^{-1} \rightarrow 5p$ resonant excitation for both fine structure components. Currently, we do not know what kind of interaction can produce a left-right asymmetry in photon-atom collisions but the shape of the oscillations shows interference between the unknown and the resonant excitation channels. One of the most important observations is that the sign of A_{LR} changes from positive to negative and then back again to positive just within a narrow photon energy range of only 250 meV around the $(3d_{5/2})^{-1} \rightarrow 5p$ resonant excitation. Within such a narrow range artificial asymmetry of the experimental setup is totally unconceivable.
This work was supported by the NKTH-OTKA (Grant No. K67719), and by the European Community-Access to Research Infrastructure Action of the Improving Human Potential Program. Financial support by DESY is gratefully acknowledged.

References

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