Single photon multiple ionization of atoms and molecules associated with inner-shell excitation

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Synopsis We are studying multiple photoionization of atoms and molecules by synchrotron radiation with a magnetic bottle time-of-flight electron spectrometer and we will present some recent results on Ar, Rb and N_2O.

Single photon multiple ionization of atoms and molecules in which a single photon ejects several electrons is a weak but fundamental process relying on electron correlation. We have studied such multiple ionization processes in atoms and molecules following inner-shell ionization by synchrotron radiation from SOLEIL facility with a magnetic bottle time-of-flight electron spectrometer allowing the coincident detection of up to 4 electrons [1]. Recent results concerning different processes in Ar, N_2O and Rb will be reported.

The high sensitivity of our experiment has enabled a detailed study of the weak decay by emission of three Auger electrons of 2p and 2s holes in Argon. Our results show that the processes are completely different depending on the initial core hole created: the three Auger electrons are emitted dominantly simultaneously for the 2p case, but in cascade for the 2s one [2]. Fig 1 represents an example of energy correlations between the 3 Auger electrons of fixed total energy in the case of the Ar 2p hole decay using a variant of Dalitz plots.

In order to gain resolution on fast Auger electrons we have implemented retardation in our MB-TOF. The efficiency of the method was tested on the N_2O molecule, by resolving each site-specific N $1s^{-1}$ Auger spectra (from the central or terminal N atoms of the N_2O molecule) with higher resolution than in literature [3].

In order to study in details the multiple photoionization of alkali vapors a home-made oven has been used [4,5].

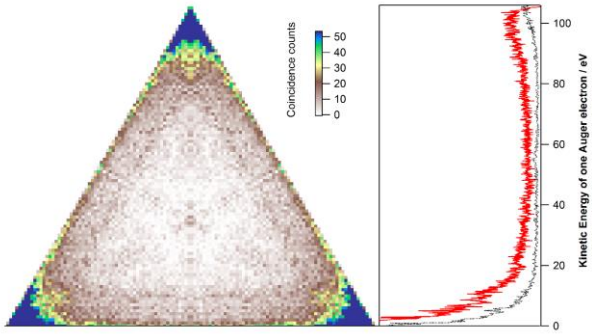

Figure 1. Triple Auger decay of Ar 2p hole. Left shows the Dalitz plot displaying the energy correlation between the three Auger electrons detected in coincidence with the 2p photoelectron, with the constraint that the final Ar^{4+} $3p^{-4}$ level is reached. The spectrum in the right (red) shows the energy of one of these three Auger electrons obtained by projection of the 2-dimensional Dalitz plot perpendicularly to its height.

We observed for instance the spectroscopy of K^{n+} and Rb^{n+} ions (n= 2 to 4), the peculiar Auger decay of the K 3s inner-valence shell and the decay of 3d hole and their satellite states [5].

References

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