Direct measurements of the photoelectrons or Auger electrons associated with inner shell ionization of positively charged ions are extremely difficult and rarely realized. Recently, we presented an alternative method to obtain photoelectron and Auger electron spectroscopy of positively charged ions [1]. It is based on the single photon multi-ionization of the corresponding neutral atom and on coincidence techniques [2]. As a proof of principle, we demonstrated that core-valence double ionization of the Ar atom allows us to deduce the spectroscopy of the 2p holes in an Ar\(^+\) ion. A number of states were observed, reflecting the different possible couplings of the 2p hole with the valence (3p or 3s) hole. These states decay by Auger electron emission and for each of them, the associated lifetime and Auger electron spectra were obtained. Theoretical calculations for the transitions are obtained using multiconfigurational Dirac-Fock (MCDF) formalism. Good agreement was found with our predictions and the theory.

The presented method is expected to lead to important information on the core ionization of singly charged ions, and is expected to be extended to the study of core ionization of doubly charged ions; it will suffice to add a further coincidence degree in order to interpret the already documented core valence triple ionization paths [3]. Direct measurements of photoelectrons and Auger electrons of ionic species will be made more and more possible in the future by free electron laser radiation as a source for multiphoton ionization (see, e.g., Ref. [4]).