Multielectron spectroscopy: triple ionization of atomic potassium

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Synopsis Multielectron coincidence technique is combined with synchrotron radiation to investigate single photon multiple ionization of atomic potassium. Results on the different decay pathways leading to K^{3+} final states are presented.

Few studies on the photoionization of alkali atoms with synchrotron radiation have been reported [1]. This is due to the fact that, despite rare gas atoms, alkali atoms have to be heated at hundreds of degrees to be produced in gas phase. Recently, we developed a homemade resistively heated oven and we implemented it in our spectrometer. This latter consists in a magnetic bottle time of flight spectrometer [2,3] that collects almost all electrons over the 4π solid angle. The detection efficiency of the microchannel plates is estimated within 50-70% and allows the detection, with a high count rate, of up to four electrons in coincidence. Electrons kinetic energy is deduced from the time of flight in the tube and the energy resolution is estimated to $\Delta E/E = 1.5\%$. The experiment was carried out at PLEIADES beamline of the SOLEIL synchrotron facility.

The aim of this work is to study in detail the different decay pathways leading to K^{3+} final states. Three mechanisms are involved: direct triple photoionization (which has a weak contribution), double Auger (DA) decay of inner shell holes and the core valence double photoionization.

In the first part, we present the decay of the $2p_{1/2}$ and the $2p_{3/2}$ holes by a double Auger process as follows:

$$h\nu\ (350\text{eV}) + K \rightarrow K^{+*}(2p^{-1}) + e^-_{\text{photoelectron}} \quad (1)$$
$$K^{+*}(2p^{-1}) \rightarrow K^{3+} + 2\ e^-_{\text{Auger}} \quad (2)$$

Figure 1. Shows the population of the K^{3+} final states following the DA. The dominant configuration is the $3p^{-2}4s^{-1}$ configuration where the 4s valence electron is participator in the decay. Besides, a weaker decay channel populates the $3p^{-3}4s$ configuration which indicates that the valence electron is spectator during the decay process [4].

Another way to populate K^{3+} final states is core-valence double photoionization followed by single Auger:

$$h\nu\ (350\text{eV}) + K \rightarrow K^{2+*}\ (2p^{-1}4s^{-1}) + 2\ e^-_{\text{photoelectron}} \quad (3)$$
$$K^{2+*}\ (2p^{-1}4s^{-1}) \rightarrow K^{3+} + e^-_{\text{Auger}} \quad (4)$$

In this process, the absorption of a single photon leads to the simultaneous emission of two photoelectrons. Subsequently, the K^{2+} excited states decay by emitting an Auger electron.

These results shows the efficiency of the multielectron coincidence technique in unraveling different decay pathways.

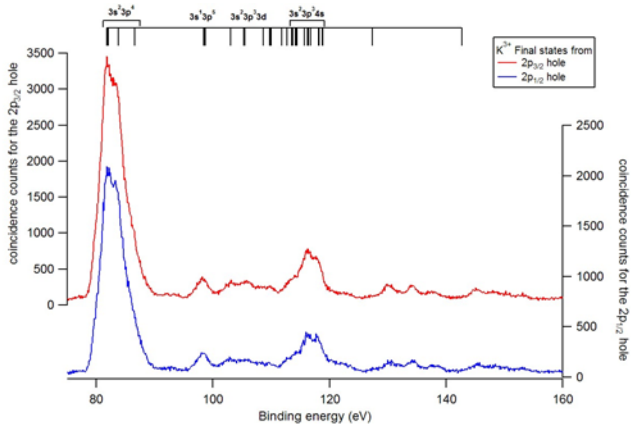

Figure 1. Shows the population of the K^{3+} final states following the DA

References

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