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Auger decay of the $4d^{9}5s^{2}5pnf$ excited states of $\text{Xe}^{5+}$ ion

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Auger decay of the 4d\(^9\)5s\(^2\)5pnf excited states of Xe\(^{5+}\) ion

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Synopsis The Auger decay of the 4d \(\rightarrow\) nf (n = 4 to 6) photoexcitations in Xe\(^{5+}\) ion has been measured using electron spectrometry. MCDF calculations allow to interpret the recorded electron spectra.

Photoionization (PI) of free ionic species is a key process for plasmas modeling. Up to now, laboratory studies on multiply-charged ions were limited mainly to photoabsorption\(^1\) and atomic ions\(^3,4\). Since that time, only the high photon flux available at free electron lasers had demonstrated in the 90’s on singly-charged atomic ions\(^3,4\). The Xe\(^{5+}\) ions were produced in an electron cyclotron resonance ion source (ECRIS). A cylindrical mirror electron analyzer (CMA), with its axis collinear to the ions and SR counter propagating beams, analyzed the kinetic energy of the electrons emitted in coincidence with the Xe\(^{6+}\) ions.

The experiment was performed with the merged-beam setup of the PLEIADES beam line at SOLEIL French SR facility\(^6\). The Xe\(^{5+}\) ions were produced in an electron cyclotron resonance ion source (ECRIS). A cylindrical mirror electron analyzer (CMA), with its axis collinear to the ions and SR counter propagating beams, analyzed the kinetic energy of the electrons emitted in coincidence with the Xe\(^{6+}\) ions.

The Figure 1 shows an example of electron spectrum recorded at the photon energy of the 4d\(^9\)5s\(^2\)5p5f resonance (108.6 eV, upper panel). The Xe\(^{5+}\) ions are produced in an ECRIS in the 5p \(^2\)P\(_{1/2}\) ground level and \(^2\)P\(_{3/2}\) metastable level. At this photon energy, resonances from both levels can be excited. At least four lines are observed and can be identified with the help of multi-configuration Dirac Fock (MCDF) calculations. The calculated electron spectrum (lower panel) is reconstructed assuming a 45% \(^2\)P\(_{1/2}\) and 55% \(^2\)P\(_{3/2}\) population and is convoluted with a Gaussian profile simulating the experimental broadening of the electron lines. All the lines are issued from resonant PI processes of the type:

\[
\begin{align*}
\text{Xe}^{5+} 5p \, 2^2P_{1/2,3/2} + h\nu &\rightarrow \text{Xe}^{5+} 4d^95s^25p5f \\
\text{Xe}^{5+} 4d^95s^25p5f &\rightarrow \text{Xe}^{6+} 5s^21^1S + e^- \\
\text{Xe}^{5+} 4d^95s^25p5f &\rightarrow \text{Xe}^{6+} 5s5p \, 1^1P + e^- 
\end{align*}
\]

The good agreement between experimental and theoretical spectra shows that at this energy mainly Xe\(^{5+}\) ions in the \(^2\)P\(_{3/2}\) metastable level are excited, and that the main decay channel leads with equal intensity to the 5s\(^2\) 1^1S\(_0\) ground level (main line at 44 eV kinetic energy) and to the 5s5p \(^1\)P\(_2\) excited level of Xe\(^{6+}\) ion (satellite line observed at 30 eV).

**Figure 1.** Electron spectrum recorded at 108.6 eV photon energy (top panel) compared to the reconstructed MCDF theoretical spectrum (bottom panel).

**References**


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