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Two Auger Electron Emission Following the Xe 4d Photoionization

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Introduction

When the photon energy is close to the threshold of the inner-shell hole creation, the subsequent Augere decay may be influenced by the photoelectron existing still in the vicinity of the M^+ ion. The Auger peak becomes asymmetric and broadened, and its maximum is shifted to a higher energy. This is called postcollsion interaction (PCI) explained in terms of the interaction between the two outgoing electrons and the ion. Our interest goes here to the much less common but richer process where two Auger electrons are emitted. We chose to study the decay of the 4d hole in xenon atoms:

$h\nu + Xe \rightarrow Xe^+(4d^{-1}) + e^-$

$Xe^+(4d^{-1}) \rightarrow Xe^{3+} + e^-_{Auger1} + e^-_{Auger2}$

The two Auger electrons are emitted either simultaneously (double Auger:DA) or in sequence (cascade Auger:CA).

DA: $Xe^+(4d^{-1}) \rightarrow Xe^{3+}\ {}^4S + e^-_{Auger1} + e^-_{Auger2}$

CA: $Xe^+(4d^{-1}) \rightarrow Xe^{2+} + e^-_{Auger1}$

$\rightarrow Xe^{3+}\ {}^4S + e^-_{Auger1} + e^-_{Auger2}$

It is a four body dissociation as a whole process, in which one can expect a strong electron correlation. In order to gain an insight into the dynamics of this decay, we detect the two Auger electrons in coincidence in the 4d photoionization threshold region where the PCI effect may be enchanced. Following the Xe energy level daigram, the total energy of the two Auger electrons is 5.4 eV for the decay of the Xe^+ of the $4d_{3/2}$ hole to the $Xe^{3+}\ {}^4S$ ground state.

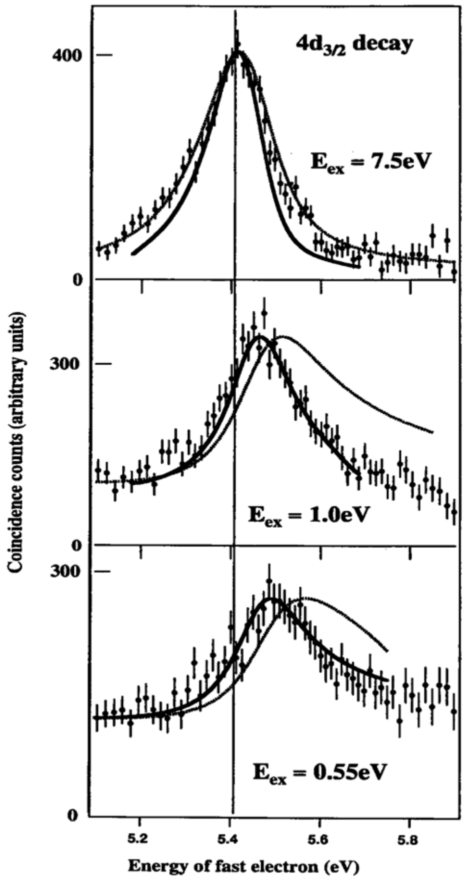
Experiments

In our experimental setting, we have two electron energy analyzers[1]; one is for threshold electrons with practically zero kinetic energy and the other is a hemispherical type analyzer with a position sensitive detector for energetic electrons. The measurements were carried out at BL-16B.

Results and Discussion

Figure 2 shows the electron spectrum measured with the hemispherical analyzer in coincidence with the threshold electron, in the region where the photoelectron energy varies from near zero to 7.5 eV. All spectra reveal PCI effects that shift and broaden the line shapes, this distortion decreasing with increasing excess photon energy.

In case of the DA process, the energy distribution of the two Auger electrons is continuous from 0 to 5.4 eV. However, the distribution will be descrete in the CA process depending on the energy levels Xe^{2+}. Furthermore, two possibilities exist in theCA cprocess; 1) CA1 process where an initial fast electron forms an intermediate state of the Xe^{2+*} ion which decays to Xe^{3+} yielding a zero energy electron, and 2) CA2 process where the initial emission of a zero energy electron forms Xe^{2+*} and its decay to Xe^{3+}, the fast electron. Calculations based on the eikonal aproach for the incoherent contribution of the DA and CA1 processes (shown with broken line), and CA2 process (shown with full line) to the cross section and estimated their role show that CA2 is dominant. The best agreement with experiment was obtained for a width of the intermediate Xe^{2+*} state, Γ, in the range: 45 meV < Γ < 70 meV.



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