# How are threshold electrons produced on the Xe 4dnp resonance?

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## Introduction

Our scientific interest, for several years, has been to elucidate the decay dynamics following photoionization and photoexcitation of innershell electrons using Auger and/or photoelectron spectroscopy in coincidence with threshold electrons.

It is well known that threshold electrons are produced following the 4d→np excitation in Xe. However, the question; which process is responsible for the formation of threshold electron on these resonances, is still unanswered. Heimann et al [1] suggested that the origin of the threshold electrons is shake-off, that is, direct emission of two electrons from decay of the np state. In this case, the two emitted electrons share the available energy and it is probable that one emerges as a threshold electron. On the other hand, Hayaishi et al [2] proposed, based on coincidence measurements between threshold electrons and ions, that a cascade or two-step model can also explain the resonant production of threshold electrons.

Here, we report coincidence measurements between threshold electrons and Auger electrons associated with the decay process Xe* $4d^{-1}np \rightarrow Xe^{2+}\ 5p^{-2}$ and $5s^{-1}5p^{-1}$, which may give an answer to the above question.

## The present experiment

The experiment consists in detecting the threshold electrons and the associated energetic electrons in coincidence [3]. The measurements were made at BL16B of the Photon Factory.

We present, in Fig.1, the Auger electron spectra measured on the Xe* $4d^{-1}$ np (n=6, 7, and 8) resonances in coincidence with threshold photoelectrons, together with the spectrum at the $4d_{5/2}$ threshold showing the energy levels of the $Xe^{2+}\ 5p^{-2}$ state. It can be seen that the Auger peak associated with the $Xe^{2+}\ ^1D$ state is strongly enhanced at the Xe* $4d^{-1}$ 7p resonance.

In Fig.2, the difference in arrival times between Auger and threshold electrons is shown for the different resonance peaks. It is apparent that, on the $4d^{-1}$ 7p-peak, the electrons, which we detect as threshold electrons, are slightly energetic. This indicates that a two-step process is present for the production of pseudo-threshold electrons on the $4d^{-1}$ 7p-peak. First, the $4d^{-1}$ 7p state decays into a $Xe^+$ state, whose binding energy is very close to, but slightly above, the $Xe^{2+}(^1D)$ state and, second, this $Xe^+$ state produces a low energy electron via autoionization into $Xe^{2+}(^1D)$ state. The most plausible candidate for the $Xe^+$ state is the $Xe^+*(5p^{-2}\ (^1S)8p)$ state.

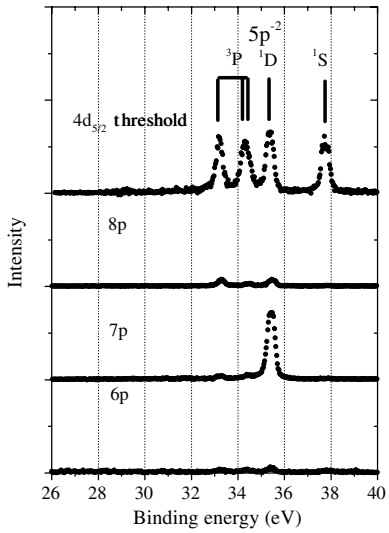


**Figure 1** Auger spectra measured on the Xe$4d^{-1}$np resonances in coincidence with threshold electrons.

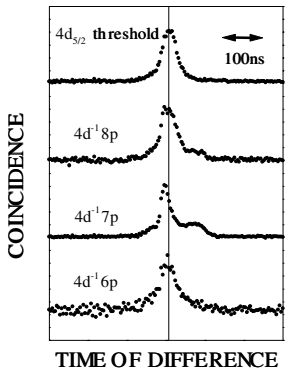


**Figure2.** Coincidence spectra between Auger and threshold electrons at the Xe$4d^{-1}$np resonances.

## References

[1] P. A.Heimann et al., J. Phys. B. **20**, 5005 (1987).
[2] T. Hayaishi et al., J. Phys. B**. 23**, 4431 (1990).
[3] Y. Hikosaka et al., Meas. Sci. Tech. **11**, 1697 (2000).
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