§8. Study of the Excitation Processes in Electron-Ion Collisions

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The understanding of the interaction of electron-ion collision process is important not only for the control and diagnostic of plasma but also for the atomic physics at many atomic processes in high temperature plasma. The research of ionization process in the electron-ion collision have been done for a long time, and the data was offered to the plasma control, the diagnostics of plasma and so on. At present, however, there are few atomic data for the excitation processes of electron-ion collisions, because of its experimental difficulties such as a low signal-to-noise ratio due to a low target ion density and very small cross sections, etc.

We developed the exclusive high-density ion source for the collision experiments. Then, the original tandem type electrostatic energy analyzer was developed at the same time. We fine-tuned the electron energy analyzer using the Auger spectrum at the electron atom collisions.

In figure 1-(a), we show the NOO Auger spectrum in electron-Xe atom collisions. The collision energy is 500eV and the observation angle is 90 degree. These Auger electrons are emitted in following processes,

$$e + Xe \rightarrow Xe^{+*}(4d^9 5s^2 5p^6) + e + e$$
$$\mapsto Xe^{2+}(4d^{10} 5s^2 5p^4) + e_{ej}. \quad \text{Line 12~19}$$

Then, Auger electrons of $N_{4,5}O_{2,3}O_{2,3}$ are dominant. The line 7~11 are peaks of $N_{4,5}O_1O_{2,3}$ Auger processes. In figure 1-(b), the Auger spectrum of B.S.Min et al.[1] (E_e=500eV, θ=70°) is shown. The energy resolution of our spectrum is better than it. From these experiments, we ascertained that our energy analyzer was completed as the design.

In fig. 2, we show the ion beam current dependence of $N_{4,5}O_{2,3}O_{2,3}$ Auger spectrum in electron-Xe collisions within the Xe^+ ion beam. When the Xe^+ ion beam current was 1.0 μA, Auger spectrum peaks were separated respectively. But at 6.0 μA, these Auger spectrum peaks are broading and shifted to the low energy side. These phenomena are attributed to the electric field distribution of the location where Auger electrons are generated. Therefore we can estimate the space charge effect for the Xe^+ ion by analyzing this spectrum. We required canceling out this space charge at the ejected electron spectroscopy in electron-ion collision. Then we are doing the tests of canceling out the space charge at present. One is the direct electron supply method using electron shower and another is the electric field supply method using a tungsten coil. From now on, we will establish the most suitable method of canceling out the ion space charge and try the ejected electron spectroscopy in the electron-ion collisions.

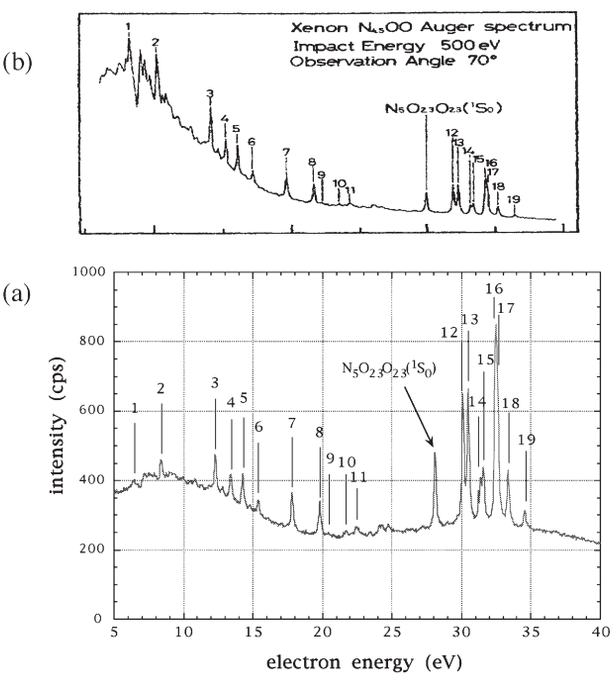

Fig. 1 Xe NOO Auger spectrum.

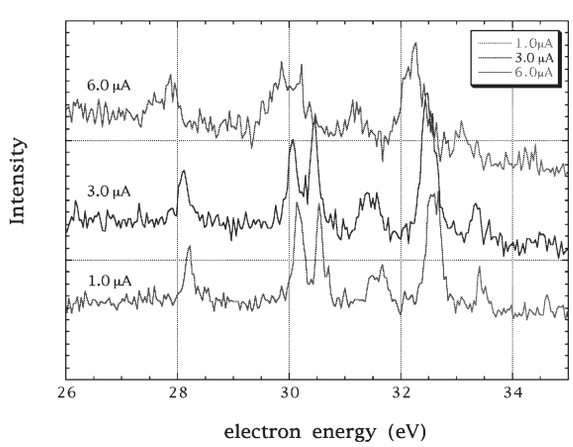

Fig. 2 The peak shift and broadning.

Reference

1)B.S.Min et al., J.P.S.J.64 1183(1993)