## §7. The Study of Excitation Processes of Atomic Ions by Electron Impact

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The understanding of the interaction between electron and ion is very important not only for the control and diagnostic of plasma but also for the atomic physics in 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 a very few data for the excitation processes of electron-ion collisions because of its experimental difficulties mainly due to a low signal-to-noise ratio because of a low target ion density and very small cross sections. In this study, we have developed a high-density ion source for the e-ion collision experiments in order to overcome the experimental difficulties. An original tandem type electrostatic energy analyzer was also developed for this experiments.

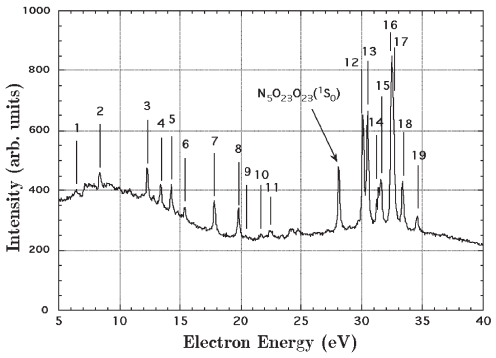


Fig. 1: NOO Auger spectrum of Xe atoms by electron impact. Incident electron energy is 500 eV.

Our ion source can produce very intense singly charged ion beam in the order of $10^{-2} \sim 10^{-3}$ A, which can greatly enhance the signal intensity, but also increase the space charge in the collision volume resulting in the serious problem in the electron spectroscopy. In order to estimate the influence of the space charge by the incident ion beam, we have measured the NOO Auger spectra of Xe atoms by electron impact in the presence of the ion beam at the collision region. Figure 1 shows a typical NOO Auger spectrum of Xe atoms by electron impact ($E_e$ = 500 eV). When a $Kr^+$ ion beam of the current of $10^{-6}$A is incident into the collision region, the increase of the peak width and the shift of the peak position were observed in the electron-impact NOO Auger spectra. Figure 2 shows the dependence of the peak width (FWHM) and the shift of the $N_5O_{23}O_{23}$ ($^1S_0$) on the incident ion beam current. As can be seen from the figure, significant peak broadening was observed even with an ion beam of the $10^{-6}$A current.

In order to compensate the space charge in the collision volume, several attempts have been done, such as a low energy electron shower which can cancel the positive space charge by thermal electrons, and a coil made of a 0.3 mm$\phi$ tungsten wire in the collision volume which can be the source of nearly-zero-energy electrons by incident ion impact. Improvements of the resolution in the Auger spectra (decrease of the space charge in the collision region) have been observed with these very low energy electron sources. The optimization of these electron sources are in progress.

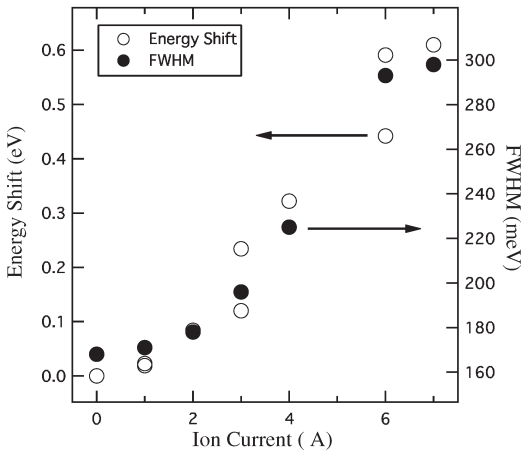


Fig. 2: Shift of the peak positions (open circles) and increase of the peak width (FWHM) (solid circles) in Xe NOO Auger spectrum by electron impact as a function of the $Kr^+$ current incident into the collision region.