§4. Resonant Excitation/Ionization Processes in Electron-Ion Collisions

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The understanding of the interaction between electron and ion is very important not only for the control and diagnostics of plasma but also for the atomic physics in many atomic processes in high temperature plasma. The study of ionization process in the electron-ion collision has been done for a long time, and the data were offered to the plasma control, the diagnostics of the plasma and so on[1]. 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 and an original tandem type electrostatic energy analyzer for the e-ion collision experiments in order to overcome the experimental difficulties.

Our ion source can produce a 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. The influence of the space charge by the incident ion beam was estimated by measuring the Auger electrons to be about 0.1 – 0.3 eV with the ion beam current of a few μA as shown in Fig. 1.

In order to compensate the space charge in the collision region, we are now designing a new high-density electron gun with a circular cathode as shown in Fig. 2. This electron gun can produce a conical low-energy electron beam with a few mA current, which is expected to cancel the space charge at the collision region.

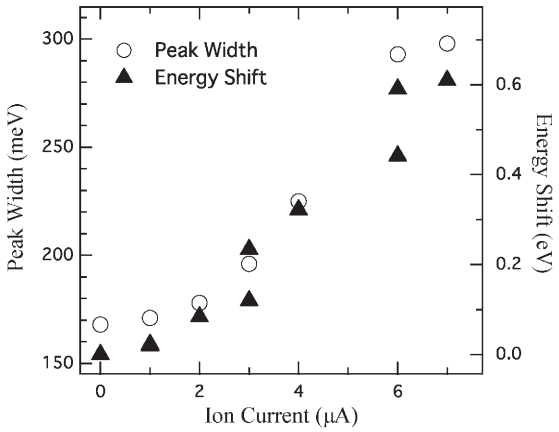

Fig. 1: Peak width (FWHM) (open cirlces) and shift of the peak positions (solid circles) in Xe NOO Auger spectrum by electron impact as a function of the Kr^+ current incident into the collision region.

1) For example, G. H. Dunn, in "Electron Impact Ionization", Edited by T. D. Märk and G. H. Dunn, (Springer Verlag, Wien New York, 1985).

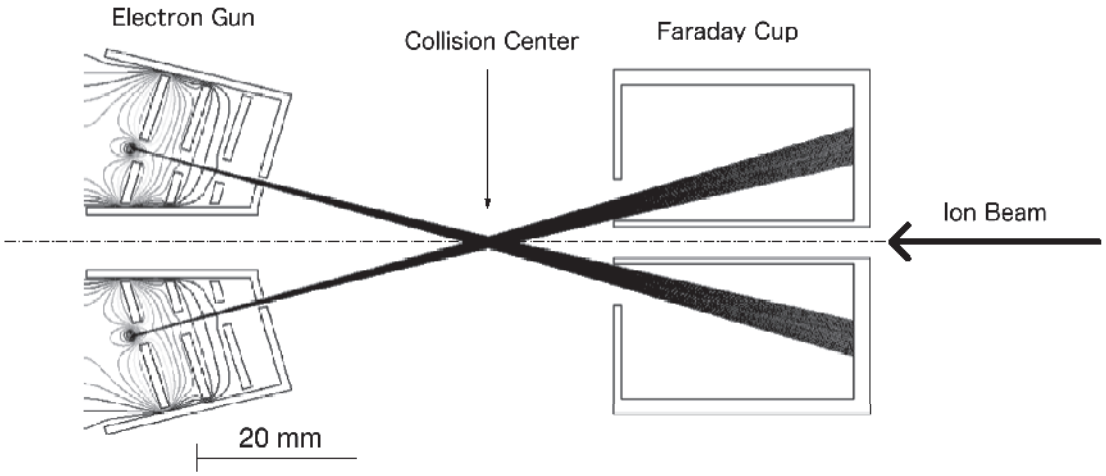

Fig. 2: Schematic of an electron gun, which produce a conical low-energy electron beam with a few mA current. Black lines show the trajectories of the electron beam simulated including the space charge effect. Equipotential lines are also shown inside the electron gun.