2 - 13 Cross-sections of Single & Double Electron Capture in Interaction of Highly Charged Ions with N_2 Gas[1]

Peng Haibo, Zhao Yongtao, Cheng Rui, Wang Yuyu, Zhou Xianming and Sun Yuanbo

Charge transfer from the atom to the ion is induced in collision of highly charged ions and atoms. The study of the charge transfer process has important applications in astrophysics, plasma diagnostic in tokamak, storage ring and electron beam ion trap[1,2].

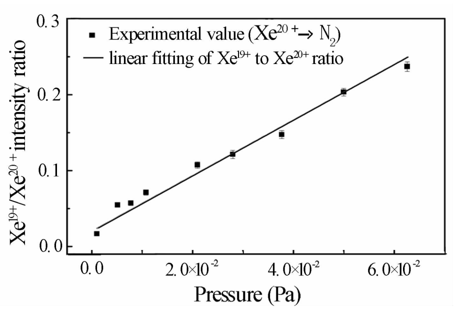

Fig. 1 The ratio of Xe^{19+} to Xe^{20+} is proportional to the pressure in the gas cell.

In this work, the interaction of highly charged Xe ions with N_2 gas was studied. The highly charged Xe^{q+} ions were extracted from 320 kV electron cyclotron resonance (ECR) ion source. Then, the Xe^{20+} ions were selected and accelerated to 1 MeV. The Xe^{20+} ions passed through a gas cell in which the Xe^{20+} ion exchanged charge with nitrogen molecules. The pressure in gas cell, which was adjusted by a leak valve, varied from 1×10^{-3} to 6×10^{-2} Pa. Then ion beam was deflected by a parallel plate, finally the Xe ions with different charge state were detected by a position sensitive detector (PSD). The base pressure in the region between the gas cell and the detector was lower than 1×10^{-4} Pa.

The ratio of $Xe^{19+,18+}$ counts to Xe^{20+} was obtained. The ratio varied with the pressure in the gas cell. The cross section of single and double electron capture cross sections was deduced by fitting the ratio versus the pressure in the gas cell.

Given the number of incident ions is N_i, N_{i-1} and N_{i-2} are number of ions which captured one or two electrons during passing though the gas cell and were detected by the PSD. The single electron capture cross section σ_{i-1} and double electron capture cross section σ_{i-2} is deduced by the following

$$N_{i-1} = N_i \sigma_{i-1} nL \quad (1)$$

$$N_{i-2} = N_i \sigma_{i-2} nL \quad (2)$$

Here n is molecule density in the gas cell. L is effective length of the gas cell which is approximate to 6.9 mm. The ratio of N_{i-1} to N_i should be proportional to the gas density from Eq. (1), which was in good agreement with experimental data shown in Fig. 1. The error bar represents the statistical error.

Table 1 Single and double electron cross sections

	Single capture	Double capture
Cross section	$(1.8\pm0.2)\times10^{-14}$ cm^2	$(2.7\pm0.4)\times10^{-15}$ cm^2

Table 1 shows cross sections of single and double electron capture measured in this study. Concerning to the error bar in the table, we only take the uncertainties of the pressure (10%) and the linear fitting (6%) into account.

References

[1] J. B. Greenwood, et al., The Astrophysical Journal, 529(2000)605.
[2] E. Wells, et al., Physical Review, A77(6)(2008)064701.

1 Supported by the Major State Basic Research Development Program of China and the National Natural Science Foundation of China.