§11. Electron Capture Processes for Highly Charged Ion (HCI) — Alkali Metal Atom Collisions

Sakaue,H.A., Tawara,H., Yamada,I.,Hosaka,K., Nakamura,N., Ohtani, S., Watanabe, H. (Univ. Electro-Communications),
Danjo, A. (Niigata Univ.)
Kimura, M. (Osaka Univ.)
Matsumoto, A. (Hiroshima Inst. Tech.)
Sakurai, M. (Kobe Univ.)
Yoshino, M. (Shibaura Inst. Tech.)

We had already measured the absolute total electron capture cross sections in 1.5q keV I^{q+} (q=6~30)-rare gas atoms (Ne,Ar,Kr and Xe) and molecules (H_2,D_2,N_2,CO,CO_2 and CH_4) collisions. The measurements of total cross sections were carried out by using the initial growth rate method.

We had also proposed following scaling law[1] which is based on the extended classical over-barrier model. It had been found that the scaling law (1) can reproduce well from our experimental data within errors of 20%.

$$\sigma_{total}=2.6\times10^{3}q/P^{2} \quad (\text{Å}^2) \qquad (1)$$

where σ_{total} is the total electron capture cross section, q is the initial charge state of the incident ion and P is the first ionization energy (eV) of target particle.

From this scaling law, it is expected that the total cross sections for alkali metal atom targets will be large in comparison with those of rare gas targets because of low ionization energy.

Here we have measured the total electron capture cross sections in HCI-alkali metal atom collisions to further examine the scaling law: above (1).

In Figure 1, we show the experimental apparatus. HCI (I^{q+}) were produced by electron beam ion source (NICE). The alkali metal atom vapor targets were generated through a thermal oven whose temperature (T) was controlled by a programmable controller within ±0.1 ℃. The targets densities were estimated from knowing the oven temperature measured with thermocouples.

In Figure 2, in addition to our scaling law, the present total electron capture cross sections in I^{q+}-Cs collisions are shown. It is clear that, as the incident ion charge increases, the observed total cross sections increase . But it is noted that there is significant difference between the scaling formula and the present experimental data.

More systematic experiments to measure the cross sections for other alkali metal atom targets (Li,Na,K), are now in progress.

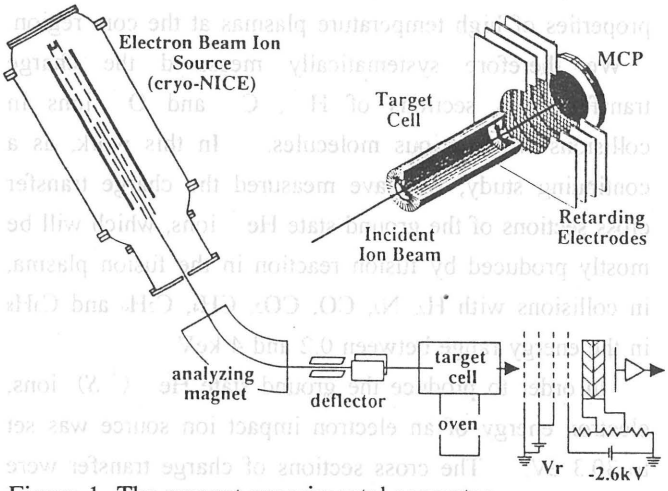

Figure 1. The present experimental apparatus.

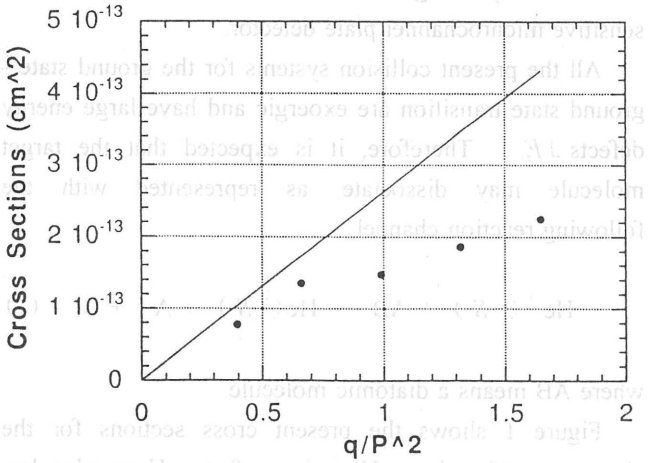

Figure 2. The total electron capture cross sections in I^{q+}-Cs collisions at 1.5q keV. The solid line represents the scaling law (1) and the solid circles the present data.

Reference

1) Kimura, M. et. al. : J. Phys. B 28 (1995) L643.