§12. The Electron Capture Processes in Highly Charged Ion-Metal Atom Collisions

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We had already measured the absolute total electron capture cross sections in highly charged ion-atom and -molecule collisions[1,2] in the following processes.

$$I^{q+} + A \text{ -----> } I^{(q-i)+} + A^{j+} + (j-i)e^-$$

q: 6~30,

A: He,Ne,Ar,Kr,Xe,H_2,N_2,CO,CO_2,CH_4

We had also proposed a scaling law[1] which was characterized by the initial charge state q of projectile ion and the first ionization energy P of target. It was found that the scaling law can reproduce well our experimental data within errors of 15% in ion-rare gas and -simple molecular collisions. 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 energies.

The absolute total electron capture cross sections have been measured by the initial growth-rate method. Highly charged iodine ions produced in an electron beam ion source entered a collision cell after charge selection. The alkali metal atom targets were generated in a thermal oven whose temperature was carefully controlled by programmable controllers. The relative vapor pressure was monitored by a surface ionizer during measurements. The target densities were estimated from the oven temperature.

In Figure, we show the total electron capture cross sections in I^{q+}-Cs,-Rb,-Na and rare gas atom collisions. And the total electron capture cross sections of I^{q+}+Cs collisions calculated by the classical-trajectory Monte Carlo (CTMC) method are also shown.

The observed total cross sections have been found to increase up to ~10^{-13}cm^2 as the projectile ion charge increases. The experimental data of Cs, Rb,Na and rare gas targets are scaled by q/P^2. It is clear that the data of rare gas atom and alkali metal atom targets are not described by the same scaling law.[1] But the data of alkali metal atoms agree with the calculated value using the CTMC method.

The experiments to measure the cross sections for excited state targets of alkali metal atom using the diode laser are now in progress.

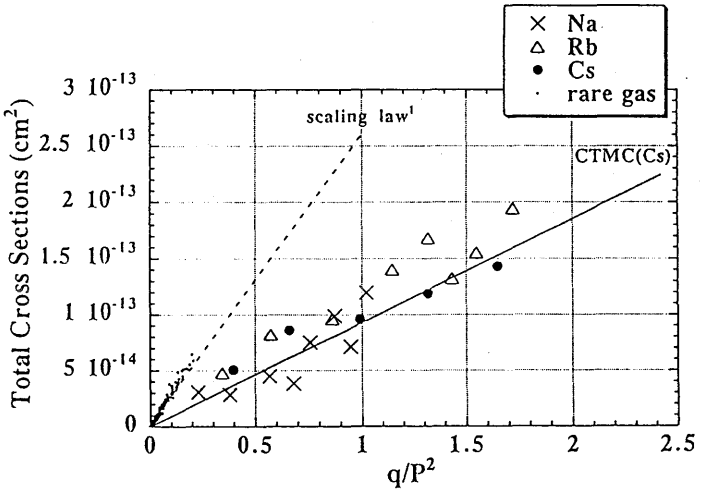

Figure. Total cross sections scaled by q/P^2. The dotted line represents the scaling law[1] of rare gas and simple molecular targets and the solid one indicates calculated results by the CTMC method.

References

1. M.Kimura et al., J.Phys.B **28**, L643(1995).
2. H.A.Sakaue et al., Physica Scripta T73,182 (1997).