§ 12. Partial Cross Sections of the Electron Capture Processes in Highly Charged Ion-Atom Collisions

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In the present experimental work we have investigated multi-electron transfer processes in I^{q+}(q = 10, 15, 20) + Ar and Xe collisions at keV/u energy range. Using the coincidence technique between the charge-selected projectiles and recoil ions, the branching ratios between Auger and radiative channels have been measured in decay processes of multiply excited states formed through multi-electron transfer. By combining them with the absolute cross sections for total and single electron transfer processes obtained through the retardation method, the cross sections for various charge changing processes have been determined.

We consider the following multiple electron capture processes

$$I^{q+} + B \rightarrow I^{(q-j)**\cdots}(n,n',\cdots) + B^{j+}$$
$$\rightarrow I^{(q-i)+} + B^{j+} + (j-i)e^- + h\nu + h\nu'$$

n,n'... : the principal quantum number

We determined the absolute partial cross sections $\sigma^j_{q,q-i}$. $\sigma^j_{q,q-i}$ is the cross section for i-electron capture into projectile ions after j-electron transfer from target.

In figure (a), (b) and (c) we show the absolute partial cross sections ($\sigma^j_{q,q-i}$) colliding with Ar and Xe targets for I^{q+}(q=10, 15 and 20), respectively.

Generally the cross sections are larger for Xe than for Ar target. And the cross sections increase as the charge number of incident ion increase. Also the following features are pointed out in these observed data:

1) The cross sections for one electron capture (i=1) after j-electron transfer ($\sigma^j_{q,q-1}$) decrease almost monotonously as the number of transferred electron increases.

2) For both Ar and Xe targets, as the number of transferred electrons increases, the cross sections for multi-electron capture ($\sigma^j_{q,q-2}$ and $\sigma^j_{q,q-3}$) increase first and then reach a maximum at a certain number of the electrons transferred and finally decrease. For example, two-electron capture cross sections $\sigma^j_{10,8}$ become maximum at j=4 in I^{10+}+Xe collisions. And this maximum peak shifts toward large number of j as charge q increase. For example, two electron capture cross sections at q=10, 15 and 20 ($\sigma^j_{10,8}$, $\sigma^j_{15,13}$ and $\sigma^j_{20,18}$) for Xe targets have maximum at j=4, 5 and 6, respectively. And the maximum peak for Xe target slightly shift toward larger j, compared with those for Ar target.

3) The two-electron capture cross sections become larger than the single electron capture cross sections at higher j. Similarly the three electron capture cross sections dominate over the two-electron capture cross sections at much higher j. This shows that more electrons are transferred, more electrons are emitted through Auger processes in highly charged ion-atom collisions.

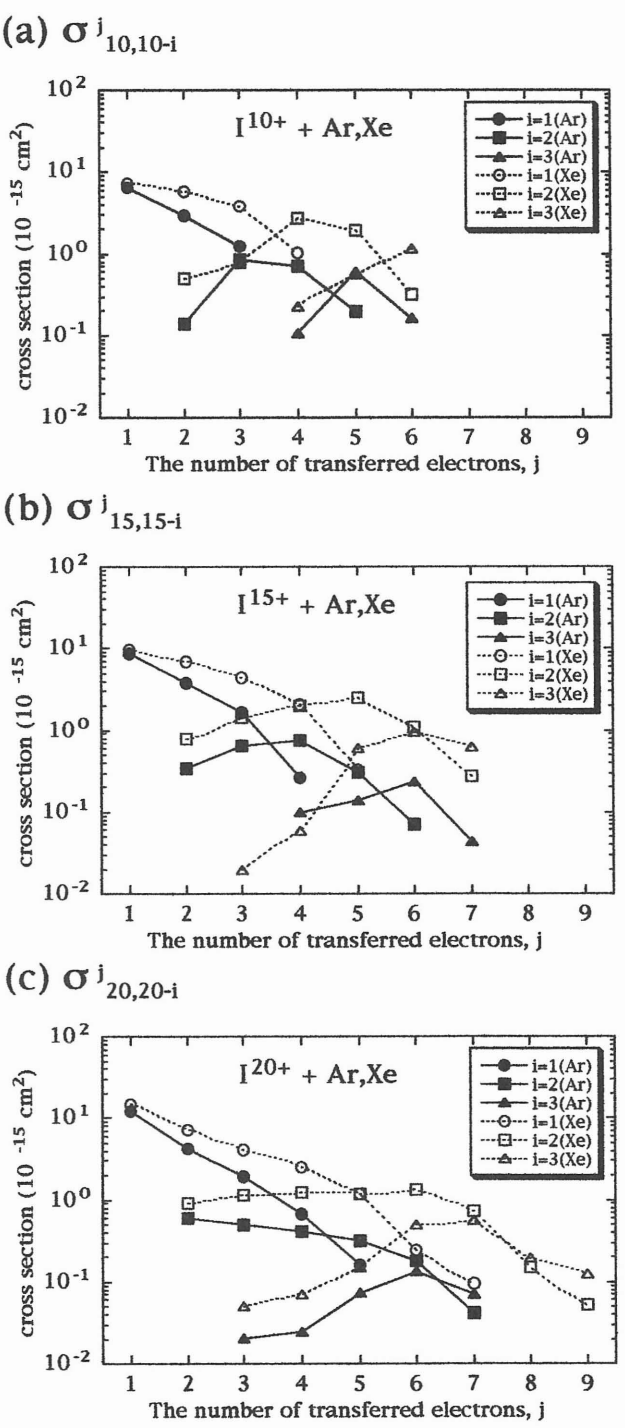

Figure. The j dependence of the absolute partial cross sections $\sigma^j_{q,q-i}$ in I^{q+} + Ar and Xe collisions. (a)-(c) correspond to q=10, 15 and 20, respectively. The solid and dotted lines are those for Ar and Xe target, respectively.