§18. Double Electron Capture in Slow, Highly Charged Ion-Molecule Collisions

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Experiments involving interactions between highly charged ions (HCI) and molecules are one of the methods of studying the dissociation of multiply charged molecular ions[1]. During collisions between highly charged ions and neutral molecules, a lot of electrons are transferred from the molecule into multiply excited levels of the highly charged ions (process 1). Finally the products of HCI are stabilized by ejection of electrons (autoionization decay) or photons (radiative decay) and the molecular ions can remain stable or dissociate into fragmented ions (process 2),

$$X^{q+} + AB \rightarrow X^{(q-j)+*} + (AB)^{j+} \quad (1)$$

$$\rightarrow X^{(q-i)+} + (AB)^{j+}/(A^{S+}+B^{R+}) + (j-i)e + n(h\nu) \quad (S+R=j) \quad (2)$$

where j and k are the numbers of electrons transferred from the target and the degree of the final projectile charge change, respectively. The kinetic energy released during the dissociation of $(AB)^{j+}$ into fragmented ions A^{S+} and B^{R+} can be determined from the measured difference in the time of flight of the fragmented ions (TOF spectrum).

In this paper, we present experimental results of 1.5q keV I^{q+} - CO collisions in the charge-state regime $8 \leq q \leq 23$. Due to a weak extraction field only the created parent molecular ions CO^+ and CO^{2+} were all collected, meanwhile not all of the fragmented ions C^{S+} and O^{R+} were collected because of their big initial kinetic energy (Fig.1). We have measured the ratio of the radiative decay to the autoionization decay after double-electron processes by using the coincidence measurement between charge-selected projectile ions and molecular ions. It was found that this ratio increases (up to about 10%) as the charge of the projectile ions increases (Fig.2). Theoretical analysis of the observed behavior is under way.

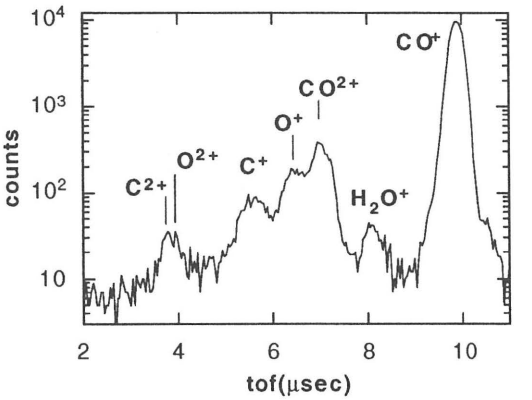

Fig.1. TOF spectrum of CO fragmentation produced by I^{10+}, with an extraction field of 10 V/cm.

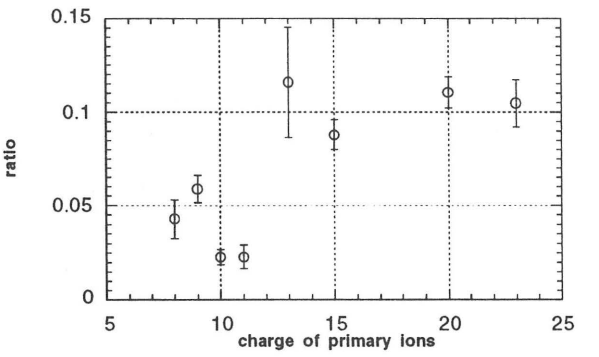

Fig.2. The measured ratio of the radiative decay to the autoionization decay after double-electron capture processes vs. the initial charge of the projectile ions.

Reference

[1] I.Ben-Itzhak et al., Phys. Rev. A 51 (1995) 391.