

## State-selected studies of electron capture by low-energy $\text{Ne}^{q+}$ ( $q = 3 - 5$ ) ions from $\text{CO}_2$ and $\text{H}_2\text{O}$ molecules

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**Synopsis** Translational energy-gain spectroscopy has been used to measure energy spectra and absolute total cross sections for single- and double-electron capture processes in low-energy collisions of  $\text{Ne}^{q+}$  ( $q = 3 - 5$ ) ions with  $\text{H}_2\text{O}$  and  $\text{CO}_2$  at collision energies between 15 and 500 qeV.

The study of single- and double-electron capture in low-energy collisions of multiply charged ions with molecules has grown tremendously in recent years, primarily due to the importance of these processes in many ionized media including plasmas and astrophysical environments. In addition,  $\text{H}_2\text{O}$  and  $\text{CO}_2$  are important components of many planetary atmospheres, and also found in earth's atmosphere [1].

In the present work, energy-gain spectra and absolute total cross sections for single- and double-electron capture processes in collisions of  $\text{Ne}^{q+}$  ( $q = 3 - 5$ ) recoil ions with  $\text{CO}_2$  and  $\text{H}_2\text{O}$  targets at impact energies between 15 and 500 qeV have been studied using the translational energy-gain spectroscopy technique. The data have been obtained on a differential energy spectrometer, which has been described by Abu-Haija et al. [2].

Figure 1 shows the projectile charge state dependence of the cross section ratio of double to single-electron capture by  $\text{Ne}^{q+}$  ( $q = 3 - 6$ ) ions from  $\text{CO}_2$  and  $\text{H}_2\text{O}$  for two collision energies. The ratio increases slowly with charge state of the projectile on average from  $0.1 \pm 0.04$  for  $q = 3$  to  $0.55 \pm 0.18$  for  $q = 6$  in disagreement with the calculations based on an extension of the classical over-the-barrier model for multi-electron capture [3], which predicts that the ratio is independent of the charge state. This results may indicate a one-step mechanism for the double-electron capture in which the electrons are captured simultaneously in one step.

The energy dependence of total cross sections for single- and double-electron capture are also measured and found to slowly increase with increasing impact energy, a pattern that can be understood by the reaction window, which broadens with increasing energies and therefore increase the probability of capture channels with large  $Q$ -values.

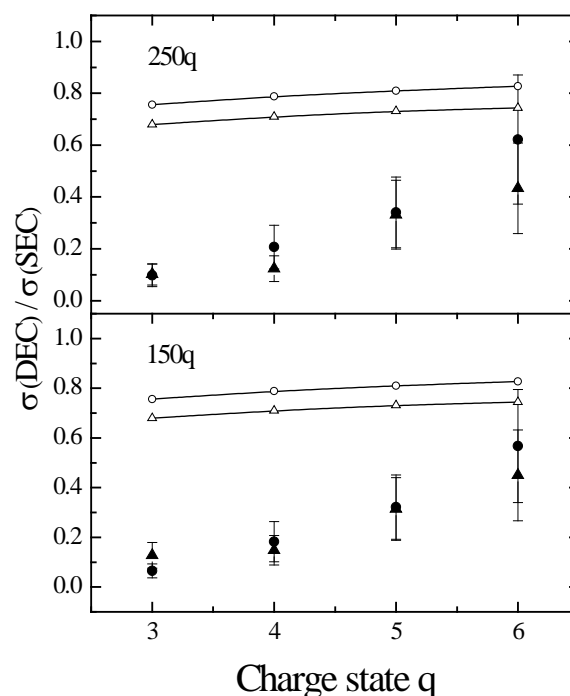


Figure 1. Projectile charge state dependence of the ratio of double-electron capture (DEC) cross sections to single-electron capture (SEC) cross sections in collisions of  $\text{Ne}^{q+}$  ( $q = 3 - 5$ ) ions with  $\text{H}_2\text{O}$  and  $\text{CO}_2$ . Present work: (●)  $\text{CO}_2$ ; (▲)  $\text{H}_2\text{O}$ . Extension of the classical over-the-barrier model: (○)  $\text{CO}_2$ ; (△)  $\text{H}_2\text{O}$ .

### References

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