Electron impact multiple ionization of C^+ and N^+ and O^+ ions

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Electron impact multiple ionization of C^+, N^+ and O^+ ions

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Synopsis Absolute cross sections for electron impact single and multiple ionization of C^+, N^+ and O^+ ions leading to the formation of C^{q+} (q=2−4), N^{q+} (q=2−5) and O^{q+} (q=2−5) are reported in the energy range extending from the respective thresholds up to 2.5 keV. The general feature of the measured cross sections is investigated.

In the present study the animated crossed electron-ion beams method [1] is applied for measurement of absolute cross sections for electron impact single and multiple ionization of C^+, N^+ and O^+ ions at incident electron energy values up to 2.5 keV. The maximum cross sections for the multiply-charged products C^{q+} (q=2−4) is found to range from 2.3×10^{-20} cm^2 (for C^{4+}) up to 6.3×10^{-17} cm^2 (for C^{2+}); for N^{q+} (q=2−5) they range from 3.0×10^{-22} cm^2 (for N^{5+}) up to 5.1×10^{-17} cm^2 (for N^{2+}) and, lastly, for O^{q+} (q=2−5) they range from 5.5×10^{-22} cm^2 (for O^{5+}) up to 5.2×10^{-17} cm^2 (for O^{2+}). The corresponding threshold energies are determined to satisfactorily compare to spectroscopic values.

The cross section values for single ionization reasonably agree with the calculations using the Coulomb-Born approximation with exchange (CBE) [2]. Those for multiple ionization are found to compare well with the semiempirical model for q=3 [3], but they appear to be notably overestimated by a semiempirical Bethe-Born type formula when q>3 [4]. The remarkable point is that, at a given incident electron energy E, the sequence of single and multiple ionization cross sections is observed to decrease exponentially with respect to the number of ejected electrons: $\sigma_n=\sigma_1\exp[-(n-1)/q_0]$ (see figure 1), where σ_1 is the single ionization cross section and the fitting parameter q_0 appears to be an effective charge. This peculiarity is also observable for neutral targets, and therefore seems to be a general feature common to any atomic or ionic target, but, up to now, it seems to have not received any theoretical treatment.

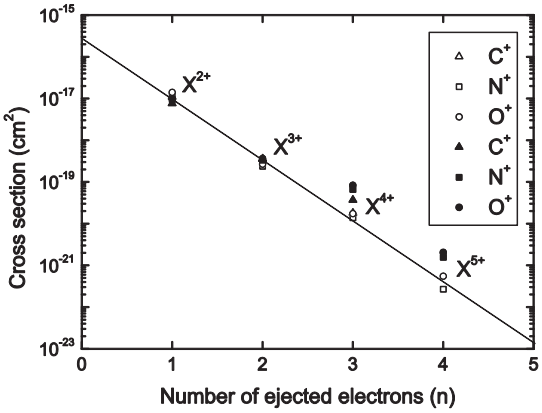

Figure 1. Ionization cross sections for C^+, N^+ and O^+ plotted as a function of the number of ejected electrons at E=1995.1 eV: present experimental results (open symbols) together with numerical calculations using the models and approximations specified in the text (filled symbols).

References

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