MERGED-BEAM STUDY OF ASSOCIATIVE IONIZATION IN COLLISIONS OF C^- WITH C^+, N^+ AND O^+

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Our merged ion beams set-up [1] has been used to measure the total cross section of the following associative ionization (AI) reactions:

$$\begin{aligned} C^- + C^+ &\rightarrow C_2^+ + e^- \\ C^- + N^+ &\rightarrow CN^+ + e^- \\ C^- + O^+ &\rightarrow CO^+ + e^- \end{aligned}$$

This study completes our previous investigation of AI in the CNO sequence [2] (reactions of O^- with C^+, N^+ and O^+). All cross sections are found to be extremely large at thermal energy ($> 10^{-14} cm^2$) and behave like E^{-1} below the detachment threshold of C^-. The reduction of the cross section by an order of magnitude when substituting O^+ for C^+ is observed for both C^- and O^- as a collision partner, suggesting some propensity rule linked to the multiplicity of the reaction channel.

Two processes come in competition with associative ionization, i.e. collisional detachment:

$$C^- + X^+ \rightarrow C + X^+ + e^-$$

and transfer ionization:

$$C^- + X^+ \rightarrow C^+ + X + e^-.$$

The second process, which coincides with the dissociation limit of CN^+ and CO^+ ground states, requires a complete rearrangement of the electronic cloud, and competes less efficiently with AI, explaining the structureless cross sections at intermediate energy (1-2 eV) . In the case of C_2^+ formation, The appearance energy of the competing detachment channel exceeds the electron affinity of carbon, due to the formation of metastable molecular ions excited above the dissociation limit. Closer examination of their predissociation lifetime is needed to confirm this hypothesis.

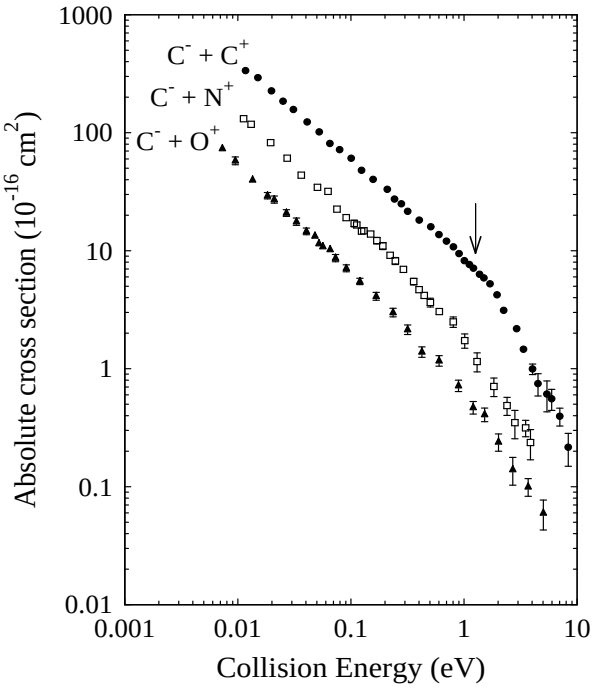

Fig. 1. Total cross sections for AI between C^- and C^+ (circles), N^+ (squares) and O^+ (triangles). The arrow indicates the collisional detachment threshold.

References

[1] A. Naji, K. Olamba, J.-P. Chenu, S. Szücs, M. Chibisov, F. Brouillard, J. Phys. B: At. Mol. Opt. Phys. **31** 2961 (1998).

[2] T. Nzeyimana, E.A. Naji, X. Urbain and A. Le Padellec, Eur. Phys. J. D **19**, 315(2002).