Negative ion productions in high velocity collision between small carbon clusters and Helium atom target.

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Synopsis We measured absolute double capture cross section of C_n^+ ions (n=1,5) colliding, at 2.3 and 2.6 a.u velocities, with an Helium target atom and the branching ratios of fragmentation of the so formed electronically excited anions C_n^-*. We also measured absolute cross section for the electronic attachment on neutral C_n clusters colliding at same velocities with He atom. This is to our knowledge the first measurement of neutral-neutral charge exchange in high velocity collision.

Negative small hydrocarbons have been observed for the first time in 2006 in the cold and dense interstellar cloud TMC1 [1] and since this time, they have been observed in many other interstellar objects. They are believed now to be ubiquitous species of the gas phase interstellar chemistry. This recent discovery raises a strong need for molecular data and dynamical properties for small free carbon and hydrocarbon anions.

Inverse kinematics experiment at high velocity (i.e. the molecule under interest is accelerated) is a unique tool to detect the fragmentation. It is because silicon detector may be used. In the present experiment we used the silicon multidetector AGAT at the Orsay Tandem accelerator facility [2]. Small carbon cluster cations (C_n^+) at 2.3 and 2.6 u.a. velocity were colliding with helium atom target at rest in laboratory. Electrostatic field and silicon detectors were then used to resolve channels involving negative species productions. Actually two processes were found to be responsible for negative species production in the experiment. The first one was the double capture process: $C_n^+ + He \rightarrow C_n^{-*} + He^{++}$ and the second was a two successive collision process: $C_n^+ + He \rightarrow \{C_n^*\}^{q+} \rightarrow \{C_m\}^{q+} + C_p$ followed by an electronic attachment of neutral fragment C_p in a second collision: $C_p + He \rightarrow C_p^- + He^+$.

As an example of the results that we will present at the conference we display on figure 1 the measured cross sections for $C + He \rightarrow C^- + He^+$ processes as a function of the first collision channel producing neutral carbon. Inside error bars variations are found small. Exception arises when the multicharged carbon clusters vaporizes (channel 4C+/C). The Cross section is then found negligible. In these vaporization cases the carbon atom could be in an electronic excited state and charge stabilization may be more difficult.

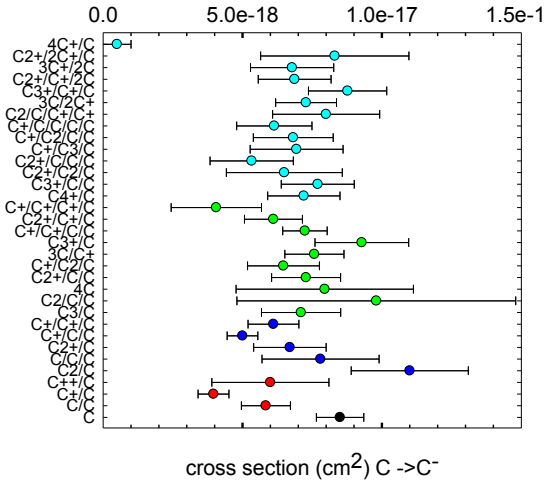

Figure 1: Carbon attachment cross sections ($C + He^{->} C^- + He^+$) as a function of the fragmentation channel providing neutral carbon atom projectile.

References

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