CARBON CLUSTERS-ATOM COLLISIONS AT INTERMEDIATE VELOCITY

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Collisional cross sections and associated fragmentation branching ratios have been measured in C_n^+ -> He systems ($n \leq 10$) at v_p=2.6 au. At this velocity, the electronic stopping power is maximum, leading to large probabilities of single and multiple electron transitions in the cluster, by excitation or ionization, as well as large fragmentation and multifragmentation probabilities.

The experiments have been performed at the Tandem accelerator in Orsay with beams of C_n^+ clusters of kinetic energy E=2n MeV (constant velocity v_p=2.6 a.u). The technique used to extract excitation and ionization cross sections has been detailed in previous papers [1]. In the present work, a larger size domain has been investigated, allowing the evolution of cross sections to be studied between n=1 and n=10. Fragmentation of the excited and ionized clusters has been extracted thanks to a new detection method, based on the shape analysis of the transient currents created in semiconductor detectors by the impinging fragments [2]. This method has been used successfully to resolve the complete fragmentation of highly excited neutral C_n clusters [3]. It allowed here to resolve the numerous fragmentation channels of C_n^{q+} (q=1,2,3), as will be shown at the conference.

Predictions of excitation and ionization cross sections in these systems is a challenge for theoreticians. Following a very simple approach previously introduced [1], we have approximated the cluster by independent atoms and treated the collision dynamics within the classical trajectory monte carlo method. Positions of the atoms within C_n^+ clusters have been determined by the DFT theory using the B3LYP exchange correlation functional [4]. As in previous works for $n \leq 5$ [1], we have found a large sensitivity of the modelled multiionization cross sections to the cluster shape, the cyclic isomers leading to enhanced multiionization as compared to linear ones. Experimentally, the size evolution of these multiionization cross sections is reasonably well reproduced by the model and exhibits trends that can be interpreted on the basis of linear, mixed and cyclic isomers when n increases from 2 to 10. Cross sections for electronic excitation have also been calculated as well as the energy deposit.

One major question related to the fragmentation of small systems is whether the dissociation is statistical or not, as a function of the energy and charge deposited in the system. The experimental determination of absolute branching ratios for the dissociation of a given charge cluster allows to test this point on very constraint grounds. Comparison between experiment and the Microcanonical Metropolis Monte Carlo Method for fragmentation of neutral C_n clusters (n=5,7,9) supports statistical fragmentation in this case [3]. This result is going to be tested in the case of the fragmentation of charged clusters in the future.

References:
[1] M.Chabot et al EPJD **14** (2001) 5 and references therein
[2] M.Chabot et al NIMB **197** (2002) 155
[3] G.Martinet et al (submitted PRL)
[4] S. Diaz-Tendero et al JCP **106** (2002) 10782