

# Carbon clusters-atom collisions at intermediate velocity : electronic processes & fragmentation channels .

Case of  $C_n^+ \rightarrow He$  ( $n \leq 10$ , velocity = 2.6 au, 2 MeV/Carb.)

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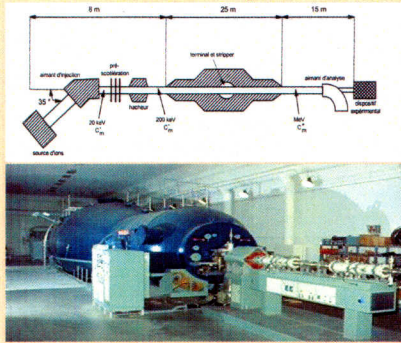


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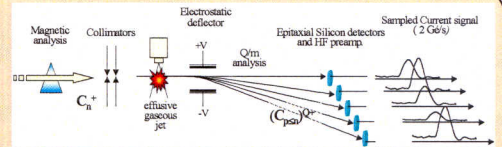
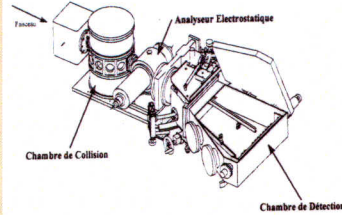
**Abstract:** Collisional cross sections and associated fragmentation branching ratios have been measured in  $C_n^+ \rightarrow He$  system ( $n \leq 10$ ) at  $v_p = 2.6$  ua. The experiments have been performed at the Tandem accelerator in Orsay with beams of  $C_n^+$  clusters of kinetic energy  $E = 2n$  MeV (constant velocity  $v_p = 2.6$  au). The technique used to extract excitation and ionisation cross sections has been detailed in previous papers [1]. In this work, a large size domain has been investigated ( $n=1 \rightarrow n=10$ ). Fragmentation of the excited and ionised clusters has been extracted thanks to a new detection method, based on the shape analysis of transient currents created in semiconductor detectors by 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  $C_n^{q+}$  ( $q=1,2,3,4$ ).

Tandem accelerator in Orsay-France



## AGAT DETECTOR

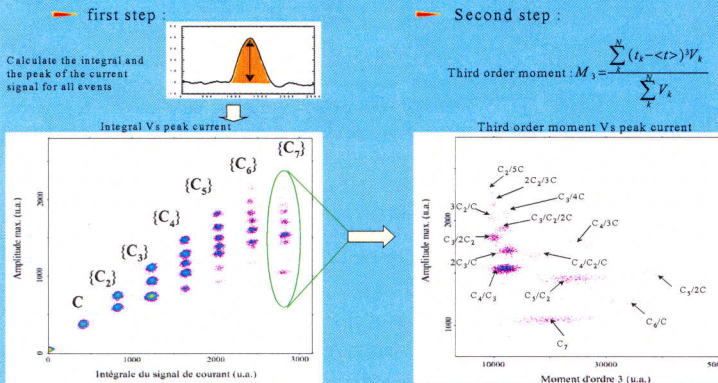
### Experimental apparatus



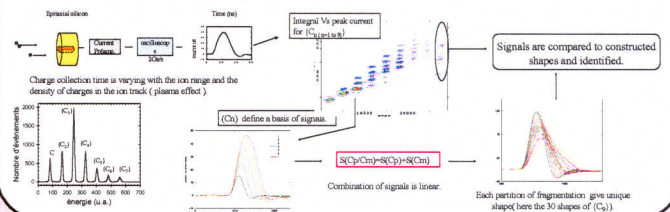
### Silicon detectors (Si)



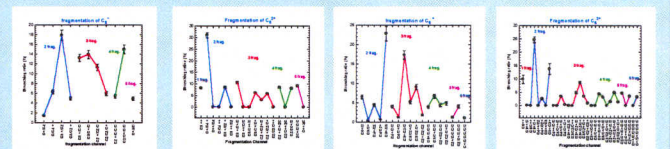
### Shape analysis of current pulses delivered by semiconductor detectors : A new tool for fragmentation studies [2].



### Detection method ( shape analysis on Silicon detectors) [2]

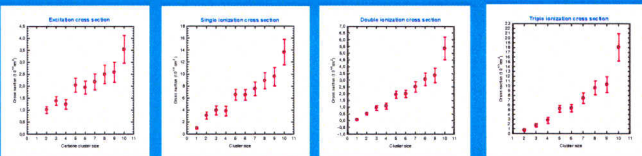


### Experimental results : branching ratios



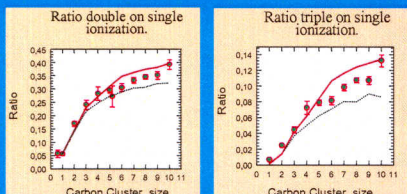
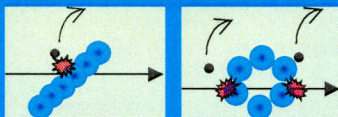
- \* Fragmentation into three fragments dominate for mono-charged clusters  $\rightarrow$  deposit energy  $> 12$  eV .
- \* Fragmentation channels in which the  $C_3$  or  $C_3^+$  appears have a large branching ratio . This is explained by the strong stability of  $C_3$  [7] and  $C_3^+$  [4]
- \* These results will be compared to microcanonical Metropolis Monte-Carlo simulation ( F. Martin et coll.) [5] . Interpretation within MMMC was done successfully for neutrals [3]
- \* Fragmentation into two fragments dominate for double charged clusters.
- \* Charge repartition is observed
- \* Molecular dynamics calculations including coulomb barrier will be performed ( F. Spiegelman and coll. ) and comparison with our experimental results will be done .

### Experimental results : Cross sections



### Multiple ionization as a test of the carbon cluster shape:

There are larger probabilities to eject many electrons from compact shapes than from linear shapes.



Calculations: independent atom and electron model [6].  
—: cyclic structures. ----: linear structures.

In conclusion we have shown that current pulses from (Si) detectors are characteristic of the cluster mass and its fragmentation state . So all fragmentation channels can be resolved . Branching ratios and cross sections are deduced . Interpretation of branching ratios within statistical and molecular dynamics approaches are in progress .

### Références :

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[2] M. Chabot et al., N.L.M. B 197 (2002) 155-164  
[3] G. Martinet et al., P.R.L. 2004 (in press)  
[4] S. Diaz-Tendero, Tesina (Madrid 2002)  
[5] D. H. E. Gross and P. A. Hervieu, Z. Phys. D 33 27 (1995)  
[6] K. Wohrer et al., J. Phys B 29 (1996) L755-L761  
[7] M. E. Geusic et al., J. Chem. Phys. 84, 2421 (1989)