Ion-pair dissociation of highly excited carbon clusters, size and charge effects

T.Launoy[§], M. Chabot[†], G. Martinet[†], T. Pino[*], A. Le Padellec[#], S.Bouneau[†], G. Féraud[¤], N.Do Thi[$], N.Vaeck[§], J.Liévin[§], J.Loreau[§], K. Béroff[*1]

[*] Institut des Sciences Moléculaires d'Orsay, Université Paris Sud and CNRS F-91405 Orsay Cedex, France
[†] Institut de Physique Nucléaire d'Orsay, Université Paris Sud and CNRS F-91406 Orsay Cedex, France
Institut de Recherche en Astronomie et Planétologie, Université Toulouse 3 and CNRS F-31028 Toulouse, France
[§] Chimie Quantique et Photophysique, Université libre de Bruxelles, Belgique

Synopsis: Ion-pair dissociation of a highly excited molecule is a relaxation process giving rise to emission of anionic and cationic fragments. We present first measurements of ion-pair dissociation of carbon clusters. We found that ion-pair relaxation is an ubiquitous, although very small, relaxation channel common to all sizes and charges of C_n^{q+} species produced in high velocity C_n^+-He collisions. Quantitative interpretation of measured branching ratios is conducted on the basis of a statistical approach i.e through listing of all possible final states.

Anion production in high velocity C_n^+-He collisions has been shown to proceed by three different mechanisms [1]. One of them is ion-pair dissociation in which a highly excited C_n^{q+} cluster, neutral (q=0) or positively charged (q≥1), relaxes by emission of one anionic and (q+1) cationic fragments. The AGAT set-up, situated nearby the Tandem accelerator in Orsay (France), is an ideal tool for studying this process. Indeed the set-up is based on a coincident recording of all fragments issued from the collision, identified in mass and charge (q=-1,0,1,2,3…).

In figure 1 are reported measured branching ratios (BR) for ion-pair dissociation of C_n^{q+} species as a function of the cluster charge q and cluster size n (symbols, see legend). The branching ratio is calculated as the ratio between measured cross sections for dissociation with anion and measured cross sections for dissociation without anion (v=2.25 a.u C_n^+ -He collision). As seen from figure 1 these BR are small (~few 10^{-4}) and little dependent on (n,q) with the exception of (n=2, q=1), and, in a lesser extent, (n=4, q=3).

Whereas ion-pair dissociation requires a large amount of energy (for instance dissociation of C_2^+ into C^{2+}/C^- requires more than 28 eV) the energetic criterion is not sufficient to interpret the results. Clearly the number of final states i.e the phase space open to ion-pair dissociation is playing the major role. We listed all possible final states for dissociation both with and without anions. Results for (q=1, n=2) and (q=1,n=3) will be presented at the conference and compared to experimental results.

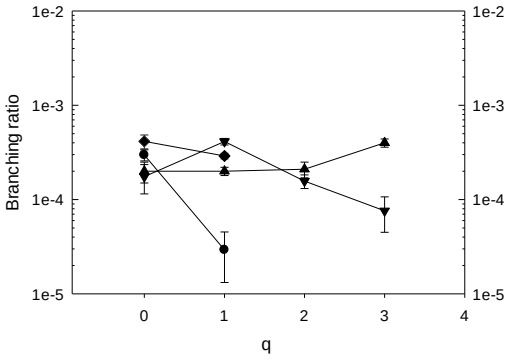

Figure 1. Measured ion-pair dissociation BR as a function of the cluster charge. Circles, diamonds, triangles down and triangles up refer to n=2,3,4,5 respectively; lines are to guide the eye.

References

[1] K.Béroff et al 2013 *J.Phys.B:At.Mol.Opt.Phys.* 46, 015201

[1]E-mail: karine.beroff@u-psud.fr
¤ present address : Departement f. Chemie and Biochemie, Universität Bern, 3012 Bern, Suisse
$ present address : Center for Computational Physics, Institute of Physics, VAST, Hanoi, Vietnam