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FRAGMENTATION OF SMALL $C_N{}^+$ CLUSTERS (N≤10) FOLLOWING ELECTRONIC EXCITATION IN HIGH VELOCITY COLLISIONS WITH ATOMS AND COMPARISON WITH PHOTO-DISSOCIATION MEASUREMENTS

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Abstract. In this paper, we investigate the role of the electronic excitation type on the fragmentation pattern of $C_n{}^+$ clusters

1 Introduction

Small carbon clusters are present in a number of astrophysical environments. Neutral species have been observed and cationic species are crucial for astrochemistry. Their evolution is partly governed by the interaction with radiation, the type of which depends on the interstellar region. UV photons are known to play a large role in PDR's whereas high energy cosmic ray penetrates dense molecular clouds and induce excitation, ionization and dissociation. In this paper we present measurements of fragmentation of $C_n{}^+$ cations after electronic excitation in a high velocity collision with a helium atom. In order to investigate the possible statistical character of the fragmentation (i.e not dependent on the way energy is deposited) we compare our fragmentation branching ratios for two-fragments break-up with those obtained in photo-dissociation by Geusic et al (1986).

2 Experimental set-up

The experiments have been performed at the Tandem accelerator in Orsay (France) with beams of $C_n{}^+$ clusters selected in mass ($1 \leq n \leq 10$), charge (+1) and velocity (v=2.6 atomic units). The experimental set-up has been described previously (Mezdari et al (2005), Chabot et al (2006)). Briefly it is made of three parts: the collision

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chamber where an effusive helium jet of known profile operates under single collision condition, an electrostatic analyzer for deflecting fragments according to their charge over mass ratio and the detection chamber in which eight solid state detectors operate in coincidence for simultaneous and total (100% efficiency, 4π detection) recording of fragments. Fragmentation associated to a particular charge q of the parent is extracted (q=0,1,2,3....). Here we present results associated to fragmentation of $C_n{}^+$ clusters (q=1) after electronic excitation during the collision with the helium atom.

3 Fragmentation branching ratios of $C_n{}^+$ clusters (two-fragments break-up) and comparison with photo-dissociation

In pioneering experiments, Geusic et al measured the fragmentation of mass resolved carbon cluster ions (n=3-19) after photo-excitation by 248nm (5 eV) laser light. A critical analysis of their data (Sowa-Resat et al (1995)) allowed to conclude that multi-photon excitation (mostly two-photon) was important. In the experiment, the ionic fragment only was detected, which determines unambiguously the fragmentation channel if the energy deposit does not exceed roughly 13 eV (Chabot et al (2006)). In figure 1, we compare the branching ratios they obtained with our two-fragments branching ratios for n=4-10. The agreement between both sets of results is rather good, which indicates that the fragmentation does not depend on the way energy has been deposited and is not very sensitive to the energy distribution. This conclusion may be important in the astrophysical context, when photo-dissociation branching ratios are needed but do not exist. This is for instance the case of small C_nH^+ molecules that we recently investigated using the high velocity collision tool (Tuna et al (2007)).

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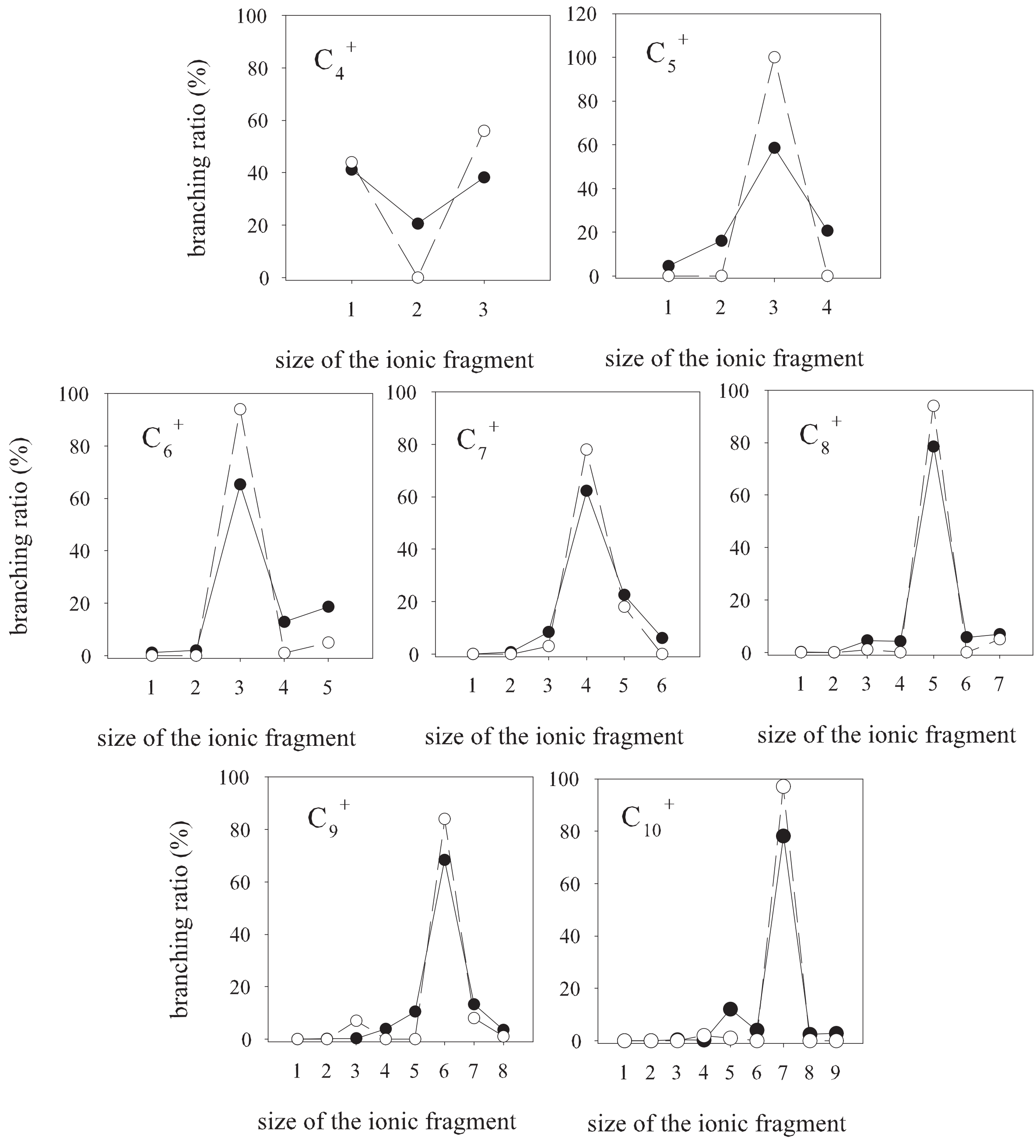

Fig. 1. Measured branching ratios for dissociation into $(C_p^+/C_n - p)$ channels of C_n^+ clusters, excited in high-velocity collisions (black circles) and by photo-excitation (open circles); lines are to guide the eye