Fragmentation dynamics of multiply ionized acetylene: dependence on the charge state of intermediate ions

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Synopsis We study fragmentation dynamics of multiply ionized acetylene by 0.8 MeV C^+ collisions. A three-dimensional momentum imaging technique has been additionally employed to our previous setup for measuring the number of emitted electrons. Various fragmentation processes including channels involving neutral fragments are discussed as functions of the charge state of the intermediate states.

In collisions of fast heavy ions with molecules, multiply ionized molecular ions are generated as transient intermediate states before fragmentation. The charge state of the intermediate ion is one of the most fundamental parameters which governs subsequent fragmentation behavior. To measure the charge state, Martin *et al*. employed a technique for counting the number of emitted electrons in a direct manner [1]. This method enables us to study fragmentation processes of multiply ionized polyatomic molecules systematically as functions of the charge state. Previously, we have applied this technique to study multiple ionization of ethane in 580-keV C^+ collisions [2]. In this work, a three-dimensional momentum imaging technique has been additionally introduced to study fragmentation dynamics as functions of the charge states of the intermediate states [3]. We present results obtained for collisions between 0.8-MeV C^+ and acetylene (C_2H_2) under the single-electron capture condition.

Experimental procedures are described elsewhere in detail [2,3]. In brief, product ions were analyzed by time-of-flight (TOF) measurements with a position sensitive detector. Electrons emitted in collisions were detected with a semiconductor detector on a potential at +25 kV. The number of the electrons are derived by analyzing pulse-height distributions of the signals.

Figure 1 shows ion-ion TOF coincidence maps plotted separately for doubly (r = 2) and triply (r = 3) charged intermediate states. The slope for the H^+-C_2^+ pair at r = 3 is nearly 0. This shows that C_2^+ has lower kinetic energies than those at r = 2 owing to the symmetric fragmentation into $H^+ + C_2^+ + H^+$. A similarly flat shape was reported in collisions with 1.2-MeV Ar^{8+} ions, although they did not specify the charge state r [4]. In addition, we found that the island of H^+-C^+ at r = 2 exhibits both of positive and negative slopes. In Auger electron-ion-ion coincidence measurements, the H^+-C^+ island has only a positive slope [5]. The present results suggest that additional fragmentation processes are induced via higher excited states formed in fast ion collisions.

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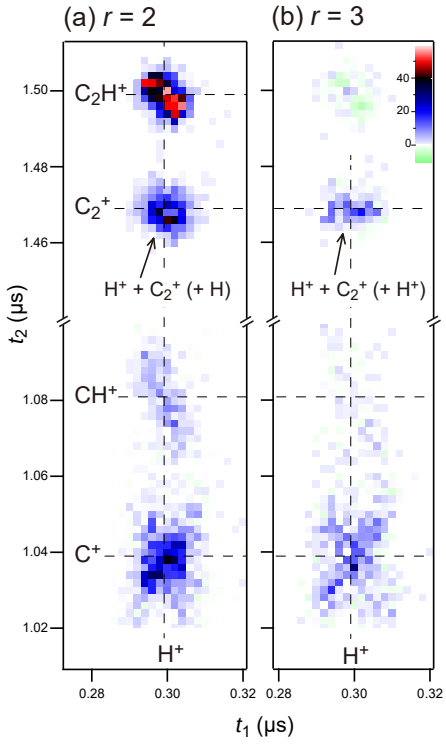

Figure 1. Correlation map between TOF of the first detected ion (t_1) and TOF of the second one (t_2)

References

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