

Fragmentation of Acetylene in Collisions with 3.6 MeV/u Xe⁴⁰⁺-ions

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The multiple ionization and fragmentation of acetylene was studied in collisions with 3.6 MeV/u Xe⁴⁰⁺ ions provided by the UNILAC at GSI. The fragmentation dynamics was studied using a position- and time-sensitive multi-particle detector [1] which allows the coincident measurement of the momenta of correlated fragment ions. If all fragment ions from a particular fragmentation are detected, a kinematically complete analysis of the molecular break-up is possible [2] and the released kinetic energies and several angular correlations can be derived.

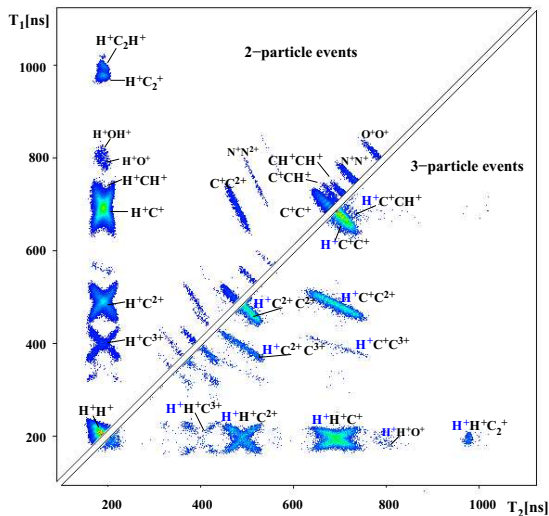


Figure 1: Coincidence maps of two- and three-particle events observed in collisions of 3.6 MeV/u Xe⁴⁰⁺ with C₂H₂. The intensity increases from black towards light gray (blue towards red).

Fig. 1 gives an overview over the observed two- and three-particle coincidences. The measured intensity is shown as function of the flight times T_1 and T_2 of the fragments. In case of three particle events, it shows the flight times of the second and third fragment ions which were detected in coincidence with another H⁺ ion. The applied coincidence mapping technique allows a detailed study of the characteristic fragmentation patterns [3]. In case of completely observed break-up processes, as e.g. C₂H₂ → CH⁺ + CH⁺ or C₂H₂ → H⁺ + C⁺ + CH⁺, even more information can be derived from the measured momenta.

As an example Fig. 2 shows some results for the symmetric and asymmetric two-particle Coulomb fragmentations C₂H₂ → CH⁺ + CH⁺ and C₂H₂ → H⁺ + C₂H⁺.

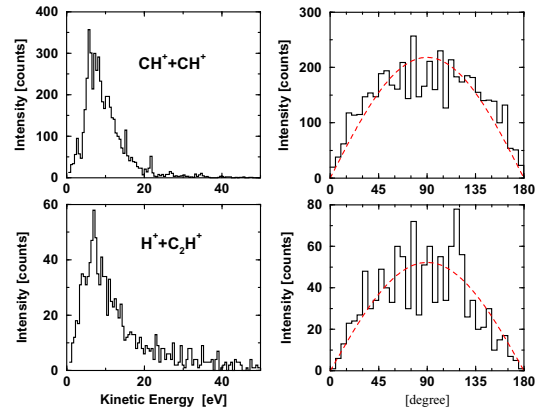


Figure 2: Total kinetic energy of coincident fragment ions: CH⁺ + CH⁺ (top) and H⁺ + C₂H⁺ (bottom). The right graphs show the corresponding dependences of the cross section on the orientation θ of the molecule axis; the dashed lines represent isotropic distributions.

The left graphs show the distributions of the total kinetic energy of both fragments. Apart from the narrower width of the symmetric process both spectra are rather similar with maxima around 7 eV.

By neglecting molecular vibrations acetylene may as a first approximation be considered as a linear molecule and the dependence of the cross sections on the orientation θ of the molecular axis with respect to the projectile beam may be studied. In this simple picture the fragment ions are driven apart by their mutual Coulomb repulsion along the molecular axis and the angle θ between the axis and the projectile beam can be derived from the velocity vectors of the fragment ions. The right graphs in Fig. 2 show the corresponding θ -distributions for the two-particle break-ups. As expected no significant orientation effects occur at this low degree of molecular ionization. Similar results were found for diatomic molecules [4].

References

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