

Fragmentation of CF₃I Induced by Electron Collision

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Synopsis The fragmentation experiment of CF₃I by 480 eV electron impact is performed, in which two charged ions are detected in coincidence, and the corresponding 3D momentum are reconstructed. Based on momentum conservation law, the momentum of the neutral atom and the kinetic energy release (KER) are deduced. For the three-body fragmentation channel, both the sequential and nonsequential dissociation are observed, which has a close correlation with KER distribution. For the four-body fragmentation channel, the sequential dissociation is found for the first time.

Because the weak interaction between C and I atoms, the C-I bond cleavage in trifluoroiodomethane (CF₃I) can be efficiently induced by visible photons or charged particles impact, which makes the CF₃I have a very short lifetime in atmosphere and be more environmental friendly than CF₃Br or CF₄ as plasma etching gas[1].

In this work, we performed the fragmentation experiment of CF₃I by 480 eV electron impact, in which two charged ions are detected in coincidence, and the corresponding momenta of both ions are reconstructed. Then the momentum of neutral atom is deduced by the momentum conservation law.

For the three-body fragmentation channel (CF₃I)²⁺ → CF₂⁺ + I⁺ + F, both the sequential and nonsequential dissociation are observed. As shown in figure 1, for events with kinetic energy release (KER) smaller than 5 eV, the corresponding fragmentation mechanism is sequential dissociation, that is, the neutral F atom leaves from (CF₃I)²⁺ ion in the first step, and the doubly charged metastable CF₂I²⁺ ion fragments into CF₂⁺/I⁺ ion pair in the second step. But for the events with KER higher than 7 eV, the main decay mechanism is nonsequential dissociation, e.g., both C-F bond and C-I bond break simultaneously.

For the four-body fragmentation channel, we observed the momentum correlation between CF⁺ ion and I⁺ ion, which is the first evidence of sequential dissociation in four-body fragmentation. One possible sequential dissociation

mechanism may be considered as: (CF₃I)²⁺ → (CFI)²⁺ + 2F → CF⁺ + I⁺ + 2F.

It should be noted that, the sequential dissociation of molecules are always observed in the highly charged molecular ion like OCS³⁺ and CO₂⁴⁺ [2]. But for the three-body and four-body fragmentation of doubly charged ion, the investigation is scarce. In this work, we give the most direct evidence so far of sequential dissociation of doubly charged molecular ion.

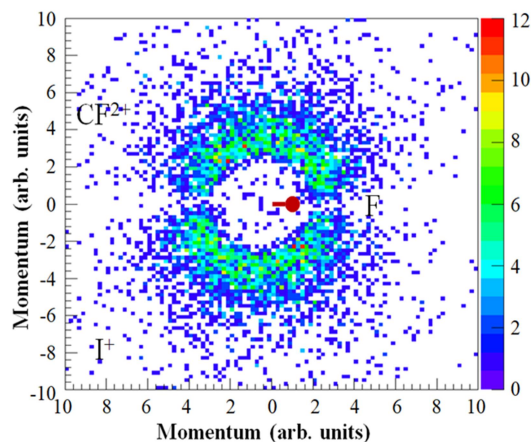


Figure 1. Newton diagram for CF₂⁺/I⁺/F ion pair with KER lower than 5 eV .

References

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