4 - 7 Dissociative Ionization of Methane: An (e,2e+ion) Investigation[1]

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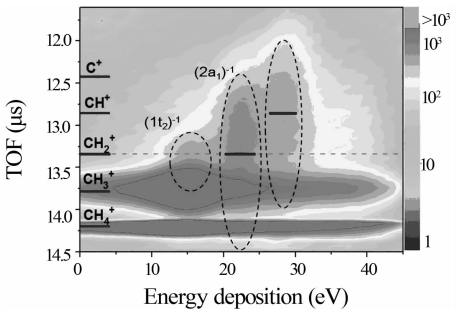

Fig. 1 Two dimensional plot for the ion-yields as a function of the energy deposition (horizontal axis) and the TOF of the ion (vertical axis). The black horizontal lines denote the TOF for different ions with zero kinetic energy.

Methane is the simplest alkanes moleculewith high symmetry. It draws great interest in numerous application fields such as plasma physics radiation damage of living tissues and chemistry of planetary atmospheres[1]. During the collision with electrons, one electron may be ionized from the target resulting in a CH_4^+ cation and two electrons in continuum states (i. e. (e, 2e) process). The CH_{4+} ion may populate a repulsive state after ionization, and dissociate to neutral and positively charged fragments. If the fragmented ion and the two outgoing electrons in the final state are detected in triple coincidence, i. e. the so called (e, 2e+ion) experiment, much more detailed information can be deduced to investigate the dissociation mechanisms.

The dissociative ionization of methane induced by 54 eV electron impact has been investigated in copperation with MPI-K employing the advanced reaction microscope[2]. Through the triple coincidence measurements of the two electrons and one positively charged fragment in the final state, the species of the fragments are identified, and the energy depositions in the target are determined. The intermediate states of the parent ion can thus be assigned according to the energy of the two outgoing electrons. As can be seen from Fig. 1 that the $(2a_1)^{-1}$ state makes the major contribution for CH_2^+, while the $(1t_2)^{-1}$ ground state has only a very small share in producing these ions at the present incident energy. The CH^+ ions are mainly formed through the ionization-excitation states. The fragment ion species strongly depend on the electronic state of the parent ion. This study demonstrates that reaction microscope is a powerful tool for the investigation of the electron induced dissociative ionization of molecules.

References

[1] X. Liu, et al., J. Geophys. Res., 111(2006)A04303.
[2] S. Xu, et al.., Phys. Rev., A83(2011)052702.

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