Fragmentation of H_2O molecules induced by 46 keV/u N^+ and N_2^+ projectiles

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Collisions of ions with small molecules have major importance in astrophysics, molecular physics and biophysics. When radiations interact with living tissues, e.g., free radicals are produced in fragmentation processes. Secondary biochemical processes caused by those free radicals may largely contribute to DNA lesions. For ion therapy, the relevant processes in the target area fall in the energy range of the Bragg peak. For carbon ions it is located around 3 MeV. At the low energy side of the Bragg peak, the equilibrium charge state of the decelerating ions is small: $\langle q \rangle = 2$ for 100keV/u C ions and close to zero below 10 keV/u [1]. In the relevant 10-100 keV/u impact energy range, C^+ ions (or Z=6-8 ions) can easily be provided by electrostatic accelerators.

In recent years an experimental setup has been developed specifically for molecule fragmentation experiments in Atomki, Debrecen [2]. Here we report on measurements on H_2O molecules by the impact of 650 keV N^+ and 1.3 MeV N_2^+ projectiles. The emitted fragments were analyzed by an energy dispersive spectrometer [2]. DDCS have been determined for ion emission in wide angular and energy range.

In this study, we compare the fragmentation spectra between atomic and molecular ion impact. In atomic collisions diatomic molecular projectiles often simply double the yield of the atomic ions with the same Z and velocity. In this case, the effect of the molecular ion can be considered as that of two independently acting atomic ions. Fig. 1 clearly shows that it is not the case in our study with H_2O molecular target.

The normalized yield per nitrogen atom is higher for the N_2^+ molecular ion than for N^+ below 3 eV and slightly higher above cca. 40 eV. In between (in the energy region of double and triple ionization), the atomic ion projectile is the more efficient ionizing agent. This fragment energy dependence can be a useful test for theories, which include both the detailed collision geometry and screening effects. The interpretation of the data is in progress. Work was supported by the Hungarian OTKA Grant (K73703) and by the TAMOP-4.2.2/B-10/1-2010-0024 project co-financed by EU and ESF.

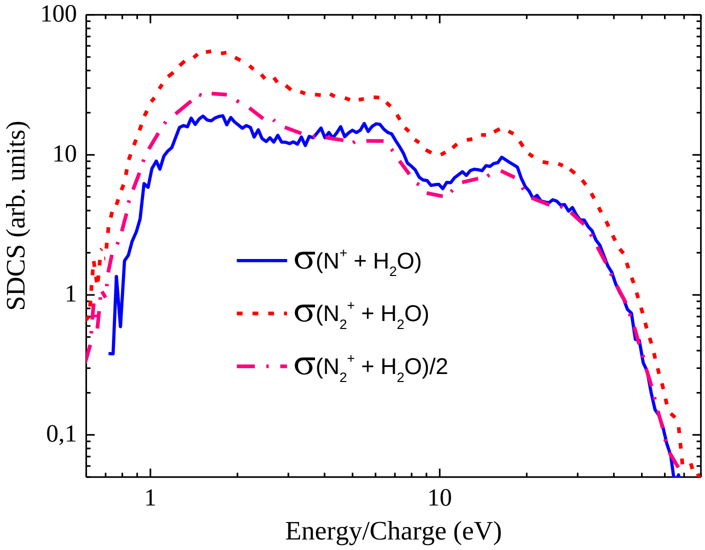

Figure 1. Fragment ion energy spectra of H_2O integrated over the observation angle. All heavy fragments appear below 3 eV. Above that energy H^+ is the dominant fragment (with some H_2^+). The energy of the H^+ fragments increases with the degree of ionization.

References:
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[2] S.T.S. Kovács *et al,* Act. Phys. Deb. **XLVI**, 65 (2012).