

# Orientation and alignment effects in ion-induced fragmentation of isolated water molecules

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**Synopsis** We report the angular distribution of the fragment ions formed in the collision of  $\text{Xe}^{9+}$  ions with isolated water molecules. A significant anisotropy, and strong alignment effects have been seen. It is observed that there is a strong forward - backward asymmetry in the emission of protons and oxygen ions in the three body dissociation of multiply charged water molecules.

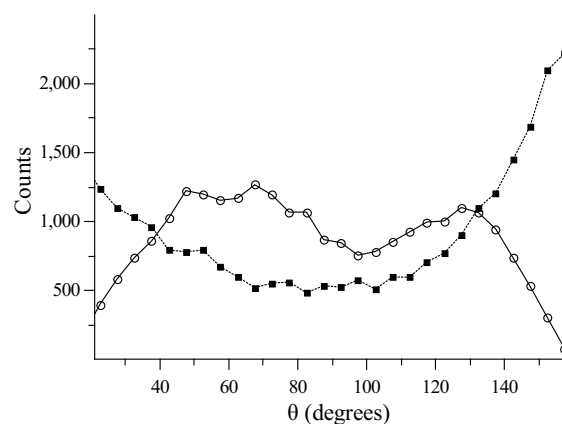
With the advent of recoil ion momentum spectrometers a detailed study of ion-molecule collision processes has become possible. One of the important parameters in such collisions is frequently represented by  $\kappa = q/v$  where  $q$  is the charge on the projectile and  $v$  is its velocity. For very fast ( $v \gg 1 \text{ a.u.}$ ) projectiles, ionization is dominant while for slower ions ( $v < 1 \text{ a.u.}$ ) electron capture is enhanced.

For collisions of fast projectiles with molecules, the interaction time is much smaller than the rotational or vibrational time scales. Hence a vertical Frank-Condon transition is expected and the nuclear conformations of the molecule can be considered to be stationary during the collision. The formation of the multiply charged molecule and its dissociation can be considered independent steps. For slow collisions, not only does the incoming slow projectile influence the electron cloud of the neutral molecule, the outgoing projectile also influences the recoil fragments as they move apart. For molecules (as opposed to atoms) the non spherical nature of the target therefore also leads to alignment and orientation effects that are dependent on the projectile velocity.

Ion impact excitation and fragmentation of water molecules has been addressed in earlier studies. Singles measurements using electrostatic analyser have reported anisotropy in proton emission [1, 2, 3] and coincidence measurements [4, 5] which have focussed on the channel ( $\text{D}^+ + \text{D}^+ + \text{O}^{q+}$ ) have shown the inability of a simple coulomb model to explain the energies and geometry of the dissociating molecular ion.

We present here, the angular distributions of recoil fragment momentum vectors with respect to the incoming projectile direction in the fragmentation of water molecules on multiple ioniza-

tion. From these measurements, made in multi-particle coincidence mode, we note that there is a strong forward backward asymmetry in the  $\text{D}^+$  and  $\text{O}^{q+}$  fragments. We also show a signature of non-planar dissociation of the water molecule.



**Figure 1.** Angle between individual momentum vectors and beam direction for the dissociation channel  $[\text{D}_2\text{O}]^{4+} \rightarrow \text{D}^+ + \text{D}^+ + \text{O}^{2+}$ . Hollow circles are for  $\text{D}^+$  fragment and full squares are for  $\text{O}^{2+}$ .

## References

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