# Splitting in the binary ridges of the $O^+ + H_2 \rightarrow O + H^+ + H$ process as a signature of molecular rotation

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Emission of low-energy fragment ions from $H_2$ and $D_2$ was studied by ion impact. Its experimental investigation is difficult since slow ions are sensitive to disturbing electric fields. A field-free time-of-flight setup was thus developed at Atomki for reliable measurement of velocity distribution for emission of fragment ions with kinetic energies down to 0.1 eV, which allows us to observe effects due to the molecular rotation.

The obtained velocity distribution of the $H^+$ and $D^+$ fragments produced by 10-keV $O^+$ ion impact is shown in Fig. 1. The velocity distributions exhibit a ridge structure due to binary knock out by the projectile. Compared to its expected position for a target at rest, this binary ridge is split and shifted towards two opposite directions. These shifts are due to the speed of the atoms in the rotating target molecule. As expected from their mass ratio, the shift is found to be twice as large for $H_2$ as for $D_2$. An asymmetry is found between the oppositely shifted ridges. This is an evidence for rotational excitation of the target molecule before dissociation. The velocity distributions were measured at room temperature and at 125 K. This did not change significantly the observed distributions since the rapid cooling of the $H_2$ jet leaves the population of the rotational levels unchanged. The studied processes can occur in the atmosphere of large moons and can play significantly role in their dynamic equilibrium .[1]

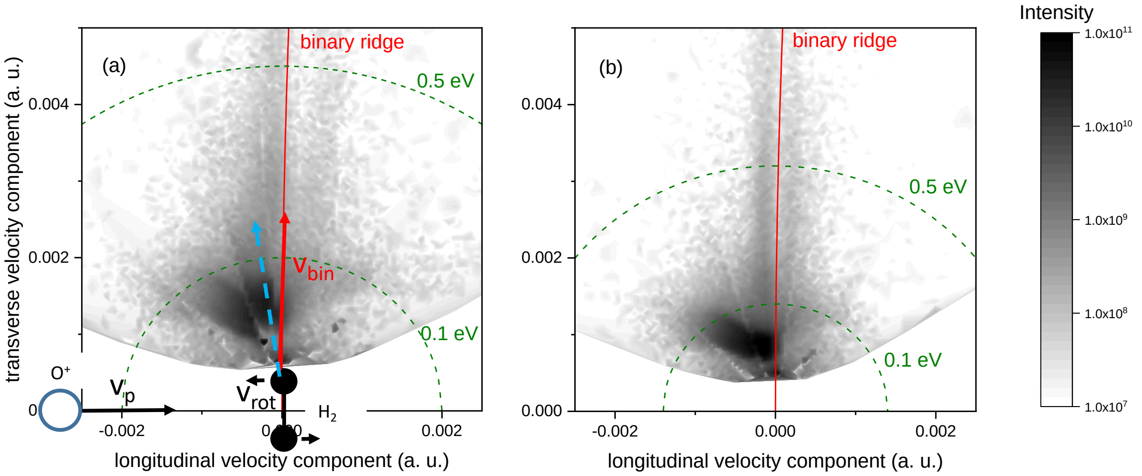


Figure 1: Velocity distribution of $H^+$ ( panel a) and $D^+$ (panel b) fragments stemming from 10-keV $O^+ + H_2$ and $D_2$ collisions, respectively. The longitudinal velocity component is the component along the beam axis.

[1]. Bolton, S. J. et al., Jupiter's Magnetosphere: Plasma Sources and Transport. *Space Sci. Rev*. **2015**, 192, 209. **2012**, *137*, 194313.