Photolysis of the water radical ion H_2O^+ in the XUV studied with the free-electron laser FLASH

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The photofragmentation of the atmospherically and astrophysically important water radical ion H_2O^+ through di-cationic states has been studied at 35.0 ± 0.2 nm (35.4 ± 0.3 eV) and at 21.8±0.2 nm (56.8±0.5 eV) with crossed ion-photon beams experiment [1] at the free electron laser FLASH [2-3].

With a newly developed fragment analyzing system, the dissociation of the di-cations was found to proceed into $O^0 + 2H^+$, $OH^+ + H^+$, and $O^+ + H_2^+$, with determined ratios $\sigma(OH^+ + H^+) / \sigma(O^+ + H_2^+) = 4.2 \pm 0.3$ and $\sigma(OH^+ + H^+)/ \sigma(O^0 + 2H^+)>0.7$. The measured kinetic energy releases for the fragmentation into $O^0 + 2H^+$ (see Figure 1(a)) and $OH^+ + H^+$ are consistent with recent theoretical predictions [4], while the fragmentation into $O^+ + H_2^+$ has so far not been considered. For the three-body channel $O^0 + 2H^+$, we also report on the angular correlation of the fragment (Figure 2(b)) which has also not yet been addressed by theory: we find the dissociation dynamics of the dication to be dominated by a symmetric departure of the two protons that carry most of the released momentum.

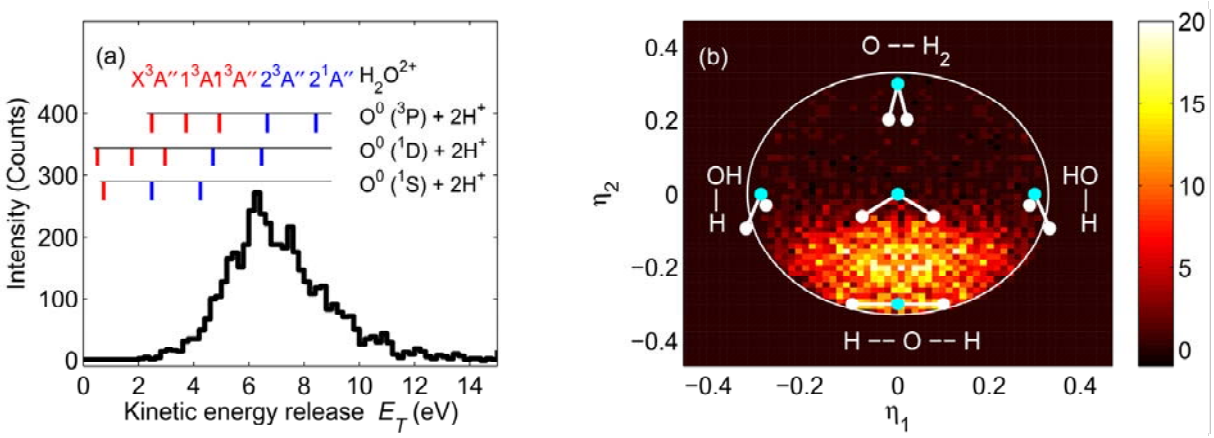

Figure 1. Photofragmentation H_2O^+ at 35.0 nm leading to $O^0 + 2H^+$ [1]. (a) Observed distribution of total kinetic energy release. The ladders above the experimental distribution show the expected kinetic energy releases [4] for vertical transitions from the vibronic ground state of H_2O^+ to five states of H_2O^{2+} followed by dissociation into three possible final states of $O^0 + 2H^+$. The blue lines marks the states for which three-body dissociation into O^0+2H^+ has been predicted [4]. (b) Dalitz plot representing the sharing of energy among the three emerging fragments.

References:

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