

Photodesorption mechanisms for H₂O from the 157 nm irradiation of amorphous solid water at 90 K

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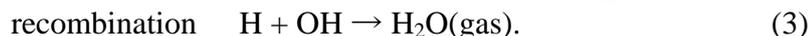
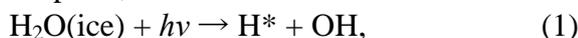
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For grains in the cosmic space, the most important desorption mechanism at the edge of molecular clouds is photodesorption. The desorption mechanisms for H₂O($v=0$) discussed in our previous papers can be grouped into three types [1]; (A) the one that experiences the initial electronic excitation, (B) expelled as a result of electronic excitation of a neighboring molecule, or (C) formed by the recombination of photofragments arising from different photodissociated molecules. Types (A) and (B) are considered to be direct processes, whereas (C) involves secondary processes. Initially, type (A) and (C) mechanisms will involve high internal energies in the desorbing molecules (due to photoexcitation and recombination, respectively). Both might thus be expected to favor formation of vibrationally excited H₂O molecules, whereas the type (B) mechanism could well result in desorbed H₂O($v=0$) molecules.

In the present work, the photodesorption of H₂O($v=0$) following 157 nm photoexcitation of amorphous solid water, has been observed. In addition, signals of H⁺ and OH⁺ were detected in the experiments. Measured H⁺ and OH⁺ signals were deduced to originate from desorbing vibrationally excited water molecules. Two distinct populations were detected, one that appeared promptly and another that grew in relative importance with increasing irradiation time. The former was found to have the same translational temperature as H₂O($v=0$), $T_{\text{trans}}=1800$ K, desorbed by the kick-out mechanism (reactions (1) and (2)) [2, 3]. We considered that the H⁺ and OH⁺ ($T_{\text{trans}}=1800$ K) component arise by the kick-out of vibrationally excited H₂O molecules, or by prompt geminate recombination of H and OH photoproducts followed by desorption, or a combination of both mechanisms.



where H* represents a highly translationally excited H photoproduct with a few eV. The population of H₂O formed by reaction (3) had a much hotter translational temperature, $T_{\text{trans}} = 10000$ K. The time evolution of this component suggests that it probably arises from the secondary recombination of photoproducts at the surface. In these experiments we might therefore have observed H₂O photodesorption resulting from three distinct mechanisms: kick-out, direct recombination, and secondary recombination.

References

- [1] S. Andersson et al., 2011, Phys. Chem. Chem. Phys. 13, 15810
- [2] T. Hama et al., 2010, J. Chem. Phys. 132, 164508.
- [3] A. Yabushita et al., 2009, ApJ 699, L80.