Translational and rotational energy measurements of vacuum-ultraviolet photodesorped water molecules in their vibrational ground state from amorphous solid water


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For large grains in the cosmic space, the most important desorption mechanism at the edge of molecular clouds is photodesorption. To reveal the details of photodesorption mechanism, we have experimentally measured the average translational and rotational energies for photodesorbed H\textsubscript{2}O (v=0) from amorphous solid water (ASW) and polycrystalline ice (PCI) at 90 K using 157 nm laser. The experimental findings are compared with the results of classical molecular dynamics (MD) calculations performed for photodesorption from ASW. The rotational temperature $T_{\text{rot}}(v=0)$ is estimated to be 300 ± 100 K by spectral simulation. Time-of-flight spectrum of H\textsubscript{2}O (v=0) measured for the (2\textsubscript{02}-3\textsubscript{21}) line of the REMPI spectrum was measured, which is well reproduced by a M-B distribution with $T_{\text{trans}}(v=0) = 1800\pm 500$ K. The main mechanisms for this photodesorption is a “kick-out” of an H\textsubscript{2}O molecule on the ice surface by the energetic H atom released from photodissociation of H\textsubscript{2}O + h\nu \rightarrow H + OH. (Fig. 1) The experimentally observed average translational and rotational energies are in good accord with predictions by classical molecular dynamics calculations for the “kick-out” mechanism. H\textsubscript{2}O molecules desorbed from ASW might be expected to lose energy in interactions with cold ice surface. Hence, a slow TOF component might be expected. The absence of any such slow TOF component suggests that H\textsubscript{2}O only on the ice surface can desorb and not from bulk phase.

References