Visible light-induced photodesorption of OH radicals adsorbed on water ice surface

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In cold interstellar medium, the OH radical would be one of the most predominant reactive species on ice dust because it is readily produced by the photolysis of H_2O or surface reaction of H and O atoms. At low temperatures, OH radicals can take part in various chemical activities on the ice dust surfaces, while once they are released from the surface, gas phase chemistry like O_2 formation can be enhanced [1]. However, because the OH radical is highly reactive and thus easily consumed by reactions with other adsorbates at higher temperatures, its thermal desorption as intact may hardly happen. Instead, the photodesorption induced by UV and X-ray photons, which often follow the photodissociation of H_2O, has been investigated for a long time. In contrast, visible light has not been considered as the trigger of photodesorption, because both isolated water molecules and OH radicals are transparent in a visible region. Recently, we observed the photodesorption of OH radical on water ice at 532 nm through combining photostimulated desorption (PSD) and resonance-enhanced multiphoton ionization (REMPI), the PSD-REMPI method [2]. According to quantum chemical calculation, the absorption of 532 nm photons is triggered by the OH strongly bonded with surrounding H_2O through three hydrogen bonds, indicating that the photodesorption strongly depends on the adsorption sites of OH on the water ice surface.

In this study, we extended the wavelength of visible light in the range of 410 to 700 nm to measure the photodesorption efficiency of OH radicals on ice surface, which would be contributed by the population of OH adsorption sites and the photodesorption cross section. The multiplication of the population and cross section represents the effective cross section for each wavelength, which was found to explain the trend of photodesorption efficiency as a function of wavelength very well.

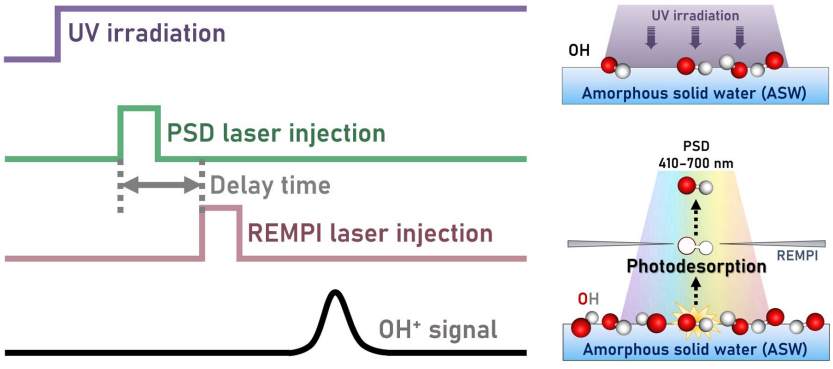

Figure 1: The schematic diagram of OH radicals photodesorb from water ice surface by the visible light.

References

[1] Chaparro et al., A&A, 537, A138 (2012)
[2] Miyazaki et al., Physical Review A, 102, 052822 (2020)