VUV absorption spectroscopy application: non-thermal desorption of astrophysical ices

Yu-Jung Chen, [1]* Ni-En Sie, [1] & Guillermo M. Muñoz Caro [2]
[1]asperchen@phy.ncu.edu.tw, Department of Physics, National Central University, Taiwan
[2]Centro de Astrobiología (INTA-CSIC), Spain

The overabundance of gas molecules in the coldest regions of space points to a nonthermal desorption process. Laboratory simulations show the efficient desorption of CO ice that is exposed to ultraviolet radiation, known as photodesorption. The previous studies of VUV photodesorption yield of CO ice have shown that is deposition temperature dependent [1−3]. However, our understanding of this abnormal phenomenon still remains elusive.

In this talk, we will introduce a novel calculation method of photodesorption yield, named instantaneous photodesorption yield (Y_{ipd}). The results show that Y_{ipd} of CO ice is ice thickness and deposition temperature dependent, which is dominated by three parameters: the desorption yield contributed by a single ice layer, the energy transfer length, and the relative effective surface area. The first step in the photodesorption process is the photon absorption in the CO ice, which is related to the photon energy distribution of the VUV light source and its VUV absorption cross-section at this range [4, 5]. The energy transfer length that plays a part in the photodesorption process, supporting a constant photodesorption yield of CO ice, is dependent on the deposition temperature. At higher deposition temperatures, thicker ice is required to reach maximum and constant values of the photodesorption yield. The roughness of CO ice is also temperature dependent. When CO ice is deposited at low temperatures, the porosity is larger compared to that at high temperatures, leading to a larger effective surface area and causing the higher photodesorption yield.

These parameters should be incorporated into astrophysical models that simulate the photodesorption of the top CO-rich ice layer in icy dust populations, with a size distribution that is related to the ice thickness.

References:

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