

Photodesorption of ices

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A long-standing problem in interstellar chemistry is how molecules can be maintained in the gas phase in dense, low-temperature regions in space. Photodesorption of ices has been suggested to explain the observed cold gas in cloud cores, at cloud edges and in disk mid-planes. We have studied the UV photodesorption of ices experimentally under ultra high vacuum and at astrochemically relevant temperatures (15 – 100 K) using a hydrogen discharge lamp (7-10.5 eV). The ice desorption during irradiation is monitored using reflection absorption infrared spectroscopy and the desorbed species using mass spectrometry. By investigating the photodesorption yield dependence on ice morphology and composition, on temperature and, on UV flux and fluence, we have constrained the photodesorption mechanisms of four different ices: CO, N₂, CO₂ and H₂O (Öberg et al, 2005, Öberg et al. submitted to A&A and to ApJ). We find that both the UV photo desorption rates and mechanisms are highly molecule specific. CO photodesorbs without dissociation from the surface layer of the ice. N₂, which lacks dipole allowed electronic transition in the range of the lamp, does not photodesorb directly though it can co-desorb with other molecules. CO₂ and H₂O desorbs through dissociation and subsequent recombination from the top few layers of the ice. At low temperatures (15 – 18 K) the derived photodesorption rates are $\sim 1 - 3 \times 10^{-3}$ for CO, CO₂ and H₂O. These yields are high enough to impact the chemical evolution of star forming regions. To exemplify this we have modeled the gas-phase H₂O abundance in a Herbig Ae/Be star+disk model. The model shows that UV photodesorption of ices increases the H₂O content by orders of magnitude compared to models where non-thermal desorption is ignored (Fig. 1).

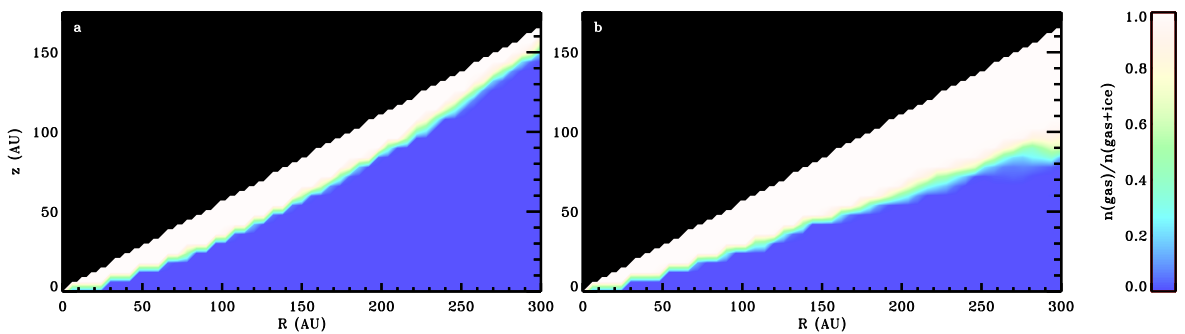


Figure 1: The distribution of gas phase over total H₂O ratio in a circumstellar disk without (a) and with (b) photodesorption. The white, H₂O-gas-dominated area extends more than 50 AU further into the disk when photodesorption is included, displaying the large impact of photodesorption on the chemistry in the outer parts of disks.