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Indirect X-ray photodesorption from ices

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In the colder parts of the interstellar medium, dust grains are covered with molecular ices composed of H₂O, CO,... Among the many radiation-induced processes that occur in these icy mantles, the ones induced by X-rays may play an important role in star and planet formation regions [1]. In particular, X-rays interacting with interstellar ices can release molecules or radicals into the gas phase, by so-called photodesorption processes, and thus have an important role in the gas phase abundances measured from observations by the most recent telescopes (ALMA, NOEMA). This X-ray induced desorption process is however rarely considered because of a lack of experimental quantitative data and because the processes at play are poorly understood [2-5].

We irradiated ices containing ¹⁵N₂ and ¹³CO with soft X-rays using the SPICES 2 set-up connected to the SEXTANTS beamline at the SOLEIL synchrotron [6]. The release of ¹³CO or of ¹⁵N₂ is recorded by mass spectrometry as a function of the incident photon energy near the N (~ 400 eV) and O K-edge (~ 500 eV). Several ices were studied including pure CO ices, pure ¹⁵N₂ ices, and mixed or layered ¹³CO/¹⁵N₂ ices. Photodesorption from a layered ¹³CO/¹⁵N₂ ice reveals an indirect desorption mechanism for which the desorption of ¹³CO is triggered by the photo-absorption of ¹⁵N₂ at the N-edge. This enables to quantify the relevant depth involved in the indirect desorption process, which is found to be 30 - 40 Monolayers in that case. This value is further related to the energy transport of Auger electrons emitted from the photo-absorbing ¹⁵N₂ molecules that scatter towards the ice surface, inducing the desorption of ¹³CO. We show that X-ray induced electron stimulated desorption (XESD), mediated by Auger scattering and subsequent secondary electrons, is the dominant process explaining the desorption from the ices studied in this work [6].

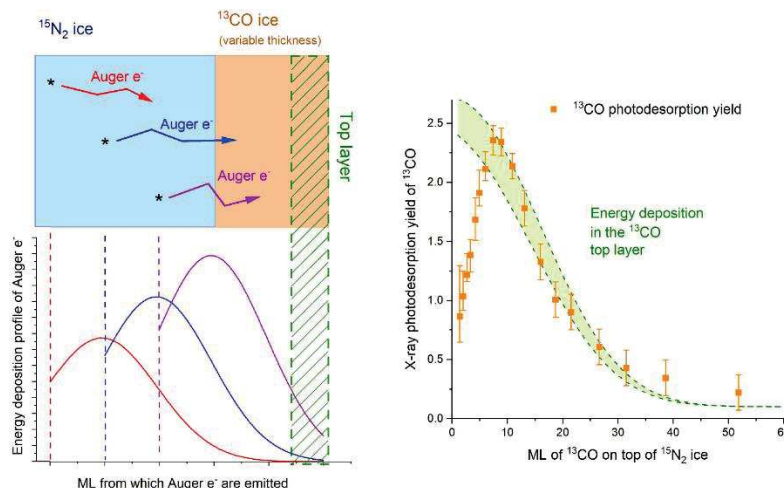


Figure 1: Left: scheme of a simple model to estimate the energy deposited to the top ¹³CO layer of a layered ¹³CO/¹⁵N₂ ice by scattering of Auger electrons emitted after photo-absorption by ¹⁵N₂ molecules. Right: in green is displayed the estimation of this energy, compared with the X-ray photodesorption yields of ¹³CO (orange squares) [7].

- Walsh, C., Nomura H., Millar T. J., et Aikawa Y. ApJ 747, 2 (2012): 114.
- Ciaravella, A.; Caro, G. M.; Escobar, A. J.; Cecchi-Pestellini, C.; Giarrusso, S.; Barbera, M.; Collura, A. ApJ 2010, 722, L45–L48.
- Dupuy, R., M. Bertin, G. Féraud, M. Hassenfratz, X. Michaut, et al. Nat. Astron. 2, 10 (2018): 796-80
- Basalgète, R.; Dupuy, R.; Féraud, G.; Romanzin, C.; Philippe, L.; Michaut, X.; Michoud, J.; Amiaud, L.; Lafosse, A.; Fillion, J.-H.; Bertin, M. A&A 2021, 647, A35.
- Basalgète, R.; Dupuy, R.; Féraud, G.; Romanzin, C.; Philippe, L.; Michaut, X.; Michoud, J.; Amiaud, L.; Lafosse, A.; Fillion, J.-H.; Bertin, M. A&A 2021, 647, A36.
- Basalgète, R.; Torres-Díaz, D.; Lafosse, A.; Amiaud, L.; Féraud, G.; Jeseck, P.; Philippe, L.; Michaut, X.; Fillion, J.-H.; Bertin, M. J. Chem. Phys. 2022, 157 (8), 084308.