

UV/VUV photo-processing of positively charged nitrogen-bearing aromatic molecules (*N*-heterocycles and cyano-PAHs)

U. Jacovella¹, C. S. Hansen², A. Giuliani^{3,4}, Adam J. Trevitt⁵,
J. A. Noble⁶ and L. Nahon³

¹ *Université Paris-Saclay, CNRS, Institut des Sciences Moléculaires d'Orsay, 91405 Orsay, France*

² *School of Chemistry, University of New South Wales, Sydney, NSW 2052, Australia*

³ *Synchrotron SOLEIL, L'Orme des Merisiers, 91192 Saint Aubin, Gif-sur-Yvette, France*

⁴ *INRAE, UAR1008, Transform Department, Rue de la Ge'raudie`re, BP 71627, F-44316 Nantes, France*

⁵ *Molecular Horizons and School of Chemistry and Molecular Bioscience, University of Wollongong, Wollongong, New South Wales 2522, Australia*

⁶ *CNRS, Aix-Marseille Université, Laboratoire PIIM, Marseille, France*

N-heterocycles are suspected to play an important role in the chemical origin of life [1]. Despite their detection in meteorites [2] and in Titan's atmosphere [3], their extra-terrestrial chemical formation networks remain elusive. The recent detection in pre-stellar sources of cyano-substituted hydrocarbon cycles has emphasized the importance of aromatic chemistry in the earliest stages of star formation, however, *N*-heterocycles remain undetected in the interstellar medium (ISM). Since ultraviolet (UV) and vacuum-UV (VUV) radiation is ubiquitous in space, the photo-processing of aromatic ions may open a window onto rich chemical networks and lead to the formation of larger aromatics in space. We assessed the photostability of protonated *N*-heterocycles and cyano-PAHs as well as cyano-PAH radical cations after UV and VUV excitation using a linear ion trap that can be coupled to the UV/VUV light from the DESIRS beamline at the synchrotron SOLEIL. For the protonated *N*-heterocycles, it provided information on their ability to retain the *N* atom into the cycle to generate larger *N*-containing species or functionalized *N*-heterocycles. For the protonated cyano-PAHs, we observed that UV and VUV photodestruction leads to the formation of a highly reactive cationic species, the inclusion of these top-down processes into existing astrochemical models might help improving the predicted abundances of aromatic species in the ISM. We also investigated the impact of the protonation versus formation of the radical cationic species on the cyano-PAH family. We evaluated the differences in their branching ratio of fragmentation over ionization and the differences in the dissociation paths that are being opened.

References

[1] S. A. Sandford, M. Nuevo, P. P. Bera, T. J. Lee, *Chem.Rev.* **120**, 4616 (2020) and references therein.

- [2] Z. Martins, *Life*, **8** 28 (2018) and references therein.
- [3] A. Ali., E. C. Sittler Jr, D. Chornay, B. Rowe, C. Puzzarini, *Planet. Space Sci.* **109** 46 (2015).
- [4] B. A. McGuire., R. A. Loomis, A. M. Burkhardt *et al.*, *Science* **371**, 1265 (2021) and references therein.