Insights into Interstellar Ice Photochemistry: Cryogenic Laboratory Studies

Malla, B. K.,[1]* and Pradeep, T.[2]
*presenter
[1]mbijesh100@gmail.com, Indian Institute of Technology Madras, Chennai 600036, India
[2] Indian Institute of Technology Madras, Chennai 600036, India

The photochemistry of molecular ices in ultrahigh vacuum ($P < 10^{-10}$ mbar) under cryogenic (T ~ 10-100 K) laboratory conditions is crucial in enhancing our understanding of interstellar chemistry complexity.[1] With over 300 simple and complex molecules detected in interstellar environments, questions regarding their formation mechanisms persist. The photolysis experiments conducted on different ice phases provide valuable insights into the intricate processes occurring within molecular ice at low temperatures. In the study of CH_3Cl photolysis, the comparison between uniform and less uniform crystalline phases revealed a significant difference in photoproduct abundance, emphasizing the role of structural organization in facilitating diffusion and radial orientation of radicals, thereby influencing photoproduct yields.[2] Similarly, the photolysis of amorphous N_2O demonstrated temperature-dependent variations in photoproduct formation, with primary photoproducts dominating at low temperatures and secondary photoproducts becoming more prominent at higher temperatures, indicative of complex reaction pathways. Furthermore, the investigation of dimethyl ether and water ice highlighted the significance of radical recombination processes within water cages, suggesting a mechanism for the selective formation of photoproducts. These findings collectively deepen our understanding of the photochemical dynamics of molecular ices under astrophysical conditions. Elucidating such processes contributes to unraveling the complexities of interstellar chemistry and provides valuable insights into the formation mechanisms of diverse molecules observed in space.

---

[1]Arumainayagam, C. R. *et al.* Extraterrestrial prebiotic molecules: photochemistry vs. radiation chemistry of interstellar ices. *Chem. Soc. Rev.* **48**, 2293–2314 (2019).
[2]Malla, B. K., Vishwakarma, G., Chowdhury, S. & Pradeep, T. Vacuum Ultraviolet Photolysis of Condensed Methyl Chloride in Interstellar Model Conditions and Trapping of Intermediates at Intergrain Interfaces. *J. Phys. Chem. C* **127**, 24149–24157 (2023).