HMT derivatives as relics of the radicals formed at low temperatures

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Hexamethylentetraamine (HMT) is a molecule known to be formed under experimentally simulated interstellar ice irradiation expected to occur in dense cloud interiors and cold protoplanetary environments. HMT could have played a significant role in the delivery of organic matter in the early Earth, as it can produce several aminoacids, being a relevant molecule for prebiotic chemistry and astrobiology. The formation pathways of HMT have been studied over the last years by several groups [1,2]. In this work [3], we have performed laboratory experiments to simulate realistic ice mantles (composed of H_2O:CH_3OH:NH_3) and study the formation of HMT-based species.

Up to 17 different HMT derivatives (HMT-R) have been detected from the GC-MS analysis of the residues left by the UV-irradiated ice mantles at room temperature, 11 of them are detected for the first time [4]. Analysis of different residues over the last decades have shown considerable differences in the detected products for similar experiments, suggesting that the analytical procedure and, as we will discuss also the storage time of the samples, play a key role in the species which are detected in the chromatographic analysis.

We propose that the abundance of the different HMT-R species is indicative of the abundance of the R groups at lower temperatures. Even though there are some considerations that should be pointed out, the idea of using these species as tracers of the radical abundances in the irradiated ice at low temperatures seems to be an interesting point that will be addressed during the talk.

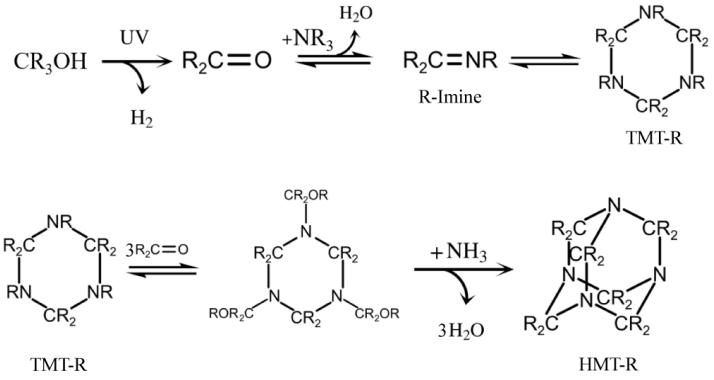

Figure 1. Synthesis of HMT-R. The proposed pathway has been modified from the accepted pathway towards the formation of HMT, showing how HMT-derivatives can be obtained.

References

[1] Vinogradoff et al. 2013 A&A, 551, A128
[2] Carrascosa et al. 2021, MNRAS, 506, 791
[3] del Burgo Olivares et al. 2025, A&A, 698, A285
[4] Muñoz Caro et al. 2004, A&A, 413, 209