UV laser desorption time-of-flight mass spectrometry of VUV photo-processed ices

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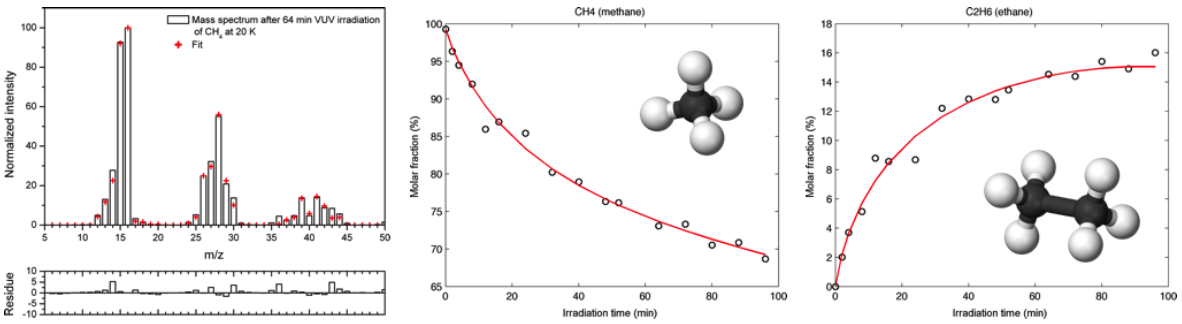
Advances in telescope and interferometer arrays have highlighted a rich and exotic chemistry occurring in the surroundings of star-forming regions, as evidenced by the detection of more than 170 molecules and ions in space. Complex organic molecules (> 6 atoms) have been unambiguously detected, but their formation mechanism and corresponding yields are still unknown. Following astronomical observations, laboratory studies and models, it has become clear that surface chemistry on icy grains steadily increases the chemical diversity and offers a way to explain the molecular complexity in space. So far, systematic experimental investigations on the formation of complex organic molecules have been restricted, mainly due to the limitations imposed by standard solid-state techniques. To overcome these limitations, a new experimental setup as been designed.

A new ultra-high vacuum experiment is described that allows studying photo-induced chemical processes in interstellar ice analogues [1]. MATRIICES: a Mass Analytical Tool to study Reactions in Interstellar ICES applies a new concept by combining UV laser desorption and time-of-flight mass spectrometry with the ultimate goal to characterize *in situ* and in real time the solid state evolution of organic compounds upon VUV photolysis for astronomically relevant ice mixtures and temperatures

The performance of the experimental setup is demonstrated by the kinetic analysis of the different photoproducts of pure methane ice at 20 K. A quantitative approach provides molar fractions at the different stages of the VUV irradiation. These data are then kinetically fitted to a reduced chemical reaction network in order to obtain the rate constants and ultimately the branching ratios of photochemical reactions yielding new species with up to four carbon atoms. Convincing evidence is found for the formation of even larger species.



References

[1] Paardekooper, D. M., Bossa, J.-B., Isokoski, K., and Linnartz H. (*submitted to RSI, 2014*)