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Formation of Organic Molecules in the Interstellar Medium

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This work presents the study of some molecules of the interstellar medium that could useful for the bookkeeping of the organic content of the universe and for the assessment of prebiotic conditions on Earth and in other environments in the universe. The Horsehead Nebula was chosen as test object, due to its simple geometry, its moderate distance to us, its well-known ultraviolet radiation field resulting from the star Orionis, and due the fact that it has been extensively studied in several works.

The main tool used in the present work was the Meudon PDR code due the fact that it is widely used as one of the legacy data analysis programs of current astronomy projects, e.g. the Herschel project, and it is public. The code can reliably model the Horsehead Nebula, since this object is a prototypic PDR (photodissociation region). We have updated the chemical sector of the code - at least a hundred more molecules - in order to test several scenarios of molecule production.

We derived the abundances of several molecules, including some of potential prebiotic importance and we investigated the role of PAHs. We explored production channels for astrobiologically relevant nitrogenated heterocycles, such as pyrrole and pyridine. PAHs are important as intermediary species that favor the production of N-heterocycle. Furthermore, we have checked the role of the cosmic rays flux, within a scenario in which cosmic rays could raise the cation abundances, therewith increasing the abundances of complex molecules.

This presents simulations show us how the exploration of only a small number of possible paths of production of heterocycles already resulted in significants abundances at least one N-heterocycle species, pyridine. Systematic tours along other productions paths are expected to reveal more species with abundances high enough to be targeted in future observational surveys.

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