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How laboratory experiments can help in studying cosmic PAHs

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Polycyclic aromatic hydrocarbons (PAHs) are commonly thought to play a key role in the chemical and physical evolution of star-forming regions from the small scales of protoplanetary disks to the large scales of galaxies. However attempts to identify individual species have been so far unsuccessful. Cosmic PAHs and related species such as C_{60}, are observed by their emission features in the mid-infrared, the so-called aromatic infrared bands (AIBs). Emission in the AIBs is triggered by the absorption of VUV photons but this process can also induce ionisation and unimolecular dissociation. The composition of the IR-emitting population might therefore reflect this processing. In addition the formation routes of these large carbonaceous molecules have still to be elucidated. Several scenarios including bottom-up and top-down ones have been proposed.

In my presentation, I will discuss how this subject takes benefit from laboratory astrophysics. The photophysics of isolated PAHs, including ionisation, dissociation and radiative cooling is studied with different setups (molecular jets, ion traps, storage rings) and makes use of VUV tunable synchrotron radiation [1-6]. The question of the formation by gas-phase condensation of PAHs and carbonaceous grains in circumstellar environments has been discussed following experiments that use techniques such as laser ablation, laser pyrolysis or plasma discharges [7-9]. Recently, the Stardust machine in Madrid [10] has been developed to study grain formation in conditions that approach those found in Asymptotic Giant Branch star environment. The molecular analysis of laboratory analogues of cosmic dust, combined with that of extraterrestrial samples such as meteorites, is expected to provide new insights into chemical pathways leading to the formation of cosmic PAHs. I will describe how this topic is addressed in the framework of the Nanocosmos ERC Synergy project using in particular the AROMA setup [11].

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