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Laboratory Synthesis of Complex Nanocarbons detected in Carbon-rich Evolved Stars

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In the laboratory scale it is possible to produce most of the molecular species known (or suspected) to be formed in the evolution from AGBs to PN. These species can be produced through the carbon arc i.e. the electric arc struck between two graphite electrodes. The key reaction product of the carbon arc is the carbon vapor, derived from the sublimation of elemental carbon at T≥4000 K. Depending from the conditions selected, the carbon arc can produce polyynes (H-(C≡C)n-H), monocyanopolyynes (H-(C≡C)n-CN) and dicyanopolyynes (NC-(C≡C)n-CN). One key parameter to selectivity in the final products regards the arc regime. The selective production of fullerenes, requires a higher power carbon arc (3000 W) much higher than the 20 W arc needed to produce polyynes.
C60 and C70 fullerenes are readily reactive with atomic hydrogen yielding fulleranes the hydrogenated fullerenes. The fullerenes are so avid of hydrogen that the hydrogenation in the laboratory conditions leads directly to C60H18 and C60H36. Thus, it is completely reasonable to think that hydrogenated fullerenes may be present in space. For the time being, attempts to unambiguously detect hydrogenated fullerenes were unsuccessful.
Fullerenes were found in various space environments, sometime in conjunction with other complex molecules like PAHs or metals. Fullerenes are reactive with certain PAHs forming adducts. Examples of adducts are those with the acene series of PAHs and with indene. Indeed, our most recent works in fullerene adducts regard the reaction with C60 with the indene hydrocarbon and with CN radicals.
The Aromatic Infrared Bands (AIBs, sometimes referred as UIBs or UIRs) represent a series of discrete infrared emission bands detected in numerous and very different astrophysical objects including (proto-)PNe. The carriers of these infrared bands have not yet unambiguously identified. It has been proposed that the carriers of the AIBs could be described by an "average"chemical structure consisting of mixed aromatic-aliphatic organic nanoparticles (MAONs) and containing also heteroatoms such as N, S and O. We have shown through infrared spectroscopy that asphaltenes are matching quite well the MAONs model.

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