Is the solid carbon depletion in the solar system universal ?

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At the location of the terrestrial planets, solid carbon—although being the fourth most abundant element in the Universe—is depleted by three orders of magnitude compared to cosmic abundances. In contrast, the outer regions of the Solar System appear to be much closer to the cosmic values. This observational fact raises important questions about the habitability of terrestrial planets if they had retained cosmic carbon abundances, as well as about the universality of this carbon depletion phenomenon. To tackle these issues, we have launched two major projects designed to improve our understanding of the origin and implications of this depletion.

We have initiated a project aiming at studying the solid carbon content in the innermost regions (1–20 AU) of protoplanetary disks using the Very Large Telescope Interferometer instrument MATISSE. Its exceptional angular resolution (10 mas) and broad spectral coverage allow us to probe the thermal infrared emission features from C–H bonds in carbon nanoparticles at 3.3, 8.6, 11.3, and 12.7 µm, across the 3–13 µm range. By using this nanoparticle emission as a proxy for solid carbon content, CYPRESS aims to measure the carbon-to-silicon abundance ratio as a function of distance from the central star. Nine bright targets (eight Herbig Ae stars and one T Tauri star) with high signal-to-noise MATISSE data have been selected for this study. This effort is supported by a grant from the French National Research Agency (ANR) under the project CYPRESS, which started in February 2026 and is planned to run for five years.

Recognizing the inherent limitations of ground-based observations, which are restricted to the brightest young stellar objects and to emission bands associated with C–H bonds, we have developed the concept of C4LIFE**.** C4LIFE is a space-based infrared interferometric mission proposed to European Space Agency within the framework of the F3 mission call. In collaboration with Thales Alenia Space, we have developed and submitted a mission concept. This two-year mission would extend the CYPRESS approach to lower-mass stars, down to a sensitivity limit of 1 mJy, while achieving an angular resolution of ~25 mas at 6.2 µm sufficient to resolve the disks at the 2-3 AU scale. A space-based infrared mission would not only enable highly sensitive detection of the C–H emission bands, but also provide simultaneous access to the 6.2 and 7.7 µm C–C bonding emission features, which are inaccessible from the ground. This capability would mitigate biases inherent to ground-based observations, particularly those arising from potentially dehydrogenated particles. Ultimately, such a mission would allow the construction of a statistically robust sample exceeding 200 targets, complete in stellar mass down to spectral type M7.

In this presentation, I will introduce the scientific questions and the observational strategy to tackle them. Some preliminary results from CYPRESS will be shown. A detailed description of the scientific objectives of the C4LIFE mission, currently open to partnerships, will also be given.