Investigating a key parameter for the emergence of life: the carbon deficit observed on Earth.

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Abstract

The inner Solar System exhibits a significant carbon deficit, approximately three orders of magnitude lower compared to the Sun, to the bodies of the outer Solar System and to the interstellar medium. This characteristic has profoundly influenced Earth's internal dynamics, supporting tectonics, volcanism, and the silicate-carbonate cycle-processes essential for habitability. The question of whether this deficit is universal remains open and is a key challenge in evaluating the habitability potential of planets.
To address this scientific goal, it is necessary to observe the inner disk regions around young stars. However, achieving this requires unprecedented technological advances. Current ground-based interferometers, such as VLTI or the upcoming ELT, cannot bypass the telluric absorption lines of Earth's atmosphere (specifically regarding key spectral signatures). Meanwhile, space telescopes like JWST or the proposed HWO are limited in angular resolution by the diameters of mirrors that can feasibly be launched into orbit.

In response to the current instrumental limitations, we are exploring the instrumental concept of a space interferometer. Through this preliminary work, we aim to characterize the key design parameters necessary to achieve our scientific goal: defining the universality of solid carbon depletion in our Solar System and providing the scientific community with an observational tool capable of very high angular and spectral resolution for targets emitting in the mid-infrared.
A survey of potential targets is required to conduct a probabilistic study quantifying the likelihood of identifying carbon signatures around young objects. Subsequently, by analyzing the requirements for such observations, studying current instrumental limitations, and leveraging the expertise of leading aerospace industry partners, we will develop a preliminary concept for a "small" space mission aligned with our pre quoted scientific ambition. This work will contribute to advancing our understanding of the conditions necessary for the emergence of life.

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