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Carbon-grain sublimation: a new top-down component to protostellar chemistry

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One of the main goals in the fields of exoplanets and planet formation is to determine the composition of terrestrial, potentially habitable, planets and to link this to the composition of protoplanetary disks. A longstanding puzzle in this regard is the Earth's severe carbon deficit; Earth is 2-4 orders of magnitude depleted in carbon compared to interstellar grains and comets. The solution to this conundrum is that carbon must have been returned to the gas phase in the inner protosolar nebula, such that it could not get accreted onto the forming bodies. A process that could be responsible is the sublimation of carbon grains at the so-called soot line (~300 K) early in the planet-formation process. I will argue that the most likely signatures of this process are an excess of hydrocarbons and nitriles inside the soot line around protostars, and a higher excitation temperature for these molecules compared to oxygen-bearing complex organics that desorb around the water snowline (~100 K). Moreover, I will show that such characteristics have indeed been reported in the literature, for example, in Orion KL, although not uniformly, potentially due to differences in observational settings or related to the episodic nature of protostellar accretion. If this process is active, this would mean that there is an heretofore unrecognized component to the carbon chemistry during the protostellar phase that is acting from the top down - starting from the destruction of larger species - instead of from the bottom up from atoms. In the presence of such a top-down component, the origin of organic molecules needs to be re-explored.