Formation of organic matter in the protosolar nebula and delivery to the Galilean moons

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Carbonaceous material is thought to exist on the surfaces of various celestial bodies in the outer solar system, such as the Galilean moons. In addition, the density and moments of inertia of icy moons and dwarf planets suggest that their refractory cores are likely to be at least partly composed of this material. This initial carbonaceous material likely consisted of complex organic molecules (COMs) that may have formed during the early stages of moon formation when precursor materials existed as pebbles and icy grains in the protosolar nebula. Experimental studies have confirmed that the UV irradiation or thermal processing of icy grains under nebular conditions can generate COMs.

A baseline scenario suggests that the Galilean moons formed within a circumplanetary disk that maintained temperatures too low to vaporise the solids from the protosolar nebula. Within this framework, the composition of the moons' building blocks is primarily determined by the thermodynamic conditions of the protosolar nebula. Our aim is to assess these thermodynamic conditions and their role in the formation and transport of complex organic molecules (COMs) into the environment where the Galilean moons formed, in the context of the above scenario. To achieve this, we have developed a two-dimensional model describing the transport of pebbles and dust particles during the protosolar nebula's evolution, employing a Lagrangian scheme. This model allows us to calculate the interstellar flux received by the particles as they pass through the nebula. We will present preliminary results showing a range of disk conditions that support the survival of COM-rich particles across the protosolar nebula, allowing them to persist until they reach the formation region of the Jovian system. Moreover, we will explore how those results could affect the composition of the primordial hydrospheres of the Galilean icy moons.