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Title: Interstellar Organics, the Solar Nebula, and Saturn's Satellite Phoebe

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ABSTRACT

The diffuse interstellar medium inventory of organic material (Pendleton et al. 1994, Pendleton & Allamandola 2002) was likely incorporated into the molecular cloud in which the solar nebula condensed. This provided the feedstock for the formation of the Sun, major planets, and the smaller icy bodies in the region outside Neptune's orbit (transneptunian objects, or TNOs). Saturn's satellites Phoebe, Iapetus, and Hyperion open a window to the composition of one class of TNO as revealed by the near-infrared mapping spectrometer (VIMS) on the Cassini spacecraft at Saturn. Phoebe (mean diameter 213 km) is a former TNO now orbiting Saturn. VIMS spectral maps of Phoebe's surface reveal a complex organic spectral signature consisting of prominent aromatic (CH) and aliphatic hydrocarbon (CH_2, CH_3) absorption bands (3.2-3.6 μm). Phoebe is the source of a huge debris ring encircling Saturn, and from which particles (~5-20 μm size) spiral inward toward Saturn. They encounter Iapetus and Hyperion where they mix with and blanket the native H_2O ice of those two bodies. Quantitative analysis of the hydrocarbon bands on Iapetus demonstrates that aromatic CH is ~10 times as abundant as aliphatic CH_2+CH_3, significantly exceeding the strength of the aromatic signature in interplanetary dust particles, comet particles, and in carbonaceous meteorites (Cruikshank et al. 2013). A similar excess of aromatics over aliphatics is seen in the qualitative analysis of Hyperion and Phoebe itself (Dalle Ore et al. 2012). The Iapetus aliphatic hydrocarbons show CH_2/CH_3 ~4, which is larger than the value found in the diffuse ISM (~2-2.5). Insofar as Phoebe is a primitive body that formed in the outer regions of the solar nebula and has preserved some of the original nebula inventory, it can be key to understanding the content and degree of processing of that nebular material. There are other Phoebe-like TNOs that are presently beyond our ability to study in the organic spectral region, but JWST will open that possibility for a number of objects. We now need to explore and understand the connection of this organic-bearing Solar System material to the solar nebula and the inventory of ISM materials incorporated therein.

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