

Synthesis Of Large Molecules In Cometary Ice Analogs: Physical Properties Related To Self-assembly Processes

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Comets and carbonaceous micrometeorites may have been important sources of volatiles on the early Earth; their organic composition may therefore be related to the origin of life. Ices on grains in molecular clouds contain a variety of simple molecules. Within the cloud and especially the presolar nebula, these icy grains would have been photoprocessed by ultraviolet light to produce more complex molecules. We are investigating the molecules that could have been generated in precometary ices. Experiments were conducted by forming a realistic interstellar ice (H_2O , CH_3H , NH_3 and CO) at ~ 10 K under high vacuum irradiated UV by a hydrogen plasma lamp. The residue remaining after warming to room temperature was analyzed by HPLC and by several mass spectrometric methods. This material contains a variety of complex compounds with MS profiles resembling those found in IDPs and meteorites. Surface tension measurements show that an amphiphilic component is also present. These species do not appear in various controls or in unphotolyzed samples. In other experiments, the residues were dispersed in aqueous media for microscopy. The organic material forms 10-40 micrometer droplets that fluoresce (300-450 nm) under UV excitation and appear strikingly similar to those produced by extracts of the Murchison meteorite. Together, these results suggest a link between organic material synthesized on cold grains photochemically and compounds that may have contributed to the organic inventory of the primitive Earth. The amphiphilic properties of such compounds permit self-assembly into the membranous boundary structures required for the first forms of cellular life.