UV Formation of Organic Molecules In Pre-Planetary Disks

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Up to 90% of stars forming today are born in dense OB associations such as Orion. Photo-evaporation by the UV radiation of nearby O and B stars can destroy disks around low-mass stars on 10^5-10^6 yr time-scales, dramatically affecting the formation of planets. However, the very same UV radiation that destroys the disks may also encourage the formation of organic molecules in these disks. UV photolysis of ices has been shown to produce solid-phase organic molecules, from simple CO and CH_4 to amino acids and alcohols (e.g., Bernstein et al 2002, Nature 416). If these compounds -- and the circumstellar disk in which they are formed -- can survive photo-evaporation, then they could play a role as biotic precursors.

Historically, models for the early chemical evolution of the pre-planetary disk have not considered UV effects because the flux from the Sun is insignificant; however, net flux from external stars can be 10^7 larger than that from the Sun.

We have numerically modeled the formation and loss rates for simple organic molecules produced in UV-irradiated circumstellar disks. We find that the total UV dose received can exceed 10^3 photons/molecule at most locations within the disk within 10^6 yr. This is sufficient flux to synthesize many organic compounds. The stability of these molecules depends on their location within the disk and the time delay between disk formation and the onset of photo-evaporation. We will identify the parameters of circumstellar disks which are most likely to allow formation and retention of organic compounds.