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原始惑星系円盤における有機物粒子の時空間変化
Temporal and spacial variation of organic materials in the proto-solar disk

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More than 80 distinct amino acids are discovered in meteorites, which, in addition to their precursors, are suggested to be extraterrestrial origin. Even the detection of glycine, the simplest amino acid, has been claimed in samples from comet 81P/Wild 2 returned by NASA's Stardust spacecraft. These discoveries suggest that interstellar chemistry can produce such complex molecules. Motivated by these studies, some observational search for complex molecules in the interstellar medium reported to detect acetic acid, acetamide, aminoacetonitrile, and ethyl formate in Sagittarius B2 molecular cloud. More recently, ALMA observation is expected to find more complexity of such organic materials.

Organic materials in the asteroids and comets may be partially derived from molecular clouds and partially processed in proto-solar disk. It is one of the critical problems whether organic materials in the interstellar dusts formed in molecular cloud could survive and accreted to planetesimals. Interstellar dusts were incorporated into the proto-solar molecular cloud and were heated to evaporate in the proto solar nebula. Since the degree of evaporation depends on temperature and pressure conditions of the solar nebula, the distribution and chemical compositions of the dusts in the solar nebula would vary from place to place and with time.

We calculated disk evolution and particle motion simultaneously in order to investigate temperature change of individual particles, which enables us to trace the change of average chemical composition of organics. The fundamental difference from the chemical network reactions on the surface of solid materials at lower temperatures of molecular clouds is that the reactions in this work are thermal processes at higher temperatures ($T \geq 297K$).

We calculate viscous disk evolution model and particle-tracking model by Ciesla (2011). Particles are released at each 10AU at $t = 0$. Particles are supposed to be small enough to well couple with gas and they are thermally equilibrated.

The starting material is assumed to be *Greenberg particle*, which consists of silicate core and organics, and the chemical composition is taken from that for 297K of Nakano et al. (2003). When heated, the C and N composition of particles varies according to Nakano et al. (2003), but do not vary if temperature decreases. By summing up all the grains with different thermal history located at every 1AU at a certain time, the local bulk chemical composition of organics in the disk is obtained.

The temporal change of gas temperature and distribution of particles shows that particles initially located in the low-temperature outer region drift inward, and that thermally unprocessed organic particles were present in the inner region after 10^6 years because the temperature of disk decreases with time where particles from outer regions move.

The temporal-spatial variation of C and N contents and C/N ratio of organic particles indicates chemical variation of the inner region ($\leq$10AU). Silicate-organics complex grains from a molecular cloud were partially evaporated to be poor in organic materials inside 5AU at the early stage of the proto-solar disk. As temperature decreases with time, primitive grains are transported inward and chemical composition of organic materials in the inner regions of the disk changed from fractionated to unfractionated composition with disk evolution. A small amount of diffuse cloud organic materials survive at the most inner region and partially evaporated molecular cloud organic materials and diffuse cloud organic materials are mixed at C/N ratio-decreasing region. This result shows that composition of organic materials accrete to a planetesimal depend on when the planetesimal is formed.

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