Interstellar Organic Chemistry

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Recent studies of organic molecule formation in dense molecular clouds will be described [1]. The principal gas phase reaction pathways to complex molecule formation by catalysis on dust grains and by gas phase reactions will be summarised. By considering surface reaction mechanisms analogous to the processes believed to have formed the precursors of the organic complement found in the Murchison meteorite, one can identify formation pathways to many interstellar organics. Protostellar cores, where warming of dust has induced evaporation of icy grain mantles, are excellent sites in which to study the interaction between gas phase and grain-surface chemistries. One can distinguish between those organics that are observed to be the direct products of grain surface reactions and those which are derived from secondary gas phase reactions amongst evaporated surface products. Observational searches for these new, large, interstellar molecules, will also be described. The connection between observed interstellar organics and those detected in comets Hale-Bopp and Hyakutake will be discussed.

[1] Charnley S.B. (2001), in Building Bridges from the Big Bang to Biology, Ed. F. Giovannelli, Consiglio Nazionale delle Ricerche President Bureau, (Rome:Italy), Special Volume, 139-149

Extinct ^{7}Be and ^{10}Be in refractory inclusions from the Allende and Efremovka chondrites

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Recent ion microprobe studies of several Ca-Al-rich refractory inclusions (CAIs) from the Allende and Efremovka chondrites revealed, for some of them, large Li and B isotopic variations which are best explained by the in situ decay of two short-lived radioactive isotopes of Be, ^{7}Be which decays to ^{7}Li with a half-life of 53 days (Chaussidon et al., 2002) and ^{10}Be which decays to ^{10}B with a half-life of 1.5 My (McKeegan et al. 2000) .

The ^{10}Be/^{9}Be ratios at the time of CAI crystallization range for these different CAIs from $4.5\times10^{-4} \pm 1.3\times10^{-4}$ to $9.5\times10^{-4} \pm 1.9\times10^{-4}$ with no clear relationship with ^{26}Al/^{27}Al ratios. In our present understanding of the origin of ^{10}Be by irradiation processes, these variations of the ^{10}Be/^{9}Be ratios between the different CAIs cannot be turned directly into age differences since they could as well reflect differences in the amount of stable ^{9}Be present in the irradiated target. At variance with the Be-B systematics, the Be-Li systematics in CAIs appears much more complex. In fact very large variations of the Li concentrations (from 1 to 368 ppb) and of the ^{7}Li/^{6}Li isotopic ratios (from 10.85±0.39 to 13.51±0.48, 2 sigmas) are observed for instance in Allende USNM 3515. These variations are compatible with a re-distribution of Li (and Li isotopes) by solid state diffusion during the cooling of the CAI and the decay of ^{7}Be, with a closure temperature for Li diffusion on the order of 400±50°C. The highest ^{7}Be/^{9}Be ratio found up to now in CAIs is of 0.22±0.13.

Because of its very short half-life, the incorporation of live ^{7}Be into CAIs would be a definitive proof for the existence of irradiation processes around the early Sun. The ^{7}Be/^{10}Be ratio which can be estimated for CAIs is within errors close to the production ratio modelled for spallation reactions between accelerated protons and O atoms (Leya et al., 2002). This implies that both ^{7}Be and ^{10}Be are produced within the early solar system around the forming Sun. These irradiation processes must thus be considered, in addition to production during supernova explosion, as an additional possible source of short-lived radioactive nuclides (e.g. ^{26}Al and ^{41}Ca) in the early solar system.

References

McKeegan K. D. et al. (2000) *Science 289*, 1334-1337.
Chaussidon M. et al. (2002) *LPS XXXIII.* 1563.
Leya I. et al. (2002) *LPS XXXII.* 1268