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Systematics between planetary properties and stellar C/O

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Abstract

The composition of planetesimals formed beyond the snowline in our solar system likely depended strongly on the abundances of C and O in the solar nebula, the ratio of CO to CH_4, and the abundance of more refractory organics. Together these factors were key determinants of the ratios of ice to rock (and metals) in bodies [1]. The observed range of stellar values of C/O, from > 1 to subsolar, suggests that the planets around these stars will exhibit interesting variations in their atmospheric spectra and (for terrestrial-sized bodies) bulk densities. The detailed examination of these differences is presented in another abstract [2]. The increasing number of determinations of stellar metallicity and C/O in stars leads to the possibility of a statistical approach to predicting planetary compositions based on the properties of the parent stars. Here we present methods for evaluating stellar planetesimal compositions from large stellar composition databases and host star surveys, and describe preliminary results using available survey data.

We also construct simple models of snowline physics and chemistry in protoplanetary disks motivated by varying ratios of C/O seen in the stellar measurements. Using the model originally developed by one of the authors and colleagues [3], we predict the depletion of water versus distance from the protostar, as a function of time, and then with a thermochemical model quantify the evolution of gas phase and condensed species. For different assumed values of the quench temperature for reactions, we then obtain the balance between CO and CH_4, N_2 and NH_3, and the abundance of refractory organics. We construct these models for a range of values of C/O from supersolar oxygen to C/O in excess of unity.

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References

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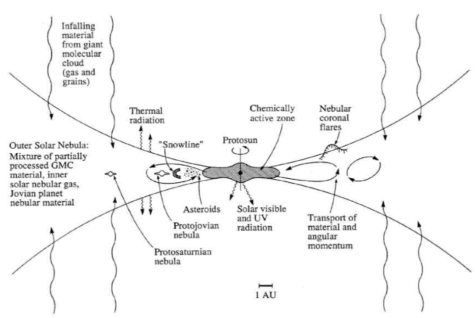

Cartoon of nebular processes associated with chemistry. Width of the disk exaggerated for clarity. The snowline is shown at an arbitrary time. After [4].