EXOPLANETS

Changing chemistry

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It is reasonable to assume that the chemical composition of a protoplanetary disk evolves with time. However, planetary formation models usually employ a chemically static disk, as coupling chemical kinetics to the physics is very computationally demanding. Christian Eistrup and colleagues study the effects of a chemically evolving disk on the planetary building blocks within a state-of-the-art planetary formation model over a timescale of 7 Myr (the limit they set for the formation of planets).

In the paper, which is an expansion of a previous article by the same authors, Eistrup et al. use a realistic physical model to vary the density and temperature of the midplane — the disk region of highest density — as well as the total mass of the disk. Then, they follow how the abundance of the most common molecules evolves, taking gas-phase, -grain and -surface chemistry into account. Interactions with ionizing cosmic rays are also included in the model.

The results highlight the importance of ionization on chemical evolution, which sets in after a few hundred thousand years and continues for the whole time interval. The midplane region between the ice lines of H_2O and O_2 is especially sensitive to it. The C/O ratio, a key diagnostic to determine the origin of exoplanetary atmospheres, strongly decreases with time in the gas, sometimes becoming lower than the C/O ratio in the ice whose temporal evolution is less pronounced. Globally, Eistrup et al. show that chemical evolution needs to be included in order to infer the correct formation scenario from the observations.

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