A POSSIBLE NITROGEN BARRIER TO LIFE AROUND COOL STARS

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Although nitrogen is one of the most abundant elements in the universe it is only present at ppm levels in the terrestrial crust. Yet, partly due to its unique potential for defining the structure of complex biomolecules this rare element plays a central role in life.

Similarly to other volatiles, nitrogen must be delivered to the early Earth in *solid phase*, i.e. as an ice. The N_2 iceline, beyond which molecular nitrogen is stable in ice form, is at approximately 40 AU in the proto-solar nebula. While transporting nitrogen-containing planetesimals from this distance to the radii where habitable planets can form (~1-2 AU) is possible, it is not efficient. An easier and more likely process for getting nitrogen to Earth and other planets is available if UV or X-ray photoelectrons can dissociate gas-phase N_2. Once split, nitrogen will readily form HCN and other nitrogen-rich compound, many of which are stable at ices at much higher temperatures, thus bringing the nitrogen in ice form much closer to the forming habitable planets. For example, HCN itself, a common product in circumstellar N-rich chemistry, has a sublimation temperature *above* that of water.

Thus, *in systems where* powerful UV emission or photoelectrons are available, planets in the habitable zone may have an access to a N-rich ice reservoir. In systems poor in high-energy particles or photons, most nitrogen may remain locked in N_2 and never be delivered to forming planets.

This speculative, unproven, but exciting picture finds support in our recent Spitzer Space Telescope study [1]. When comparing two large groups of coeval young stars – low-mass stars and approximately sun-like stars – we showed that the very low mass group systematically (>99% c. l.) and very significantly depleted in HCN in respect to the disks around sun-like stars.

The only feasible explanation yet proposed for this difference is a chemistry strongly influenced by the stellar radiation field. If this explanation is right, the connection with the nitrogen delivery may follow, as outlined above.

Here we will discuss the delivery of nitrogen to forming planets and the constraints the Spitzer observations place on this process. In addition, we will highlight testable predictions of the N-barrier hypothesis and explore its astrobiological implications.

References: [1] Pascucci, Apai et al. 2009 ApJ 696, 143