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## [Life from Interstellar Dust?](#)

Does adenine, a key organic molecule, occur in interstellar dust clouds? If so, those clouds could have delivered the molecule to Earth billions of years ago, a possibility interesting not only in terms of life's formation on this planet but, of course, on other worlds as well. And as University of Missouri chemist Rainer Glaser notes, the idea of space-borne adenine is not implausible, for adenine is known to occur in meteorites and was identified in 1986 in the organic mantle surrounding comet Halley's core.

Could adenine have been synthesized on the early Earth? Perhaps, but there are reasons for finding an outside delivery mechanism provocative. Note this from the paper on this work, which appeared in the journal *Astrobiology* (internal references omitted for brevity). HCN refers to hydrogen cyanide, which can flag the presence of adenine:

The idea of prebiotic adenine synthesis on Earth remains controversial. The HCN-based syntheses rely on the presence of a reducing atmosphere, and there is growing evidence that Earth did start out with a reducing atmosphere. But even with the substrates present, questions remain regarding the kinetic and thermodynamic feasibilities and probabilities of adenine synthesis under various conditions on an early Earth.

Clearly, space-borne adenine would be prime fodder for astrobiologists. The nucleotide [adenosine triphosphate](#) (ATP) is formed when phosphates are added to [adenosine](#) (a nucleoside formed from adenine and ribose), enabling the transfer of chemical energy in cellular metabolism. If such an essential organic molecule were found in interstellar space, it could actually become a diagnostic tool, helping us identify areas where life is more likely to occur in our galaxy. Here's Glaser on the possibilities:

“There is a lot of sky with a few areas that have dust clouds. In those dust clouds, a few of them have HCN. A few of those have enough HCN to support the synthesis of the molecules of life. Now, we have to look for the HCN concentrations, and that's where you want to look for adenine.”

And then this:

“Chemistry in space and ‘normal chemistry’ can be very different because the concentrations and energy-exchange processes are different. These features make the study of chemistry in space very exciting and academically challenging; one really must think without prejudice.”

A University of Missouri news release is [here](#). The paper is Glaser et al., “Adenine Synthesis in Interstellar Space: Mechanisms of Prebiotic Pyrimidine-Ring Formation of Monocyclic HCN-Pentamers,” *Astrobiology* Vol. 7 No. 3 (2007), pp. 455-470 ([available](#) online).



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This entry was posted on Monday, September 3rd, 2007 at 9:21 and is filed under [Astrobiology and SETI](#). You can follow any responses to this entry through the [RSS 2.0](#) feed. You can [leave a response](#), or [trackback](#) from your own site.

## 6 Responses to “Life from Interstellar Dust?”

1. [» Links for 04-09-2007 » Velcro City Tourist Board » Blog Archive](#) Says:  
[September 4th, 2007 at 12:26](#)

[...] 3 - Life from Interstellar Dust? [...]

2. *ljk* Says:  
[September 7th, 2007 at 10:38](#)

The largest oxygen bearing organic molecule repository

Authors: M. A. Requena-Torres, J. Martin-Pintado, S. Martin, M. R. Morris

(Submitted on 5 Sep 2007)

Abstract: We present the first detection of complex aldehydes and isomers in three typical molecular clouds located within 200 pc of the center of our Galaxy.

We find very large abundances of these complex organic molecules (COMs) in the central molecular zone (CMZ), which we attribute to the ejection of COMs from grain mantles by shocks. The relative abundances of the different COMs with respect to that of CH<sub>3</sub>OH are strikingly similar for the three sources, located in very different environments in the CMZ. The similar relative abundances point toward a unique grain mantle composition in the CMZ.

Studying the Galactic center clouds and objects in the Galactic disk having large abundances of COMs, we find that more saturated molecules are more abundant than the non-saturated ones. We also find differences between the relative abundance between COMs in the CMZ and the Galactic disk, suggesting different chemical histories of the grain mantles between the two regions in the Galaxy for the complex aldehydes. Different possibilities for the grain chemistry on the icy mantles in the GC clouds are briefly discussed. Cosmic rays can play an important role in the grain chemistry.

With these new detections, the molecular clouds in the Galactic center appear to be one of the best laboratories for studying the formation of COMs in the Galaxy.

Comments: 20 pages, 4 figures, accepted in ApJ

Subjects: Astrophysics (astro-ph)

Cite as: arXiv:0709.0542v1 [astro-ph]

Submission history

From: Miguel Angel Requena-Torres [view email]

[v1] Wed, 5 Sep 2007 13:25:27 GMT (144kb)

<http://arxiv.org/abs/0709.0542>

3. *Athena* Says:

[September 7th, 2007 at 15:11](#)

There is no doubt that complex molecules can form in space — amino acids, nucleotides, etc. There are two issues to consider, however. One is speed of formation and stability (given the extremes of temperature in space and near stars). More importantly, all molecules involved in life on earth are chiral (non-superimposable on their mirror image), whereas identical molecules, if prebiotic, are racemic. So the crucial question is whether the complex molecules found in space are asymmetric.

4. *ljk* Says:

[September 10th, 2007 at 11:35](#)

The Meaning of Life

We create life, we search for it, we manipulate and revere it. Is it possible that we haven't yet defined the term?

[http://www.seedmagazine.com/news/2007/09/the\\_meaning\\_of\\_life.php](http://www.seedmagazine.com/news/2007/09/the_meaning_of_life.php)

To quote:

“A science in which the most important object has no definition—that’s absolutely unacceptable,” says Popa. “How are we going to discuss it if you believe the definition of life has something to do with DNA and I think it has something to do with dynamic systems? We cannot have a conversation on any level. We cannot make artificial life because we cannot agree on what life is. We cannot find life on Mars because we cannot agree on what life represents.”

Recently, a new voice has entered the debate. Carol Cleland, who teaches philosophy at the University of Colorado and works with NASA’s National Astrobiology Institute—essentially as their philosopher-in-residence—is making a more radical argument: Scientists should simply give up looking for a definition of life. They can’t even begin to understand what life really is, she claims, until they find forms of life profoundly different from those we know here on Earth. Only when we can compare alien life with life on our planet will we understand the true nature of this ubiquitous, ephemeral thing.

5. *ljk* Says:

[September 12th, 2007 at 14:51](#)

Life’s Ingredients May Have ‘Sprinkled’ on Earth

<http://bcast1.imaginoa.com/t?r=2&ctl=1C98C:4A48D>

Study suggests some DNA ingredients may have sprinkled down to young Earth.

6. *ljk* Says:

[November 30th, 2007 at 12:12](#)

The c2d Spitzer spectroscopic survey of ices around low-mass young stellar objects II: CO<sub>2</sub>

Authors: Klaus M. Pontoppidan, A. C. A. Boogert, Helen J. Fraser, Ewine F. van Dishoeck, Geoffrey A. Blake, Fred Lahuis, Karin I. Oberg, Neal J. Evans II, Colette Salyk

(Submitted on 28 Nov 2007)

Abstract: This paper presents Spitzer-IRS spectroscopy of the CO<sub>2</sub> 15.2 micron bending mode toward a sample of 50 embedded low-mass stars in nearby star-forming clouds, taken mostly from the “Cores to Disks (c2d)” Legacy program. The average abundance of solid CO<sub>2</sub> relative to water in low-mass protostellar envelopes is 0.32 +/- 0.02, significantly higher than that found in quiescent molecular clouds and in massive star forming regions.

It is found that a decomposition of all the observed CO<sub>2</sub> bending mode profiles requires a minimum of five unique components. Roughly 2/3 of the CO<sub>2</sub> ice is found in a water-rich environment, while most of the remaining 1/3 is found in a CO environment. Ground-based observations of solid CO toward a large subset of the c2d sample are used to further constrain the CO<sub>2</sub>:CO component and suggest a model in which low-density clouds form the CO<sub>2</sub>:H<sub>2</sub>O component and higher density clouds form the CO<sub>2</sub>:CO ice during and after the freeze-out of gas-phase CO. It is suggested that the subsequent evolution of the CO<sub>2</sub> and CO profiles toward low-mass protostars, in particular the appearance of the splitting of the CO<sub>2</sub> bending mode due to pure, crystalline CO<sub>2</sub>, is first caused by distillation of the CO<sub>2</sub>:CO component through evaporation of CO due to thermal processing to ~20-30 K in the inner regions of infalling envelopes.

The formation of pure CO<sub>2</sub> via segregation from the H<sub>2</sub>O rich mantle may contribute to the band splitting at higher levels of thermal processing (>50 K), but is harder to reconcile with the physical structure of protostellar envelopes around low-luminosity objects.

Comments: Accepted for ApJ

Subjects: Astrophysics (astro-ph)

Cite as: arXiv:0711.4616v1 [astro-ph]

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<http://arxiv.org/abs/0711.4616>

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