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Astrobiology And Scientific Proof

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Astrobiology theories are often inspiring but necessarily speculative. The accepted criterion for scientific theories is that they can be falsified by experiment (Popper 1935, 1959). It is of interest to examine some common astrobiology statements in this respect.

1. "Process X contributed to the origins of life". Cannot be falsified. We cannot return in time and test the actual mechanism of biogenesis.

2. "Process X could have contributed to the origins of life". Cannot be falsified. The chemistry of biogenesis is complex and it is unlikely that a unique mechanism for the origins of life can be proven.

3. "There exists extraterrestrial life". Cannot be falsified in practice. We cannot examine every potential habitat in the universe.

4. "There does not exist extraterrestrial life". Can be falsified by a single observation.

5. "The universe will remain habitable indefinitely". Cannot be falsified experimentally. If the statement is false, there cannot be observers to prove this.

6. "The universe will become uninhabitable after a long time." Can be falsified in principle by the presence of observers, but cannot be falsified experimentally in advance or in practice. The observable past of the universe may be too short to predict its future with certainty.

The experimental verifiability of astrobiology theories requires careful examination (Mautner 2000). A debate within the astrobiology community about scientific proof could be valuable. For long-term scientific credibility, it seems appropriate to communicate the nature of astrobiology theories accurately both within the scientific community and to the public.

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Evidence Of Degradation Of Cometary Meteoroids In The Interplanetary Medium

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The range of masses of cometary meteoroids varies from several kilograms which can produce fireballs, (Ceplecha et al., 1998), to 10^{-17}g detected by spacecraft in comet 1P/Halley, (Jessberger et al., 1988). The fluffy nature of cometary material facilitates the degradation of these particles in the interplanetary medium. Once ejected from their parent bodies, they are fully exposed to different erosion processes such as solar wind heating and collisions with interplanetary dust (Hughes, 1993). From the astrobiological point of view, one important question remains unanswered: Is the chemical composition of meteoroids affected during long exposure heating in the interplanetary medium? Depending on the degree of alteration, the subsistence of water and other organic compounds during typical residence times of thousand of years (Hughes, 1993) would be problematic. In order to gain insight into the significance of meteoroid streams on the origin of life (Jenniskens et al., 2000), we need to determine the importance of these degradation processes. Our approach in this work is based on recent meteor spectroscopy results.

We used the Borovicka(1993) model to determine the relative chemical abundances of ten cometary meteoroids by analyzing their fireball paths (Trigo-Rodriguez et al., 2003). We have observed that sodium may be associated with volatile phases in these meteoroids (Trigo-Rodriguez et al., 2004), as was also suggested from video spectroscopy (Borovicka et al., 1999). The importance of the presence of Na in comets is underscored by the discovery of a sodium tail in Hale-Bopp that could be produced by direct cometary degassing or via the break-up of Na-bearing molecules, ions or dust particles (Cremonese et al., 1997). Sodium is also present in Interplanetary Dust Particles (IDPs), presumably the survival counterpart of low-velocity cometary (and asteroidal) meteoroids, that contain layered silicates and salt minerals produced by hydro-cryogenic alteration (Rietmeijer, 2002). These minerals would be easily eroded by solar radiation; consequently, the study of the abundance of Na in meteor spectra provides interesting clues on the role that such processes may have played in the delivery of volatiles to the Earth from cometary meteoroid streams. Our observations are in agreement with theoretical studies that show that long stays in the interplanetary medium affect sodium and other alkali volatile elements such as potassium (Young, 2000). Meteor spectroscopy can provide new ideas on the survival of volatile compounds of astrobiological significance.

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