THE GOLDILOCKS PROBLEM FOR LIFE: ITS POSSIBLE SOLUTION

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Of the many who have remarked over the apparently extraordinary coincidences necessary for our universe to sustain life, perhaps Paul Davies provides the best detailed accounts in his books, "The Goldilocks Enigma: Why is the Universe Just Right for Life?" (2006), and "Cosmic Jackpot" (2007). However, he deals with the universe at large, indeed, multiple universes, mostly examining fundamental physical constants. However, the universe is a big place, so it might be best to ask the question at the planetary level, the region where we can more readily access in the search for life.

I would like to start with Mars, where, next to Earth, I have had the most direct experience. How different might science be on Mars? Let us examine the basic sciences: mathematics, physics, chemistry and biology.

Mathematics

Even though Einstein once said that mathematics is not an exact science, "As far as the laws of mathematics refer to reality, they are not certain; and as far as they are certain, they do not refer to reality" (Quoted in J R Newman, The World of Mathematics, New York 1956), I don't think that anyone would doubt that 2 x 2 on Mars equals 4. The complex mathematics that guided spacecraft unerringly to the red planet continued to work precisely on entering the Martian environment. No one to my knowledge has suggested a different mathematics on Mars, or anyplace else.

Physics

Some physicists have ventured that some of the constants of physics may be different in remote regions of the cosmos than they are in our region. However, no one has proposed that Mars might so qualify, not in any of the research papers, comments and reviews that have been published about Mars. As indicated above, gravity worked fine, as did all the optical, electric and electronic equipment, indicating that our laws derived by Farraday, Ohm, Maxwell, Einstein, etc., performed identically as on Earth.

Chemistry

Most scientists think that chemistry works the same on Mars and Earth. However, innuendos that this might not be the case have been raised. In 1976, both Jerry Soffen, Viking Principal Scientist, and Harold Klein, Viking Biology Team Leader, in trying to explain their confusion over the life detection experiment results on Mars, said that they might be caused by chemistry mimicking life, perhaps even

caught in the very act of evolving from chemistry to life. This year, the same explanation was offered by the NASA Director of the Mars Program, Michael Meyer. However, neither 35 years ago, when first uttered, nor today, this proposition that Viking might have monitored the origin of life has not gained traction in the scientific community. Most scientists think that chemistry on Mars behaves precisely as chemistry on Earth. Still, the fact that the Viking LR results have eluded the many experimental and theoretical efforts to explain them as chemistry, has not turned the consensus in favor of life.

The just-out "news" that there is liquid water on Mars (proven by Viking, and shown to be virtually pure water, not brine), and that there is no strong oxidant in the surface material (R. Quinn et al., Geophys.Res. Letters, 38, l14202, 4 pp., 2011, doi:10.1029/2011gl047671), (also proven by Viking) may help the concept that Earth and Mars constitutes one biosphere.

Biology

So, the big, remaining issue is, "Can biology be different on Mars than on Earth?" My new paper, "Ramifications of a Sterile Mars," attempts to show that this is highly unlikely. An examination of both planets' environmental parameters finds none on Mars inimical to life, even as we know it on Earth. Indeed, it would thus seem that both planets lie within the Goldilocks zone. The news on liquid water and lack of the strong oxidant comports with this concept. The zone would, then, have to embrace ranges of the critical parameters at least broad enough, but not necessarily limited to, the Earth-Mars spreads of each of those parameters. At this juncture in our exploration of the cosmos, we have no way of knowing how wide those spreads might be and still accommodate life as we know it on Earth, and in my view, on Mars. With respect to the later, I can't help but wonder whether the "news" on liquid water and the lack of a strong oxidant will start the paradigm change about life on Mars.

L'Envoi?

Rather than marveling at the Goldilocks paradigm, let's explore an alternative to it. Suppose there really is a Biologic Imperative that inevitably develops some form of life within any set of environmental parameters, excepting, perhaps, where high temperatures reduce matter to plasma (although I have read science-fiction stories embracing life there, also). Then, when a life form evolves under a particular set of conditions, as on a particular planet, for instance, this environment would constitute a Goldilocks zone. Under this theory, life could not evolve except within its own Goldilocks zone. "Zone" is a well-chosen descriptor, since it allows for some hysteresis in the vital parameters instead of defining a rigid line. This range was probably established by celestial variations in the critical parameters as life evolved and adapted to them. If so, every life form on every planet or other body would live in a Goldilocks zone, ending the requirement for, and our astonishment at, these "amazing coincidences."