

The following was written by Rich Deem.

Let's look at a few of the improbable highlights for the design of the earth and our Solar System.

Unique location in our galaxy - co-rotation radius

[Milky Way Galaxy \(reconstructed\) \(NASA/JPL-Caltech\)](#)



The Sun and our Solar System have been located in a stable orbit within our galaxy for the last 4.5 billion years. This orbit lies far from the center of our galaxy and between the spiral arms. The stability of our position is possible because the sun is one of the rare stars that lies within the $\frac{1}{2}$ galactic co-rotation radius. Typically, the stars in our galaxy orbit the center of the galaxy at a rate that differs from the rate of the trailing spiral arms. Thus, most stars located between spiral arms do not remain there for long, but would eventually be swept inside a spiral arm. Only at a certain precise distance from the galaxy's center, the "co-rotation radius," can a star remain in its place between two spiral arms, orbiting at precisely the same rate as the galaxy arms rotate around the core (Mishurov, Y.N. and L. A. Zenina. 1999. Yes, the Sun is Located Near the Corotation Circle. *Astronomy & Astrophysics* 341: 81-85.). Why is it important that we are not in one of the spiral arms? First, our location gives us a view of the universe that is unobstructed by the debris and gases found in the spiral arms. This fact allows us to visualize what the Bible says, "The heavens declare the glory of God." If we were within the spiral arms, our view would be significantly impaired. Second, being outside the spiral arms puts us in a location that is safer than anywhere else in the universe. We are removed from the more densely occupied areas, where stellar interactions can lead to disruption of planetary orbits. In addition, we are farther from the deadly affects of supernovae explosions. The 4+ billion year longevity of life on earth (the time needed to prepare the planet for human occupation) would not have been possible at most other locations in our galaxy.

Medvedev, M.V. and A. L. Melott. 2007. Do extragalactic cosmic rays induce cycles in fossil diversity? *Astrophys. J.* 664: 879-889 ([arXiv:astro-ph/0602092v3](#)).

Unique stabilization of the inner solar system

A recent study reveals some unusual design in our solar system. With the continuing growth in the capabilities and sophistication of computer systems, scientists are gaining the ability to model the dynamics of the Solar System and ask "what if" questions regarding the presence and size of planets. The presence of Jupiter is required to allow advanced life to exist on the Earth ([see below](#)). However, Jupiter's large mass (along with the other gas giants) has a profound destabilizing effect upon the inner planets. In the absence of the Earth-moon system, the orbital period of Jupiter sets up what is called resonance over the period of 8 million years. This resonance causes the orbits of Venus and Mercury to become highly eccentric, so much so, that eventually the orbits become close enough so that there would be a "strong Mercury-Venus encounter." Such an encounter would certainly lead to the ejection of Mercury from the Solar System, and an alteration of the orbit of Venus. In doing the simulations, the scientists learned that the stabilizing effect of the Earth-moon requires a planet with at least the mass of Mars and within 10% of the distance of the Earth from the Sun. The authors of the study used the term "design" twice in the conclusion of their study:

Our basic finding is nevertheless an indication of the need for some sort of rudimentary "design" in the solar system to ensure long-term stability. One possible aspect of such "design" is that long-term stability may require that terrestrial orbits require a degree of irregularity to "stir" certain resonances enough so that such resonances cannot persist. (Innanen, Kimmo, S. Mikkola, and P. Wiegert. 1998. The earth-moon system and the dynamical stability of the inner solar system. *The Astronomical Journal* 116: 2055-2057.)

Unusually circular orbit of the earth

The unique arrangement of large and small planetary bodies in the solar system may be required to ensure the 4+ billion year stability of the system. In addition, it is readily apparent from the cycle of ice ages that the earth is at the edge of the life zone for our star. Although the earth has one of the most stable orbits among all the planets discovered to date, its periodic oscillations, including changes in orbital eccentricity, axial tilt, and a 100,000-year periodic elongation of Earth's orbit, results in a near freeze over (Kerr, R. 1999. Why the Ice Ages Don't Keep Time. *Science* 285: 503-505, and Rial, J.A. 1999. Pacemaking the Ice Ages by Frequency Modulation of Earth's Orbital Eccentricity. *Science* 285: 564-568.). According to Dr. J. E. Chambers, simulations of planetary formation "yield Earth-like planets with large eccentricities ($e \sim 0.15$)," whereas the Earth has an e value of 0.03. He goes on to say, "Given that climate stability may depend appreciably on e , it could be no coincidence that we inhabit a planet with an unusually circular orbit." (Chambers, J. E. 1998. How Special is Earth's Orbit? American Astronomical Society, [DPS meeting #30, #21.07](#)) With this new information, it seems very unlikely that stable planetary systems, in which a small earth-like planet resides in the habitable zone, exist in any other galaxy in our universe. This does not even consider the other design parameters that are required for life to exist anywhere in the universe.

Axial tilt and eccentricity of orbit

The earth is tilted on its axis at an angle of $23.5^\circ \pm \frac{1}{2}$. This is important, because it accounts for the seasons. Two factors impact the progression of seasons. The most important is the location of land

masses on the earth. Nearly all of the continental land mass is located in the Northern Hemisphere. Since land has a higher capacity to absorb the Sun's energy, the earth is much warmer when the Northern Hemisphere is pointing towards the Sun. This happens to be the point at which the earth is farthest from the Sun (the aphelion of its orbit). If the opposite were true, the seasons on the earth would be much more severe (hotter summers and colder winters). For more information, see [Aphelion Away!](#) from the [NASA website](#).

The presence of an "impossibly" large moon

The earth has a huge moon orbiting around it, which scientists now know 1) did not bulge off due to the earth's high rotational speed and 2) could not have been captured by the earth's gravity, due to the moon's large mass. For further explanations, see "The scientific legacy of Apollo" (2). The best explanation (other than outright miracle) for the moon's existence is that a Mars-sized planet crashed into the earth around 4.25 billion years ago (the age of the Moon). As you can imagine, the probability of two planets colliding in the same solar system is extremely remote. Any "normal" collision would not have resulted in the formation of the moon, since the ejecta would not have been thrown far enough from the earth to form the moon. The small planet, before it collided with the earth, must have had an unusually elliptical orbit (unlike the orbit of any other planet in the Solar System), which resulted in a virtual head-on collision. The collision of the small planet with the earth would have resulted in the ejection of 5 billion cubic miles of the earth's crust and mantle into orbit around the earth. This ring of material, the theory states, would have coalesced to form the moon. In addition, the moon is moving away from the earth (currently at 2 inches per year), as it has been since its creation. If we calculate backwards we discover that the moon must have formed just outside the Roche limit, the point at which an object would be torn apart by the earth's gravity (7,300 miles above the earth's surface). A collision which would have ejected material less than the Roche limit would have formed only rings around the earth. Computer models show that a collision of a small planet with the earth must have been very precise in order for any moon to have been formed at all (coincidence or design?). (see *What If the Moon Didn't Exist?*, by Neil F. Comins, professor of Astronomy and Physics).

Unusually thin atmosphere

Why is the moon important to life on earth? The collision of the small planet with the earth resulted in the ejection of the majority of the earth's primordial atmosphere. If this collision had not occurred, we would have had an atmosphere similar to that of Venus, which is 80 times that of the earth (equivalent to being one mile beneath the ocean). Such a thick atmosphere on Venus resulted in a runaway greenhouse affect, leaving a dry planet with a surface temperature of 800°F. The earth would have suffered a similar fate if the majority of its primordial atmosphere had not been ejected into outer space. In fact, the Earth is 20% more massive than Venus and further away from the Sun, both factors of which should have lead to a terrestrial atmosphere much thicker than that of Venus. For some strange reason, we have a very thin atmosphere - just the right density to maintain the presence of liquid, solid and gaseous water necessary to life (coincidence or design?).

Slowing rotation makes advanced life possible

The moon has had other beneficial effects on the earth. Scientists now know that the earth originally had a rotational period of eight hours. Such a rapid rotational period would have resulted in surface wind velocities in excess of 500 miles per hour. The gravitational tug of the moon over the last 4+ billion years has reduced the rotation period of the earth to 24 hours (likewise, the gravitational attraction of the earth on the moon has reduced its rotational period to 29 days). Needless to say, winds of 500 miles per hour would not be conducive to the existence of higher life forms (coincidence or design?).

Van-Allen radiation shield is unique to Earth

Another fortuitous result of the collision of the Mars-sized planet with the Earth is the presence of the Earth's large and heavy metallic core. In fact, the Earth has the highest density of any of the planets in our Solar System. This large nickel-iron core is responsible for our large magnetic field. This magnetic field produces the Van-Allen radiation shield, which protects the Earth from radiation bombardment. If this shield were not present, life would not be possible on the Earth. The only other rocky planet to have any magnetic field is Mercury - but its field strength is 100 times less than the Earth's. Even Venus, our sister planet, has no magnetic field. The lack of a magnetic field on Venus is thought to have resulted in the planet losing virtually all of its water through stripping by the solar wind (see [Venus: Express dispatches](#) from *Nature*). For more information on the magnetosphere, see NASA's [What is the Magnetosphere?](#) and [Space Weather on Mars](#). The Van-Allen radiation shield is a design unique to the Earth (coincidence or design?).

Unique continental crust and tectonic activity

Recent evidence tells us that the earth is unique in many ways, even compared to the other rocky planets in our Solar System. In a recent study (3), Dr. Roberta Rudnick says that the earth has a unique continental crust, which is different from any other planet in our Solar System (even Venus, our "sister planet"). The mechanisms which resulted in this unique continental crust is not entirely certain as she stated, "Perhaps the greatest dilemma facing those interested in understanding how the continents formed is their composition." However, the earth's crust is much thinner (4 km) than that of Venus (30 km). Tectonic processes cannot happen with such thick plates. If most of the crust of the earth had not been blown away during the formation of the moon, the earth would have no continents, but would be completely covered by water (see [The Moon And Plate Tectonics: Why We Are Alone](#) from [spacedaily.com](#)). The tectonic processes which recycle the crust are extremely important in maintaining life on our planet by recycling minerals and nutrients (coincidence or design?).

All other earth-sized planets will be either deserts or waterworlds

Scientists now know that planets like the earth, with large amounts of both water and land, are virtually impossible to form. Large planets do not form continents because the increased gravity prevents significant mountain and continent formation. Earth-sized planets completely flood, and any land formed is eroded by the seas in a short period of time (in the absence of tectonic activity, which results only from the effects of the formation of the moon). Smaller planets lack tectonic activity, so would have no land masses, but would be completely covered with water. According to Dr. Nick Hoffman of La Trobe University, Melbourne Australia:

"Around countless stars in our galaxy, and innumerable galaxies through space there will surely be Terrestrial planets, yet they will not be Earth-like. They will not have glistening Silver Moons orbiting silently through space around them, but only small dull rocks whizzing in orbit. The worlds will be, almost without exception, waterworlds." ([Venus - What the Earth would have been like](#) from [spacedaily.com](#))

Reduction of greenhouse gases with increasing solar luminosity

Another study points out the uniqueness of the earth in maintaining temperatures suitable for life over a period of at least 3.5 billion years. At the formation of the Solar System (about 4.5 billion years ago) the Sun was approximately one third less luminous than it is now (known from studies of stellar burning rates). Scientists have postulated that certain greenhouse gases must have been present at higher concentrations to prevent the earth from becoming a frozen planet. In a recent study ("Atmospheric carbon dioxide concentrations before 2.2 billion years ago" published in December, 1995 in *Nature*) Drs. Rye, Kuo, and Holland have determined (by sampling ancient rocks) that carbon dioxide levels could not have been high enough to compensate for the lower solar luminosity. The presence of other greenhouse gases, such as ammonia and methane is also problematical, since it is known that the earth possessed an oxidative atmosphere even at four billion years ago (4). In addition, 1) ammonia is extremely sensitive to solar ultraviolet radiation and 2) ammonia at levels needed to influence the earth's temperature would have prevented photosynthetic organisms from fixing nitrogen (i.e., An organic compound made of amino acids arranged in a linear chain, joined together by peptide bonds between the carboxyl and amino groups of the adjacent amino acid residues. [protein](#), Deoxyribonucleic acid: the chemical inside the nucleus of a cell that carries the genetic instructions for making living organisms. [DNA](#) and Ribonucleic acid: a chemical that directs the manufacture of proteins and sometimes codes for the genetic material within certain organisms. [RNA](#) synthesis would have been prevented). Fossil evidence indicates that photosynthetic organisms have been present on the Earth for at least 3.5 billion years. Methane has similar problems to ammonia, in that it is sensitive to solar ultraviolet radiation in an oxidative atmosphere. The problem remains unresolved, but some unique design must have existed to prevent the Earth from becoming a planet frozen solid in ice (early on) or a sweltering inferno (now) (coincidence or design?).

At least part of the design for the removal of greenhouse gases may have been answered by a recent study. It seems that life itself (and rather remarkable life, at that) may have been responsible for keeping the earth from turning into a scorched planet like Venus. Scientists have discovered a methane metabolizing Archea in the extreme pressures of deep sea sediments. It is estimated that these bacteria-like organisms consume 300 million tons of methane each year, which prevent the Earth from turning into a furnace. According to Kai-Uwe Hinrichs, a biogeochemist at the Woods Hole Oceanographic Institution in Massachusetts and one of the authors of the study, "If they hadn't been established at some point in Earth's history, we probably wouldn't be here." According to an analysis of the study:

"...on early Earth, these microbes might have been even more significant. Atmospheric scientists have suggested that methane levels in the atmosphere may have been 1000 times higher than they are today, created initially by volcanoes and later by methane-producing microbes (Science, 25 June 1999,

p. 2111). At first, this methane may have been beneficial, creating a greenhouse effect that kept the planet from freezing. But if the rise in methane had gone unchecked, Earth might have become too hot for life, as Venus is today." (Zimmer, C. 2001. 'Inconceivable' Bugs Eat Methane on the Ocean Floor. [Science 293: 418-419.](#))

The need for Jupiter-sized planets at 5 AU from its star

We have already discussed the destabilizing effects of large planets in our Solar System. However, these large bodies are *required* for life to exist on the Earth. A recent study implicates Jupiter as the indirect cause of oceans on the earth. Several studies have concluded that comets brought water to the earth. However, there are problems with this theory. The water on the earth contains 150 ppm deuterium, or heavy hydrogen, which is five or six times the deuterium-to-hydrogen ratio found in the sun and in the solar nebula gas. In addition, it's only about a third of the deuterium-to-hydrogen ratio measured in comets Halley, Hyakutake, and Hale-Bopp. However, the ratio of deuterium-to-hydrogen in meteorites is similar to that seen in the Earth's oceans. Scientists have hypothesized that the presence of Jupiter sent large amounts of water-containing meteorites into the inner Solar System soon after it was forming. It is also possible that Jupiter was also responsible for sending the Mars-sized planet that formed the moon. What is unique is that Jupiter-sized planets are not found as far out as 5 AU in other stellar systems. In fact, nearly all large planets have been found to be closer to their stars than the earth is to the Sun (which would remove all rocky planets in the habitable zone from those systems). For more information, see [Only Solar Systems With Jupiters May Harbor Life](#) (from [spacedaily.com](#))

"We now know that these other planetary systems don't look like the solar system at all... We also know that the solar system is special and understand at some level what makes it special."

(Frederic Rasio, Professor of Physics and Astronomy, Northwestern University)

Despite having been responsible for the shower of meteors that pelted the early earth, Jupiter is now our [great protector](#) and is responsible for collecting and ejecting a large proportion of the comets that enter into orbit around the Sun (e.g., comet [Shoemaker-Levy](#)). Without Jupiter life on Earth at this time would be difficult or impossible due to the large number of cometary collisions (approximately 1,000-10,000 times more collisions) with the Earth ([5](#)). There have been many large planets found around other stars recently, but none of these planets are far enough away from their star (most orbit at a position comparable to Mercury) to stabilize the orbits of planets in the zone that can support life or protect these inner planets from cometary bombardment (see [Universally Speaking, Earthlings Share a Nice Neighborhood](#), from NSF). The presence of Jupiter-like planets in the universe is a rare event. According to Dr. Peter D. Ward of the University of Washington, "All the Jupiters seen today [31 to date] are bad Jupiters. Ours is the only good one we know of. And it's got to be good, or you're thrown out into dark space or into your sun." (See [Rare Earth: Why Complex Life is Uncommon in the Universe, click for review](#)). Is this coincidence or design?

Conclusion

The following table ("Uniqueness of the galaxy-sun-earth-moon system for life support") is based upon the assumption that life is based upon carbon. As you are probably aware, there has been speculation that life might be based upon boron or silicon (mainly in Hollywood productions, such as Star Trek). However, these elements do not form very long-chained compounds, which would make any form of life based upon these elements virtually impossible (6).

Life based upon carbon requires that water exist in the liquid state (a very narrow range of $100\pm\frac{1}{2}^{\circ}\text{C}$). For practicality, this range is even more narrow. There are a few bacteria which can exist near the boiling point, but they are very specialized. Nearly all other life forms must exist below a temperature of $50\pm\frac{1}{2}^{\circ}\text{C}$. This is the major constraint on the system, which requires stable galaxies (spirals only) stable stars (eliminating all large or small stars and all binary systems, which most stars are part of), stable planetary orbits (orbital eccentricity must be small), exact rotational characteristics (long rotational periods will lead to too widely varying temperatures, short ones to high winds).

References

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6. Dicke, R.H. 1961. Dirac's cosmology and Mach's principle. *Nature* 192: 440.