The Incredible Design of the Earth and Our Solar System

by [Rich Deem](#)

> "Modern astronomers are learning more about the motions they observe and uncovering some astonishing examples of chaotic behavior in the heavens. Nonetheless, the long term stability of the solar system remains a perplexing, unsolved issue." [1]
> (Ivars Peterson. 1993. *Newton's Clock: Chaos in the Solar System*)

Introduction

The universe, our galaxy, our Solar System and the Earth-Moon double planet system demonstrate some remarkable evidence of intelligent design. Taken separately, each characteristic is highly improbable by random chance. When taken together, the probability is so small as to be impossible—by random chance. The alternative explanation, design by an intelligent Creator is a more realistic explanation. Either way, one must admit that we are a product of a miracle—either a miracle of chance or a miracle of design. 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

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 "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.

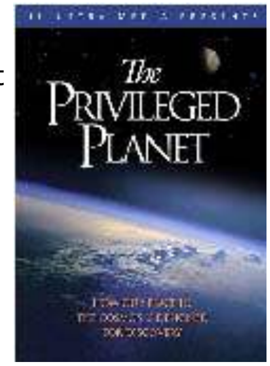
Medvedev, M.V. and A. L. Melott. 2007. Do extragalactic cosmic rays induce cycles in fossil diversity? *Astrophys. J.* 664: 879-889 (arXiv:astro-ph/0602092v3).

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 ~ 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 titled on its axis at an angle of 23.5". 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 must have collided with a precise glancing blow in order to account for the angular momentum of the earth-moon system. 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?).

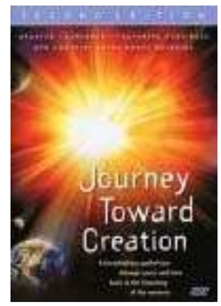
Slowing rotation makes advanced life possible

The moon has had other beneficial affects 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., protein, DNA and 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°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°C. This is the major constraint on the system, which requires stabile galaxies (spirals only) stabile stars (eliminating all large or small stars and all binary systems, which most stars are part of), stabile 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).

The table below lists the parameters required for a planet to be able to sustain life. Individually, the probabilities of occurrence of each parameter are not particularly impressive. The fact that all of these parameters are found on the Earth is extremely impressive, indicating an extreme deviation from random chance. The probability values below are ones obtained from that observed in the universe as a whole.

Uniqueness of the Galaxy-Sun-Earth-Moon System for Life Support

1. galaxy size (9) (p = 0.1)
   if too large: infusion of gas and stars would disturb sun's orbit and ignite deadly galactic eruptions
   if too small: infusion of gas would be insufficient to sustain star formation long enough for life to form
2. galaxy type (7) (p = 0.1)
   if too elliptical: star formation would cease before sufficient heavy elements formed for life chemistry
   if too irregular: radiation exposure would be too severe (at times) and life-essential heavy elements would not form
3. galaxy location (9) (p = 0.1)
   if too close to dense galaxy cluster: galaxy would be gravitationally unstable, hence unsuitable for life
   if too close to large galaxy(ies): same result
4. supernovae eruptions (8) (p = 0.01)
   if too close: radiation would exterminate life
   if too far: too little "ash" would be available for rocky planets to form
   if too infrequent: same result
   if too frequent: radiation would exterminate life
   if too soon: too little "ash" would be available for rocky planets to form
   if too late: radiation would exterminate life
5. white dwarf binaries (8) (p = 0.01)
   if too few: insufficient fluorine would exist for life chemistry
   if too many: orbits of life-supportable planets would be disrupted; life would be exterminated
   if too soon: insufficient fluorine would exist for life chemistry
   if too late: fluorine would arrive too late for life chemistry
6. proximity of solar nebula to a supernova eruption (9)
   if farther: insufficient heavy elements would be attracted for life chemistry
   if closer: nebula would be blown apart
7. timing of solar nebula formation relative to supernova eruption (9)
   if earlier: nebula would be blown apart
   if later: nebula would not attract enough heavy elements for life chemistry
8. parent star distance from center of galaxy (9) (p = 0.2)
   if greater: insufficient heavy elements would be available for rocky planet formation
   if lesser: radiation would be too intense for life; stellar density would disturb planetary orbits, making life impossible
9. parent star distance from closest spiral arm (9) (p = 0.1)
   if too small: radiation from other stars would be too intense and the stellar density would disturb orbits

of life-supportable planets
if too great: quantity of heavy elements would be insufficient for formation of life-supportable planets
10. z-axis range of star's orbit (9) (p = 0.1)
if too wide: exposure to harmful radiation from galactic core would be too great
11. number of stars in the planetary system (10) (p = 0.2)
if more than one: tidal interactions would make the orbits of life-supportable planets too unstable for life
if fewer than one: no heat source would be available for life chemistry
12. parent star birth date (9) (p = 0.2)
if more recent: star burning would still be unstable; stellar system would contain too many heavy elements for life chemistry
if less recent: stellar system would contain insufficient heavy elements for life chemistry
13. parent star age (9) (p = 0.4)
if older: star's luminosity would be too erratic for life support
if younger: same result
14. parent star mass (10) (p = 0.001)
if greater: star's luminosity would be too erratic and star would burn up too quickly to support life
if lesser: life support zone would be too narrow; rotation period of life-supportable planet would be too long; UV radiation would be insufficient for photosynthesis
15. parent star metallicity (9) (p = 0.05)
if too little: insufficient heavy elements for life chemistry would exist
if too great: radioactivity would be too intense for life; heavy element concentrations would be poisonous to life
16. parent star color (9) (p = 0.4)
if redder: photosynthetic response would be insufficient to sustain life
if bluer: same result
17. $H3^{+}$ production (23) (p = 0.1)
if too little: simple molecules essential to planet formation and life chemistry would never form
if too great: planets would form at the wrong time and place for life
18. parent star luminosity (11) (p = 0.0001)
if increases too soon: runaway green house effect would develop
if increases too late: runaway glaciation would develop
19. surface gravity (governs escape velocity) (12) (p = 0.001)
if stronger: planet's atmosphere would retain too much ammonia and methane for life
if weaker: planet's atmosphere would lose too much water for life
20. distance from parent star (13) (p = 0.001)
if greater: planet would be too cool for a stable water cycle
if lesser: planet would be too warm for a stable water cycle
21. inclination of orbit (22) (p = 0.5)
if too great: temperature range on the planet's surface would be too extreme for life
22. orbital eccentricity (9) (p = 0.3)
if too great: seasonal temperature range would be too extreme for life
23. axial tilt (9) (p = 0.3)
if greater: surface temperature differences would be too great to sustain diverse life-forms
if lesser: same result
24. rate of change of axial tilt (9) (p = 0.01)
if greater: climatic and temperature changes would be too extreme for life
25. rotation period (11) (p = 0.1)
if longer: diurnal temperature differences would be too great for life
if shorter: atmospheric wind velocities would be too great for life
26. rate of change in rotation period (14) (p = 0.05)
if more rapid: change in day-to-night temperature variation would be too extreme for sustained life
if less rapid: change in day-to-night temperature variation would be too slow for the development of advanced life
27. planet's age (9) (p = 0.1)
if too young: planet would rotate too rapidly for life
if too old: planet would rotate too slowly for life

28. magnetic field ([20]) (p = 0.01)
if stronger: electromagnetic storms would be too severe
if weaker: planetary surface and ozone layer would be inadequately protected from hard solar and stellar radiation
29. thickness of crust ([15]) (p = 0.01)
if greater: crust would rob atmosphere of oxygen needed for life
if lesser: volcanic and tectonic activity would be destructive to life
30. albedo (ratio of reflected light to total amount falling on surface) ([9]) (p = 0.1)
if greater: runaway glaciation would develop
if less: runaway greenhouse effect would develop
31. asteroid and comet collision rates ([9]) (p = 0.1)
if greater: ecosystem balances would be destroyed
if less: crust would contain too little of certain life-essential elements
32. mass of body colliding with primordial earth ([9]) (p = 0.002)
if greater: Earth's orbit and form would be too greatly disturbed for life
if lesser: Earth's atmosphere would be too thick for life; moon would be too small to fulfill its life-sustaining role
33. timing of above collision ([9]) (p = 0.05)
if earlier: Earth's atmosphere would be too thick for life; moon would be too small to fulfill its life-sustaining role
if later: Earth's atmosphere would be too thin for life; sun would be too luminous for subsequent life
34. oxygen to nitrogen ratio in atmosphere ([25]) (p = 0.1)
if greater: advanced life functions would proceed too rapidly
if lesser: advanced life functions would proceed too slowly
35. carbon dioxide level in atmosphere ([21]) (p = 0.01)
if greater: runaway greenhouse effect would develop
if less: plants would be unable to maintain efficient photosynthesis
36. water vapor quantity in atmosphere ([9]) (p = 0.01)
if greater: runaway greenhouse effect would develop
if less: rainfall would be too meager for advanced land life
37. atmospheric electric discharge rate ([9]) (p = 0.1)
if greater: fires would be too frequent and widespread for life
if less: too little nitrogen would be fixed in the atmosphere
38. ozone quantity in atmosphere ([9]) (p = 0.01)
if greater: surface temperatures would be too low for life; insufficient UV radiation for life
if less: surface temperatures would be too high for life; UV radiation would be too intense for life
39. oxygen quantity in atmosphere ([9]) (p = 0.01)
if greater: plants and hydrocarbons would burn up too easily, destabilizing Earth's ecosystem
if less: advanced animals would have too little to breathe
40. seismic activity ([16]) (p = 0.1)
if greater: life would be destroyed; ecosystem would be damaged
if less: nutrients on ocean floors from river runoff would not be recycled to continents through tectonics; not enough carbon dioxide would be released from carbonate buildup
41. volcanic activity ([26])
if lower: insufficient amounts of carbon dioxide and water vapor would be returned to the atmosphere; soil mineralization would be insufficient for life advanced life support
if higher: advanced life would be destroyed; ecosystem would be damaged
42. rate of decline in tectonic activity ([26]) (p = 0.1)
if slower: crust conditions would be too unstable for advanced life
if faster: crust nutrients would be inadequate for sustained land life
43. rate of decline in volcanic activity ([9]) (p = 0.1)
if slower: crust and surface conditions would be unsuitable for sustained land life
if faster: crust and surface nutrients would be inadequate for sustained land life
44. oceans-to-continents ratio ([11]) (p = 0.2)
if greater: diversity and complexity of life-forms would be limited
if smaller: same result
45. rate of change in oceans-to-continents ratio ([9]) (p = 0.1)

if smaller: land area would be insufficient for advanced life
if greater: change would be too radical for advanced life to survive

46. distribution of continents (10) (p = 0.3)
if too much in the Southern Hemisphere: sea-salt aerosols would be insufficient to stabilize surface temperature and water cycle; increased seasonal differences would limit the available habitats for advanced land life
47. frequency and extent of ice ages (9) (p = 0.1)
if lesser: Earth's surface would lack fertile valleys essential for advanced life; mineral concentrations would be insufficient for advanced life.
if greater: Earth would experience runaway freezing
48. soil mineralization (9) (p = 0.1)
if nutrient poorer: diversity and complexity of lifeforms would be limited
if nutrient richer: same result
49. gravitational interaction with a moon (17) (p = 0.1)
if greater: tidal effects on the oceans, atmosphere, and rotational period would be too severe for life
if lesser: orbital obliquity changes would cause climatic instabilities; movement of nutrients and life from the oceans to the continents and vice versa would be insufficient for life; magnetic field would be too weak to protect life from dangerous radiation
50. Jupiter distance (18) (p = 0.1)
if greater: Jupiter would be unable to protect Earth from frequent asteroid and comet collisions
if lesser: Jupiter's gravity would destabilize Earth's orbit
51. Jupiter mass (19) (p = 0.1)
if greater: Jupiter's gravity would destabilize Earth's orbit 9
if lesser: Jupiter would be unable to protect Earth from asteroid and comet collisions
52. drift in (major) planet distances (9) (p = 0.1)
if greater: Earth's orbit would be destabilized
if less: asteroid and comet collisions would be too frequent for life
53. major planet orbital eccentricities (18) (p = 0.05)
if greater: Earth's orbit would be pulled out of life support zone
54. major planet orbital instabilities (9) (p = 0.1)
if greater: Earth's orbit would be pulled out of life support zone
55. atmospheric pressure (9) (p = 0.1)
if smaller: liquid water would evaporate too easily and condense too infrequently to support life
if greater: inadequate liquid water evaporation to support life; insufficient sunlight would reach Earth's surface; insufficient UV radiation would reach Earth's surface
56. atmospheric transparency (9) (p = 0.01)
if greater: too broad a range of solar radiation wavelengths would reach Earth's surface for life support
if lesser: too narrow a range of solar radiation wavelengths would reach Earth's surface for life support
57. chlorine quantity in atmosphere (9) (p = 0.1)
if greater: erosion rate and river, lake, and soil acidity would be too high for most life forms; metabolic rates would be too high for most life forms
if lesser: erosion rate and river, lake, and soil acidity would be too low for most life forms; metabolic rates would be too low for most life forms
58. iron quantity in oceans and soils (9) (p = 0.1)
if greater: iron poisoning would destroy advanced life
if lesser: food to support advanced life would be insufficient
if very small: no life would be possible
59. tropospheric ozone quantity (9) (p = 0.01)
if greater: advanced animals would experience respiratory failure; crop yields would be inadequate for advanced life; ozone-sensitive species would be unable to survive
if smaller: biochemical smog would hinder or destroy most life
60. stratospheric ozone quantity (9) (p = 0.01)
if greater: not enough LTV radiation would reach Earth's surface to produce food and life-essential vitamins
if lesser: too much LTV radiation would reach Earth's surface, causing skin cancers and reducing plant growth
61. mesospheric ozone quantity (9) (p = 0.01)

if greater: circulation and chemistry of mesospheric gases would disturb relative abundance of life-essential gases in lower atmosphere
if lesser: same result

62. frequency and extent of forest and grass fires (24) (p = 0.01)
if greater: advanced life would be impossible
if lesser: accumulation of growth inhibitors, combined with insufficient nitrification, would make soil unsuitable for food production
63. quantity of soil sulfur (9) (p = 0.1)
if greater: plants would be destroyed by sulfur toxins, soil acidity, and disturbance of the nitrogen cycle
if lesser: plants would die from protein deficiency
64. biomass to comet-infall ratio (9) (p = 0.01)
if greater: greenhouse gases would decline, triggering runaway freezing
if lesser: greenhouse gases would accumulate, triggering runaway greenhouse effect
65. quantity of sulfur in planet's core (9) (p = 0.1)
if greater: solid inner core would never form, disrupting magnetic field
if smaller: solid inner core formation would begin too soon, causing it to grow too rapidly and extensively, disrupting magnetic field
66. quantity of sea-salt aerosols (9) (p = 0.1)
if greater: too much and too rapid cloud formation over the oceans would disrupt the climate and atmospheric temperature balances
if smaller: insufficient cloud formation; hence, inadequate water cycle; disrupts atmospheric temperature balances and hence the climate
67. dependency factors (estimate 100,000,000,000)
68. longevity requirements (estimate .00001)

Total Probability = 1:10^{99}

Click here to see these parameters in table format.

Updated List of parameters

Taken from *Big Bang Refined by Fire* by Dr. Hugh Ross, 1998. Reasons To Believe, Pasadena, CA.

By putting together probabilities for each of these design features occurring by chance, we can calculate the probability of the existence of a planet like Earth. This probability is 1 chance in 10^{99}. Since there are estimated to be a maximum of 10^{23} planets in the universe (10 planets/star, see note below), by chance there shouldn't be any planets capable of supporting life in the universe (only one chance in 10^{76}). Design or random chance?

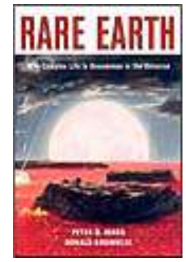
Don't we ALL believe in miracles?

Note: This is most likely a huge over estimate. In a recent survey of globular cluster 47 Tucanae, scientists found zero extrasolar planets out of 37,000 stars searched (Astronomers Ponder Lack of Planets in Globular Cluster from the *Hubble Space Telescope*).

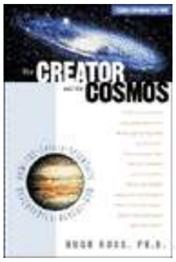
Related Resources

- The Fine Tuning and Design of the Moon's Formation
- Moons Like Earth's Moon are Rare in the Universe
- Does 'Goldilocks' Planet Gliese 581g Harbor Life?
- God of the Gaps—Do All Christian Apologetics Fall Into This Kind of Argument?

Rare Earth: Why Complex Life is Uncommon in the Universe by Peter D. Ward and Donald Brownlee



A secular book that recognizes the improbable design of the earth. Paleontologist Peter D. Ward and astrobiologist Donald Brownlee examine the unusual characteristics of our galaxy, solar system, star, and Earth and conclude that ET may have no home to go to. Surprisingly, the authors conclude that the amazing "coincidences" are the result of good luck and chance.



The Creator and the Cosmos by Dr. Hugh Ross

A classic book for modern Christian apologetics and science. Dr. Ross presents the latest scientific evidence for intelligent design of our world and an easy to understand introduction to modern cosmology. This is a great book to give agnostics, who have an interest in cosmology and astronomy.

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