

# Fine-Tuning For Life In The Universe

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For physical life to be possible in the universe, several characteristics must take on specific values, and these are listed below.<sup>1</sup> In the case of several of these characteristics, and given the intricacy of their interrelationships, the indication of divine "fine tuning" seems incontrovertible.

1. Strong nuclear force constant
2. Weak nuclear force constant
3. Gravitational force constant
4. Electromagnetic force constant
5. Ratio of electromagnetic force constant to gravitational force constant
6. Ratio of proton to electron mass
7. Ratio of number of protons to number of electrons
8. Ratio of proton to electron charge
9. Expansion rate of the universe
10. Mass density of the universe
11. Baryon (proton and neutron) density of the universe
12. Space energy or dark energy density of the universe
13. Ratio of space energy density to mass density
14. Entropy level of the universe
15. Velocity of light
16. Age of the universe
17. Uniformity of radiation
18. Homogeneity of the universe
19. Average distance between galaxies
20. Average distance between galaxy clusters
21. Average distance between stars
22. Average size and distribution of galaxy clusters

23. Numbers, sizes, and locations of cosmic voids
24. Electromagnetic fine structure constant
25. Gravitational fine-structure constant
26. Decay rate of protons
27. Ground state energy level for helium-4
28. Carbon-12 to oxygen-16 nuclear energy level ratio
29. Decay rate for beryllium-8
30. Ratio of neutron mass to proton mass
31. Initial excess of nucleons over antinucleons
32. Polarity of the water molecule
33. Epoch for hypernova eruptions
34. Number and type of hypernova eruptions
35. Epoch for supernova eruptions
36. Number and types of supernova eruptions
37. Epoch for white dwarf binaries
38. Density of white dwarf binaries
39. Ratio of exotic matter to ordinary matter
40. Number of effective dimensions in the early universe
41. Number of effective dimensions in the present universe
42. Mass values for the active neutrinos
43. Number of different species of active neutrinos
44. Number of active neutrinos in the universe
45. Mass value for the sterile neutrino
46. Number of sterile neutrinos in the universe
47. Decay rates of exotic mass particles
48. Magnitude of the temperature ripples in cosmic background radiation
49. Size of the relativistic dilation factor
50. Magnitude of the Heisenberg uncertainty
51. Quantity of gas deposited into the deep intergalactic medium by the first supernovae
52. Positive nature of cosmic pressures
53. Positive nature of cosmic energy densities
54. Density of quasars
55. Decay rate of cold dark matter particles
56. Relative abundances of different exotic mass particles
57. Degree to which exotic matter self interacts
58. Epoch at which the first stars (metal-free pop III stars) begin to form
59. Epoch at which the first stars (metal-free pop III stars) cease to form
60. Number density of metal-free pop III stars
61. Average mass of metal-free pop III stars
62. Epoch for the formation of the first galaxies
63. Epoch for the formation of the first quasars
64. Amount, rate, and epoch of decay of embedded defects
65. Ratio of warm exotic matter density to cold exotic matter density
66. Ratio of hot exotic matter density to cold exotic matter density
67. Level of quantization of the cosmic spacetime fabric

68. Flatness of universe's geometry
69. Average rate of increase in galaxy sizes
70. Change in average rate of increase in galaxy sizes throughout cosmic history
71. Constancy of dark energy factors
72. Epoch for star formation peak
73. Location of exotic matter relative to ordinary matter
74. Strength of primordial cosmic magnetic field
75. Level of primordial magnetohydrodynamic turbulence
76. Level of charge-parity violation
77. Number of galaxies in the observable universe
78. Polarization level of the cosmic background radiation
79. Date for completion of second reionization event of the universe
80. Date of subsidence of gamma-ray burst production
81. Relative density of intermediate mass stars in the early history of the universe
82. Water's temperature of maximum density
83. Water's heat of fusion
84. Water's heat of vaporization
85. Number density of clumpuscules (dense clouds of cold molecular hydrogen gas) in the universe
86. Average mass of clumpuscules in the universe
87. Location of clumpuscules in the universe
88. Dioxygen's kinetic oxidation rate of organic molecules
89. Level of paramagnetic behavior in dioxygen
90. Density of ultra-dwarf galaxies (or supermassive globular clusters) in the middle-aged universe
91. Degree of space-time warping and twisting by general relativistic factors
92. Percentage of the initial mass function of the universe made up of intermediate mass stars
93. Strength of the cosmic primordial magnetic field

<sup>1</sup> Most of the source references may be found in *The Creator and the Cosmos*, 3<sup>rd</sup> edition by Hugh Ross (Colorado Springs, CO: NavPress, 2001), pp. 145-157, 245-248. Additional references are listed below:

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