Fine Tuning Parameters for the Universe

1. strong nuclear force constant
   if larger: no hydrogen would form; atomic nuclei for most life-essential elements would be unstable; thus, no life chemistry
   if smaller: no elements heavier than hydrogen would form: again, no life chemistry
2. weak nuclear force constant
   if larger: too much hydrogen would convert to helium in big bang; hence, stars would convert too much matter into heavy elements making life chemistry impossible
   if smaller: too little helium would be produced from big bang; hence, stars would convert too little matter into heavy elements making life chemistry impossible
3. gravitational force constant
   if larger: stars would be too hot and would burn too rapidly and too unevenly for life chemistry
   if smaller: stars would be too cool to ignite nuclear fusion; thus, many of the elements needed for life chemistry would never form
4. electromagnetic force constant
   if greater: chemical bonding would be disrupted; elements more massive than boron would be unstable to fission
   if lesser: chemical bonding would be insufficient for life chemistry
5. ratio of electromagnetic force constant to gravitational force constant
   if larger: all stars would be at least 40% more massive than the sun; hence, stellar burning would be too brief and too uneven for life support
   if smaller: all stars would be at least 20% less massive than the sun, thus incapable of producing heavy elements
6. ratio of electron to proton mass
   if larger: chemical bonding would be insufficient for life chemistry
   if smaller: same as above
7. ratio of number of protons to number of electrons
   if larger: electromagnetism would dominate gravity, preventing galaxy, star, and planet formation
   if smaller: same as above
8. expansion rate of the universe
   if larger: no galaxies would form
   if smaller: universe would collapse, even before stars formed
9. entropy level of the universe
   if larger: stars would not form within proto-galaxies
   if smaller: no proto-galaxies would form
10. mass density of the universe
    if larger: overabundance of deuterium from big bang would cause stars to burn rapidly, too rapidly for life to form
    if smaller: insufficient helium from big bang would result in a shortage of heavy elements

11. velocity of light
    if faster: stars would be too luminous for life support *if slower*: stars would be insufficiently luminous for life support
12. age of the universe
    if older: no solar-type stars in a stable burning phase would exist in the right (for life) part of the galaxy
    if younger: solar-type stars in a stable burning phase would not yet have formed
13. initial uniformity of radiation
    if more uniform: stars, star clusters, and galaxies would not have formed
    if less uniform: universe by now would be mostly black holes and empty space
14. average distance between galaxies
    if larger: star formation late enough in the history of the universe would be hampered by lack of material
    if smaller: gravitational tug-of-wars would destabilize the sun's orbit
15. density of galaxy cluster
    if denser: galaxy collisions and mergers would disrupt the sun's orbit
    if less dense: star formation late enough in the history of the universe would be hampered by lack of material
16. average distance between stars
    if larger: heavy element density would be too sparse for rocky planets to form
    if smaller: planetary orbits would be too unstable for life
17. fine structure constant (describing the fine-structure splitting of spectral lines) *if larger*: all stars would be at least 30% less massive than the sun
    if larger than 0.06: matter would be unstable in large magnetic fields
    if smaller: all stars would be at least 80% more massive than the sun
18. decay rate of protons
    if greater: life would be exterminated by the release of radiation
    if smaller: universe would contain insufficient matter for life
19. ^{12}C to ^{16}O nuclear energy level ratio
    if larger: universe would contain insufficient oxygen for life
    if smaller: universe would contain insufficient carbon for life
20. ground state energy level for ^{4}He
    if larger: universe would contain insufficient carbon and oxygen for life
    if smaller: same as above
21. decay rate of ^{8}Be
    if slower: heavy element fusion would generate catastrophic explosions in all the stars
    if faster: no element heavier than beryllium would form; thus, no life chemistry
22. ratio of neutron mass to proton mass
    if higher: neutron decay would yield too few neutrons for the formation of many life-essential elements
    if lower: neutron decay would produce so many neutrons as to collapse all stars into neutron stars or black holes
23. initial excess of nucleons over anti-nucleons
    if greater: radiation would prohibit planet formation
    if lesser: matter would be insufficient for galaxy or star formation

24. polarity of the water molecule
    if greater: heat of fusion and vaporization would be too high for life
    if smaller: heat of fusion and vaporization would be too low for life; liquid water would not work as a solvent for life chemistry; ice would not float, and a runaway freeze-up would result
25. supernovae eruptions
    if too close, too frequent, or too late: radiation would exterminate life on the planet
    if too distant, too infrequent, or too soon: heavy elements would be too sparse for rocky planets to form
26. white dwarf binaries
    if too few: insufficient fluorine would exist for life chemistry
    if too many: planetary orbits would be too unstable for life
    if formed too soon: insufficient fluorine production
    if formed too late: fluorine would arrive too late for life chemistry
27. ratio of exotic matter mass to ordinary matter mass
    if larger: universe would collapse before solar-type stars could form
    if smaller: no galaxies would form
28. number of effective dimensions in the early universe
    if larger: quantum mechanics, gravity, and relativity could not coexist; thus, life would be impossible
    if smaller: same result
29. number of effective dimensions in the present universe
    if smaller: electron, planet, and star orbits would become unstable
    if larger: same result
30. mass of the neutrino
    if smaller: galaxy clusters, galaxies, and stars would not form
    if larger: galaxy clusters and galaxies would be too dense
31. big bang ripples
    if smaller: galaxies would not form; universe would expand too rapidly
    if larger: galaxies/galaxy clusters would be too dense for life; black holes would dominate; universe would collapse before life-site could form
32. size of the relativistic dilation factor
    if smaller: certain life-essential chemical reactions will not function properly
    if larger: same result
33. uncertainty magnitude in the Heisenberg uncertainty principle
    if smaller: oxygen transport to body cells would be too small and certain life-essential elements would be unstable
    if larger: oxygen transport to body cells would be too great and certain life-essential elements would be unstable
34. cosmological constant
    if larger: universe would expand too quickly to form solar-type stars

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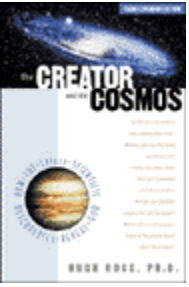
Taken from *Big Bang Refined by Fire* by Dr. Hugh Ross, 1998. Reasons To Believe, Pasadena, CA.



The Creator and the Cosmos by Dr. Hugh Ross