THE FINE-TUNING DESIGN ARGUMENT:

An Argument from Physics and Cosmology for the Divine Creation of the Cosmos

The Big Issue: Science and God

It is commonly assumed that modern science undercuts belief in God. I will argue just the opposite, that the discoveries of physics and cosmology in the last 50 years strongly supports **divine creation**.

What is the Fine-Tuning? An Analogy

In the last 50 years, scientists have discovered that the universe is analogous to a **biosphere:** its basic structure must be precisely set for life to exist. This is called the **fine-tuning of the cosmos.**

Arizona Biosphere (1991-1994): everything had to be constructed and set just right for it to be self-sustaining. Even then it failed in two years.

Key Assumption

The relevant kind of life for the argument is what I call embodied conscious agents, and such agents require stable, reproducible complexity.

Three Types of Fine-Tuning for Life

1. Fine-tuning of the **laws of nature**

2. Fine-tuning of the **constants of physics**

3. Fine-tuning of the **initial distribution of mass-energy** of the universe at the time of the big bang.

Fine-Tuning of Laws

To say that the laws are fine-tuned means that the universe must have precisely the right set of laws in order for (highly complex) life to exist.

We will consider 5 of around 14 examples.

Example 1: Universal Attractive Force – Gravity

What would the universe be like if gravity did not exist?

No Gravity: No Stars, No Planets and therefore No Life!

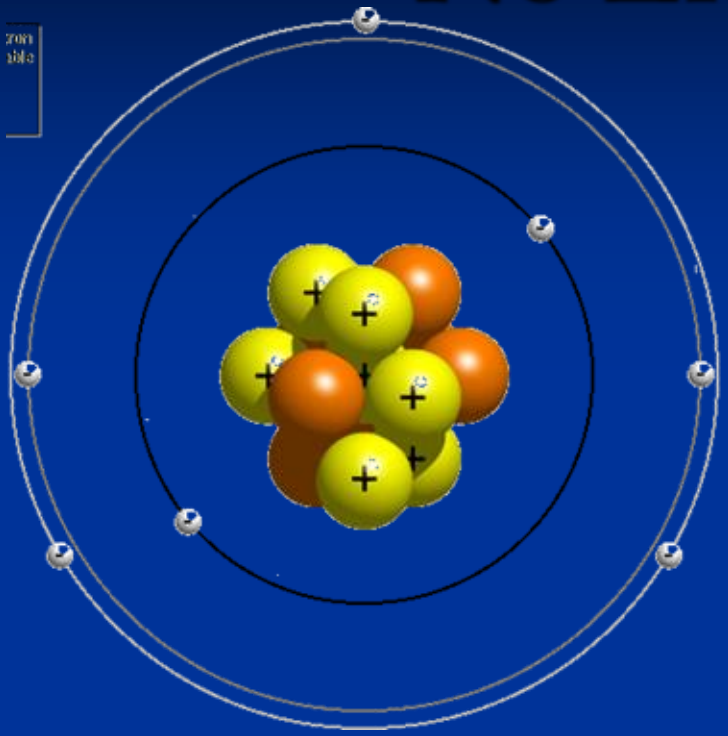
Photo of N90, part of Small Magellanic Cloud, about 200,000 light years away. [Photo released January 2007. Image from http://www.spacetelescope.org/news/html/heic0702.html]

Example of star formation caused by gravitational attraction.

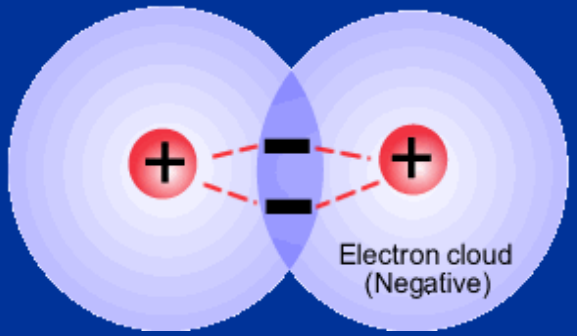
Example 2: Existence of Electromagnetic Force

The electromagnetic force refers to the combination of the electric and magnetic forces. James Clerk Maxwell unified the two forces in the late 1800's.

No Electric Force:



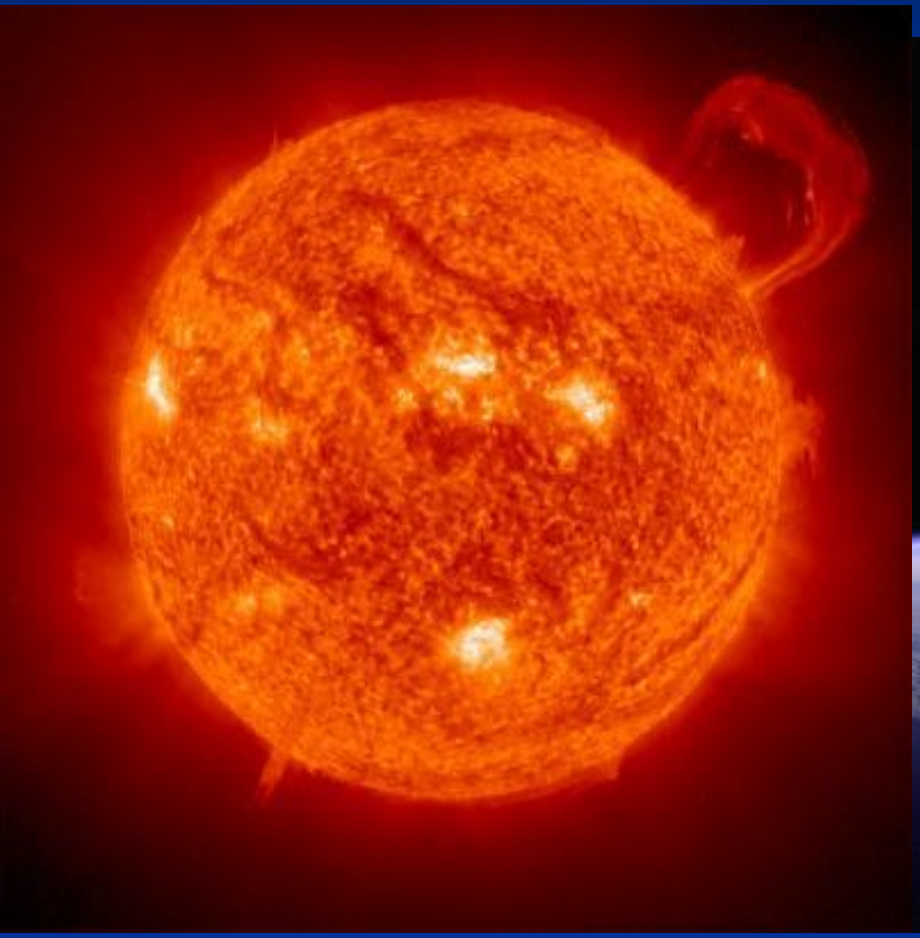
Then no atoms and therefore NO LIFE!



Then no chemical bonding and therefore NO LIFE!

Images from http://education.jlab.org/qa/atom_model_04.gifibchem.com/IB/ibfiles/bonding/bon_img/cov2.gif

No Electromagnetic Force: No Light, No Life!

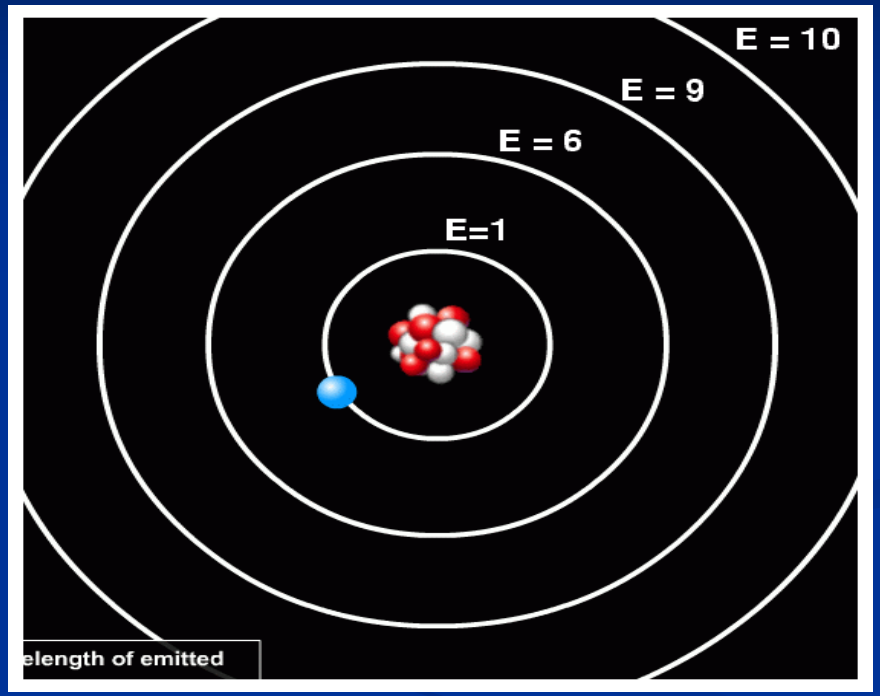


Images courtesy of NASA

What Holds the Nucleus Together?

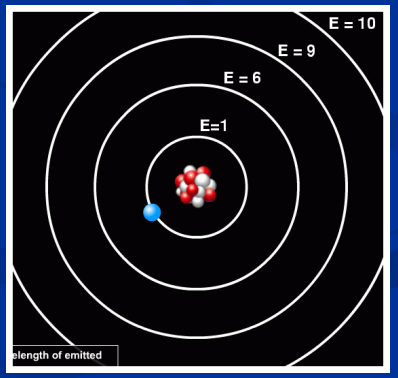
Have you ever wondered: What holds the nucleus together? After all, **protons** are positively charged and like charges repel each other. Why doesn't the nucleus just fly apart?

Protons Repelling each other



Answer: The Strong Nuclear Force

Strong "Nuclear Force" Collins
Holding Killer Protons Together.



What keeps electrons from being sucked into the nucleus?

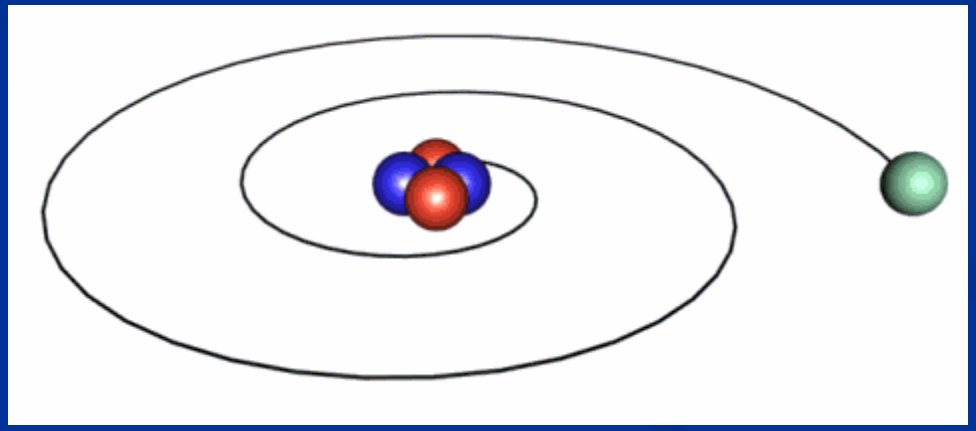
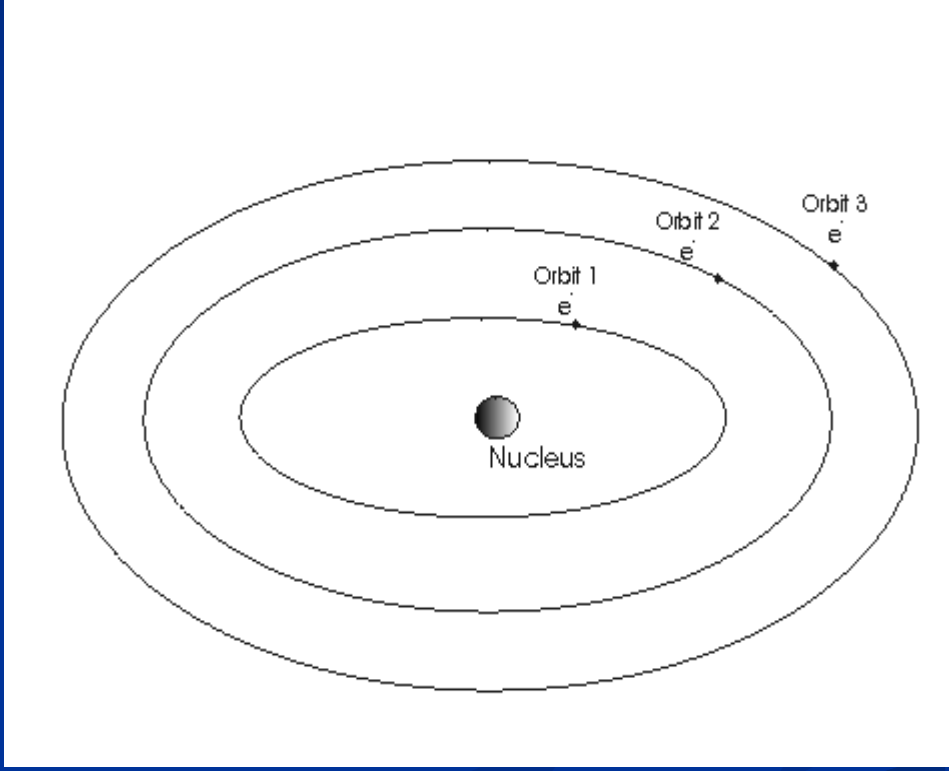


Illustration from www.sr.bham.ac.uk/xmm/fmc2.html , University of Birmingham.

Answer: Principle of Quantization

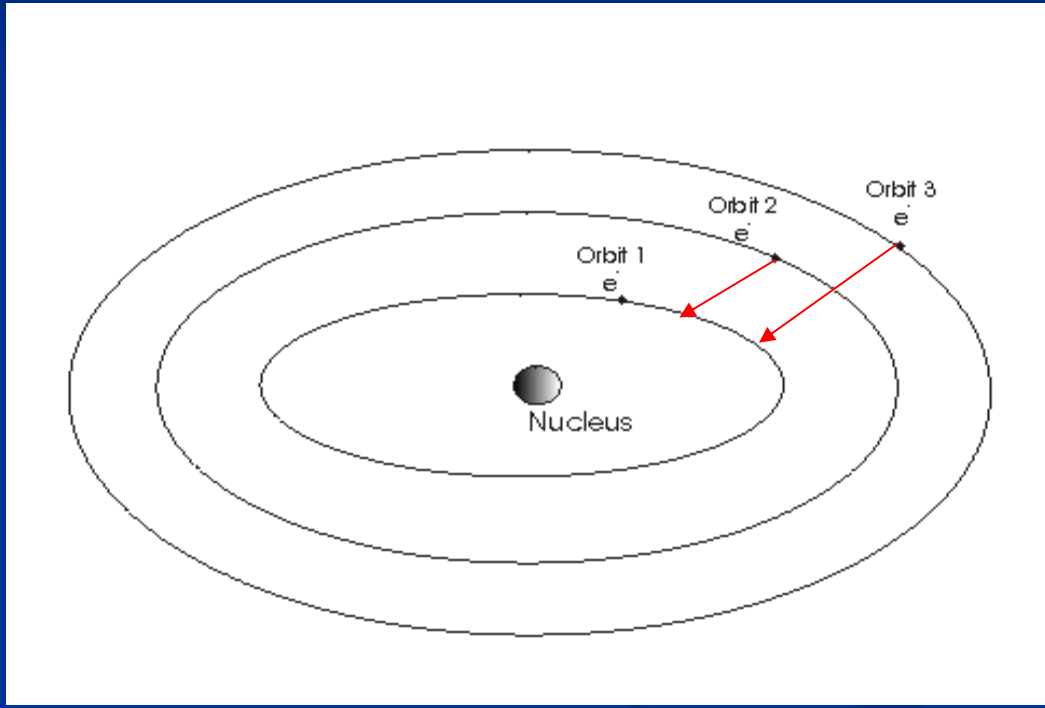
Principle of Quantization dictates that electrons occupy fixed orbitals. This keeps them from being sucked into the nucleus.

[The Principle of Quantization was first proposed by Niels Bohr in 1913]



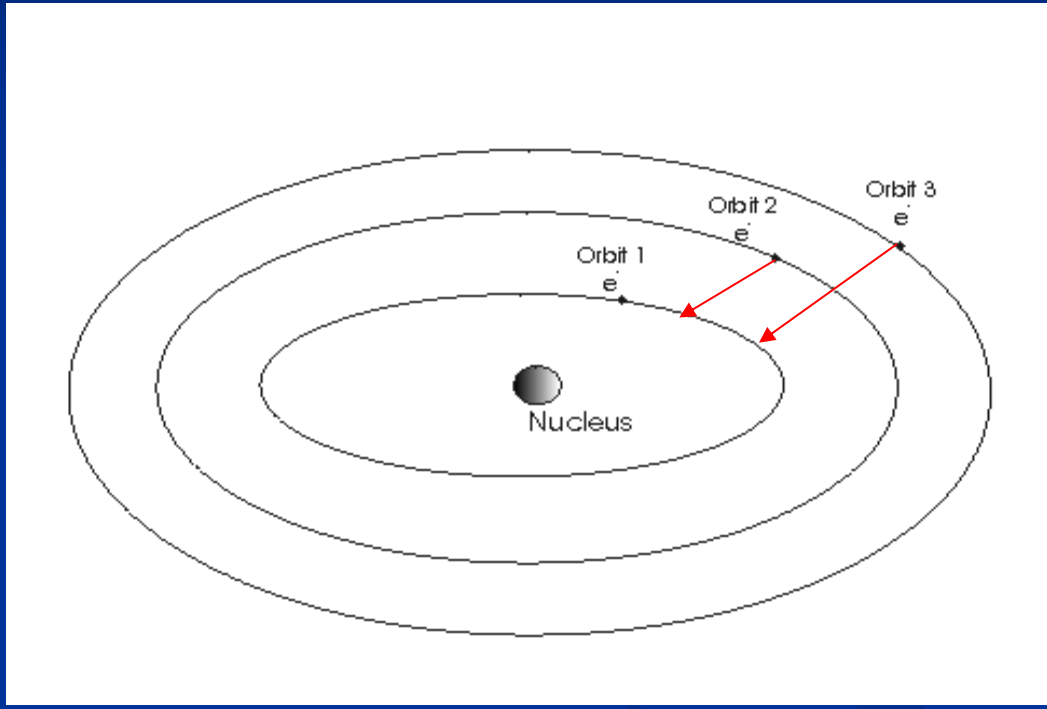
Another Problem

Even with the Principle of Quantization, shouldn't all the electrons fall into the lowest orbital since that is the lowest energy state? What keeps this from happening?



Solution: Pauli Exclusion Principle

By requiring that no more than two electrons can occupy any orbital, the Pauli Exclusion Principle keeps this from happening.



[[This principle was first proposed by Wolfgang Pauli in 1925.]

Conclusion

Precisely the right laws are needed for highly complex life to exist. If one of these laws were missing, such life would be impossible.

Summary of Examples:

Gravity

Electromagnetism

Strong Nuclear Force

Principle of Quantization

Pauli-Exclusion Principle

Fine-tuning of the Constants

Question: "What are the constants of physics?"

Answer: They are the numbers that occur in the fundamental equations (or laws) of physics.

Many of these must be precisely adjusted to an extraordinary degree for life to occur.

Example: Gravitational Constant

The Newton's **gravitational constant** – designated by **G** -- determines the strength of gravity between two masses via Newton's law of gravity:

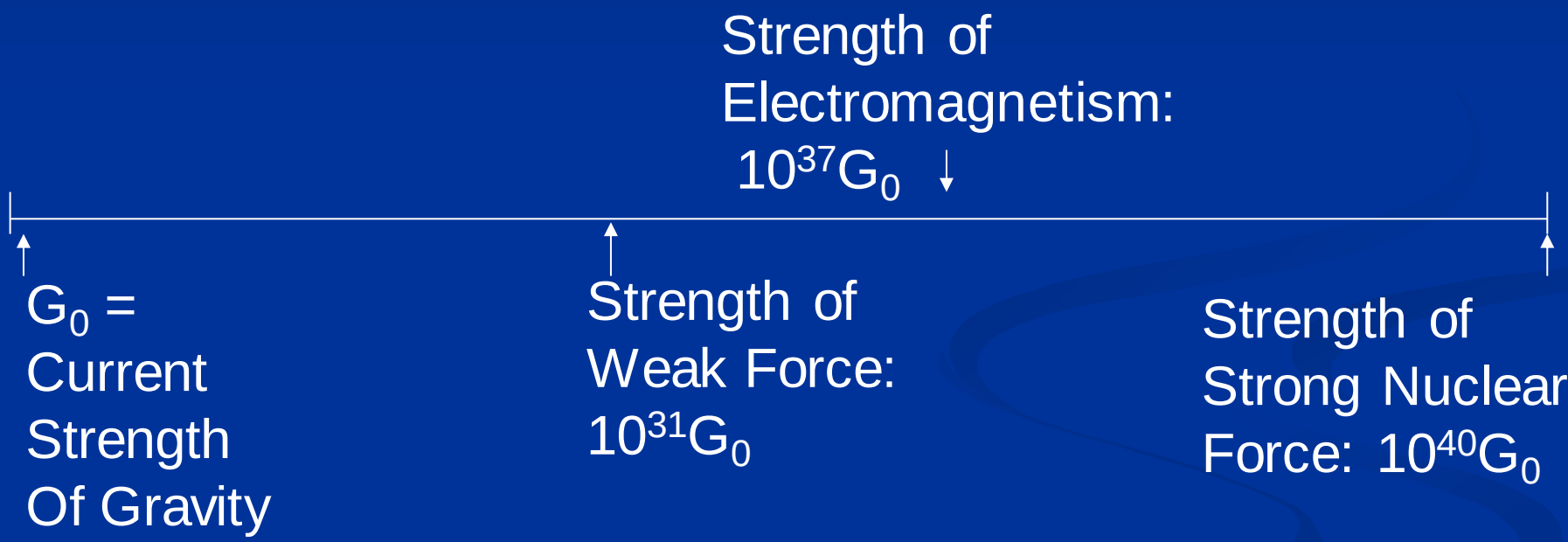
$$F = \frac{Gm_1m_2}{r^2},$$

where F is the force between two masses, m_1 and m_2, that are a distance r apart. **Increase or decrease G and the force of gravity will correspondingly increase or decrease.** (The actual value of G is 6.67 x 10^{-11} Nm^2/kg^2.)

How fine-tuned is the strength of gravity as given by G?

To answer that, we must first look at the range of force strengths in nature:

Range of Force Strengths
(based on standard dimensionless measure)



$10^{40}G_0$ = ten thousand, billion, billion, billion, billion times the strength of gravity

Ruler Representation of Force Strengths

(Ruler stretches across entire universe)

G_0 = Strength of Gravity: 1 **trillionth** of an inch.

Strength of Strong Force: **15 billion light years** ($10^{40}G_0$)

Fine-Tuning of Gravity

If one increased the strength of gravity by **one part in 10^{34}** of the range of force strengths (i.e., a billion-fold increase in strength), then:

- Even single-celled organisms would be crushed, and only planets less than around 100 feet in diameter could sustain life with our brain-size. Such planets, however, could not contain an ecosystem to support life of our level of intelligence.

Gravity Too Strong

Life-forms in a strong gravity world!

Value of G Ideal for Life

- In fact, if G were increased by a mere 64-fold, the force of gravity on the surface of *any* planet that could retain an atmosphere would be at least 4 times as large. A 400-fold increase in G would result in *any* such planet having a surface force at least 10 times as large. Such a planet would be far less ideal than earth for embodied conscious agents.
- On the other hand, a significant decrease in G would also have serious negative effects on life.

Fine-Tuning of Gravity--Continued

Thus, in order for life to occur , the strength of gravity must fall within an exceedingly narrow range of values compared to the total range of force strengths. It must fall into an even narrower range in order for the surface force on any habitable planet to be *optimal* for embodied conscious agents.

Analogy:
Radio Dial Stretched Across the Universe

WKLF ("K-Life"): You better tune your dial to a tiny range within the first one thousandth of an inch if you want a universe with life!

+15 billion light years

(Diagram not drawn to scale!)

Fine-tuning of Cosmological Constant

The **cosmological constant** is a term in Einstein's theory of gravity that influences the expansion rate of empty space. It can be positive or negative. *Unless it is within an extremely narrow range around zero, the universe will either collapse before galaxies and stars can form, or it will expand too rapidly for them to form.*

→How fine-tuned is it?

Answer:

In the physics and cosmology literature, it is typically claimed that in order for life to exist, the cosmological constant must fall within at least **one part of 10^{120}** – that is, 1 followed by 120 zeros -- of its theoretically natural range.

This is an unimaginably precise degree of fine-tuning.

Cosmological Constant: Radio Dial Analogy

WKLF: You must tune your dial to much, much less than a trillionth of a trillionth of an inch around zero.

-15 billion light years.

+15 billion light years.

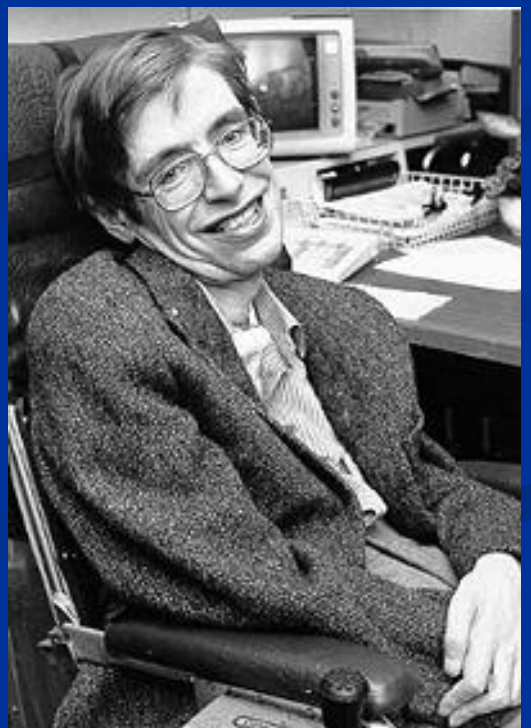
Conclusion

Many of the constants of physics must fall into an exceedingly narrow range of values for life to exist. If they had slightly different values, no complex material systems could arise. **This is widely recognized:**

Examples

Steven Hawking, the famous cosmologist:

"The remarkable fact is that the values of these numbers [i.e. the constants of physics] seem to have been very finely adjusted to make possible the development of life." (Hawking, 1988, "A Brief History of Time," p. 125.)

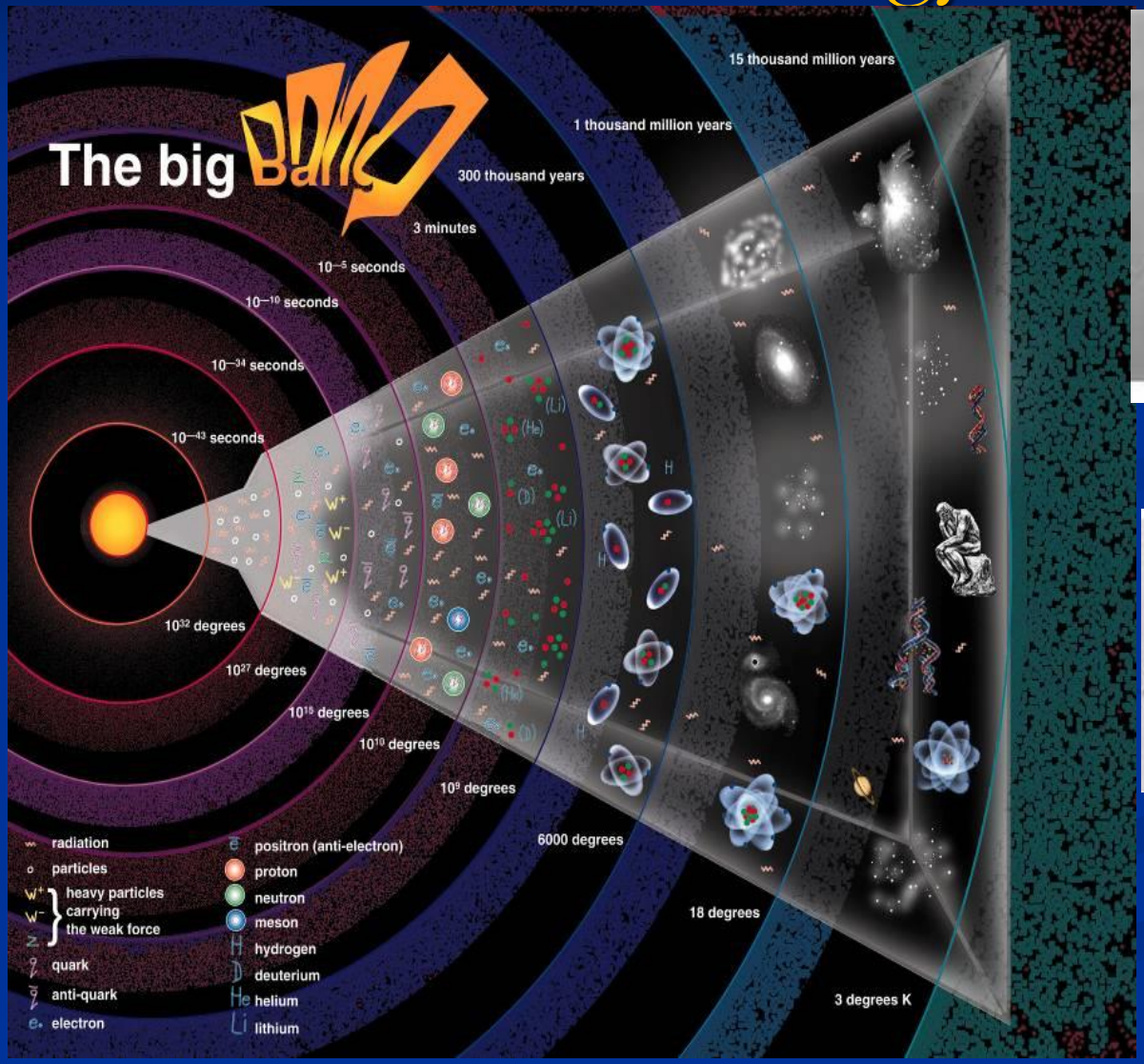


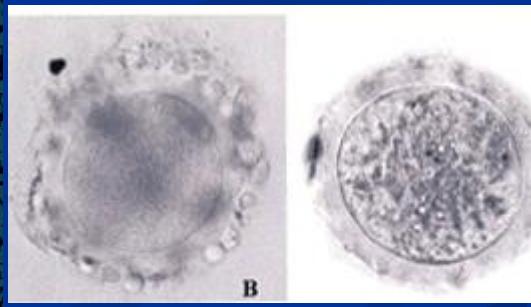
Another Example

Dr. Dennis Sciama, formerly director of Cambridge University Observatories:

"If you change a little bit the laws of nature, or you change a little bit the constants of nature . . . it is very likely that intelligent life would not have been able to *develop." (From the BBC special, "The Anthropic Principle.")*

Fine-Tuning of Initial Distribution of Mass-Energy:





How precise must the initial distribution of mass-energy be for life to exist?

Ask Roger Penrose, one of Britain's leading theoretical physicists and cosmologists:

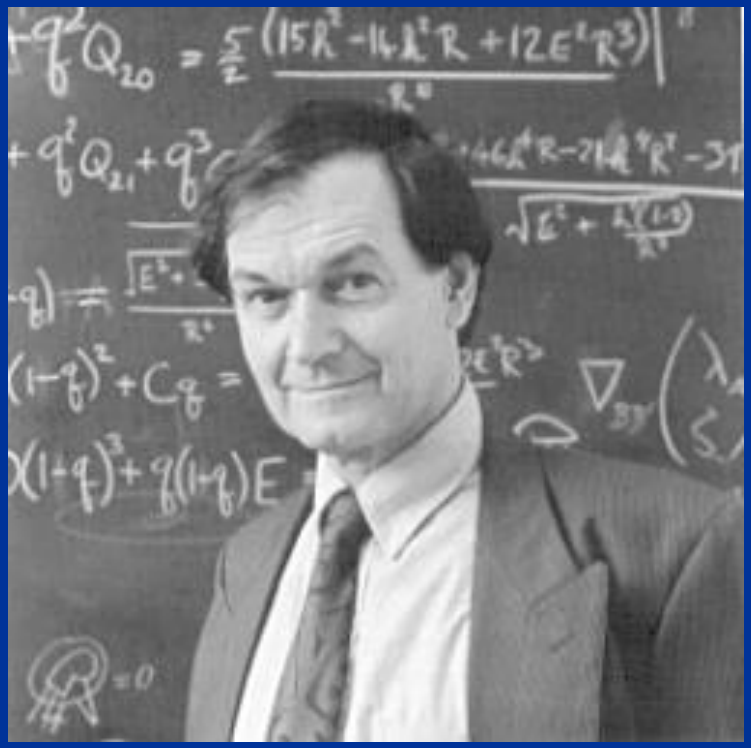


Fig. 7.19. In order to produce a universe resembling the one in which we live, the Creator would have to aim for an absurdly tiny volume of the phase space of possible universes—about $1/10^{10^{123}}$ of the entire volume, for the situation under consideration. (The pin, and the spot aimed for, are not drawn to scale!)

Analogy

To get an idea of how large $10^{10^{123}}$ is, imagine filling the universe with sheets of paper covered with zeros. Then put a 1 in front of all those zeros. The resulting number would be vastly smaller than $10^{10^{123}}$.

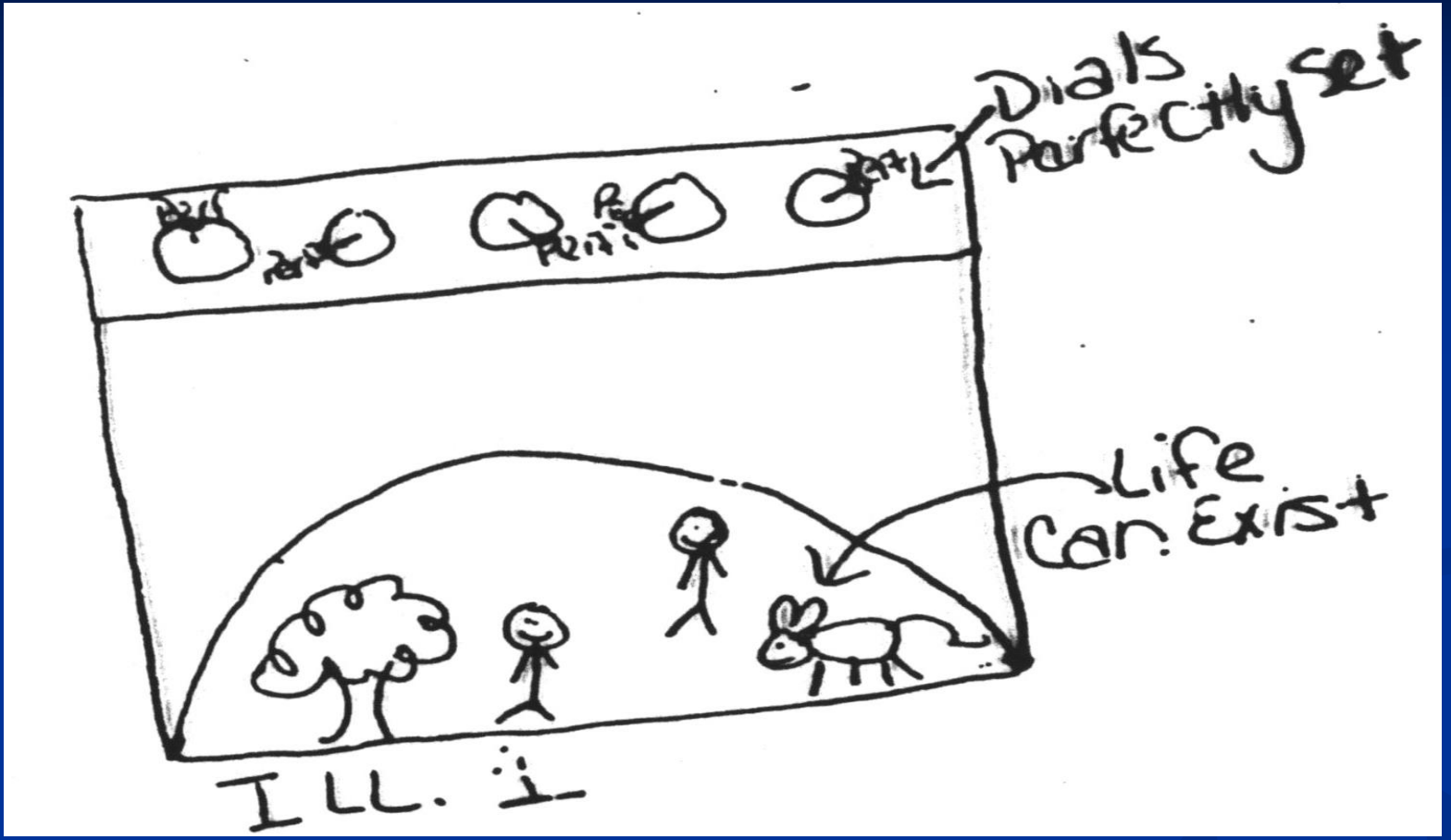
Conclusion

The initial distribution of mass-energy must fall within an unimaginably narrow range of values for complex life to occur.

Recap: Types of Fine-Tuning for Life

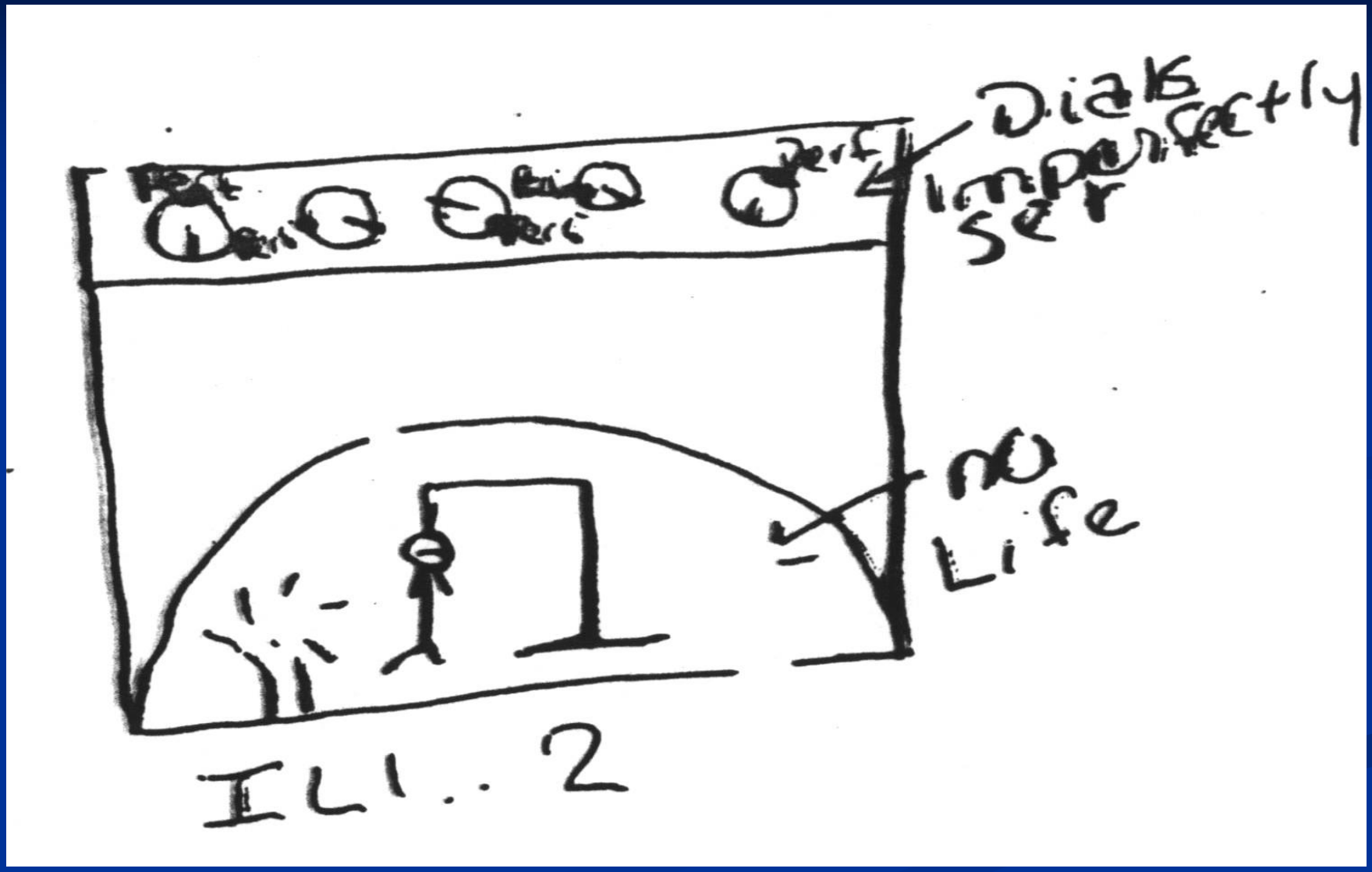
- Fine-tuning of Laws of Physics
- Fine-tuning of Constants of Physics
- Fine-tuning of the Initial Conditions of the Universe
- *Further, the constants seem to precisely adjusted for so that *living conditions would be optimal*, and it would *be optimal to develop technology and discover the universe*.

Summary of Evidence

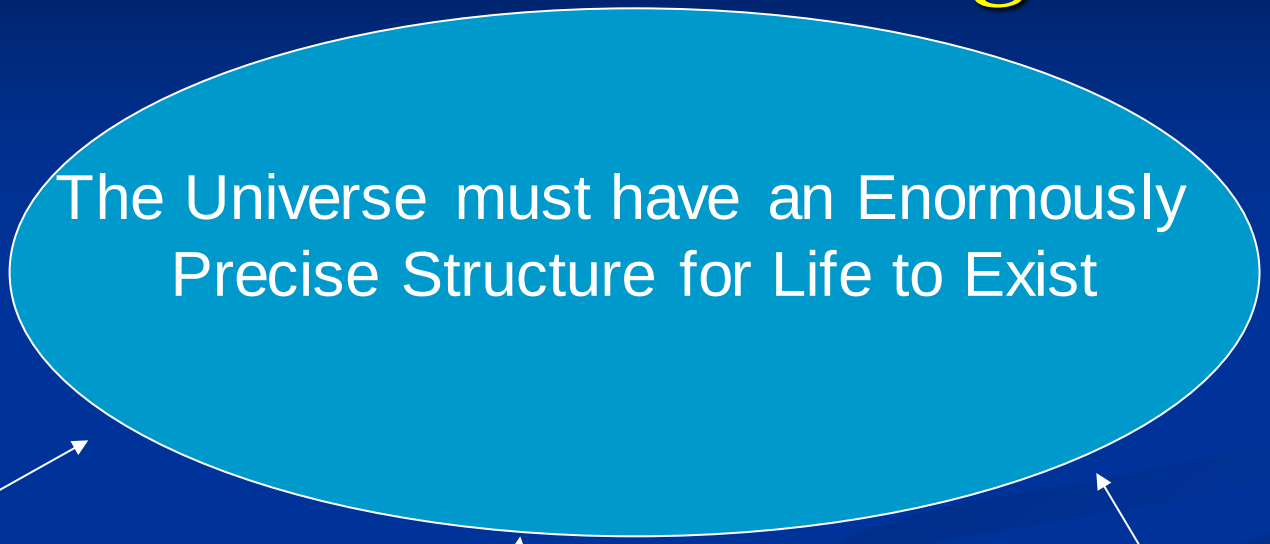


Biosphere Analogy: Dials must be perfectly set for life to occur. (Dials represent values of constants. Illustration by Becky Warner, 1994.)

Summary-continued



Cumulative Case Argument for Fine-Tuning



Laws of Physics

Constants of Physics

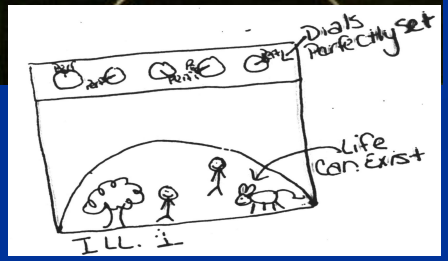
Initial Conditions of Universe.

There is not just one, but multiple, independent lines of evidence supporting the claims to fine-tuning. This makes the case for fine-tuning extremely strong.

How can we Explain the Fine-Tuning for life?

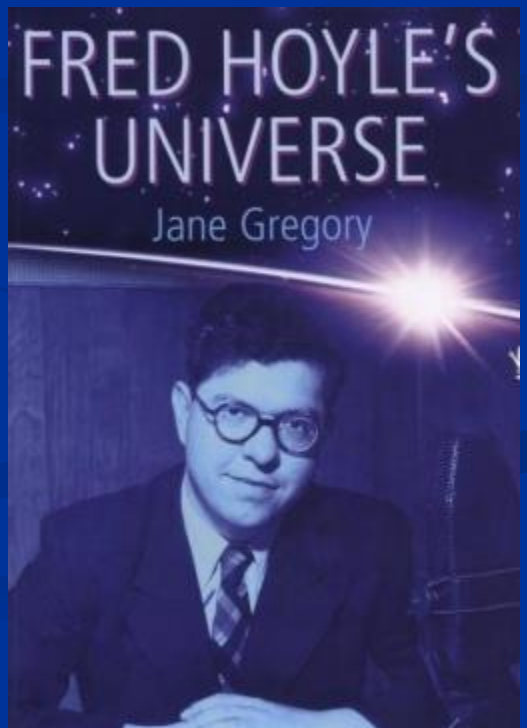
To many people the evidence of fine-tuning immediately suggests **divine creation** as the explanation. This is true for theists and non-theists.

"Ancient of Days" or "God's Creating the Universe," by William Blake (1757-1827).



Non-theist theoretical physicist and popular science writer Paul Davies: "The impression of design is overwhelming" (*The Cosmic Code,* 1988, p. 203).

After discovering one of the first purported cases of fine-tuning, the late non-theist astrophysicist Sir Fred Hoyle declared: "A commonsense interpretation of the facts suggests that a superintellect has monkeyed with physics … and that there are no blind forces in nature."



So what alternatives do non-theists offer to Divine Creation?

The Two Major Alternatives Are:

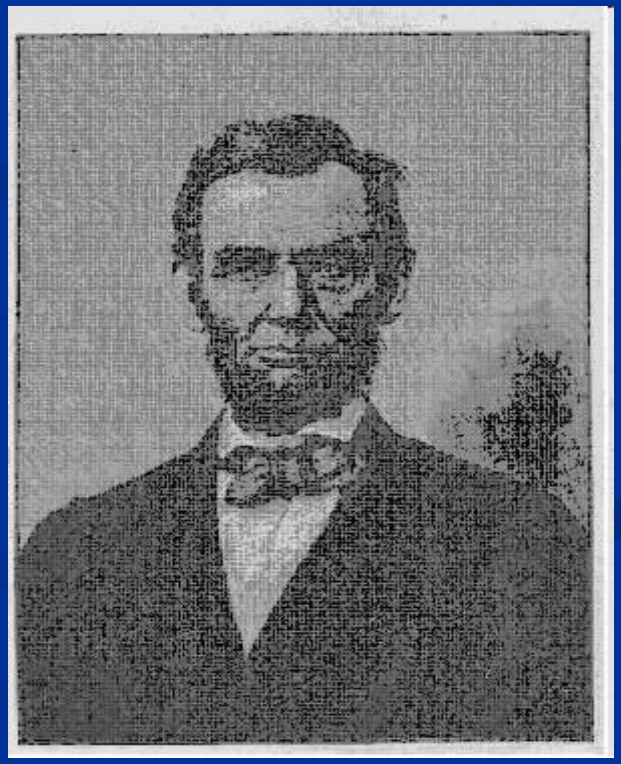
First Alternative:

Lucky Accident/Brute Fact Hypothesis. The fact that a life-permitting universe exists is just a coincidental fact that neither has nor requires an explanation. **Our existence is just an extraordinarily "lucky accident."**

Comment:

Many people find the brute fact hypothesis as implausible as claiming that a picture of the face of Abraham Lincoln was just the result of an ink spill:

An extraordinarily lucky ink spill?



Second Alternative: Multiverse Hypothesis

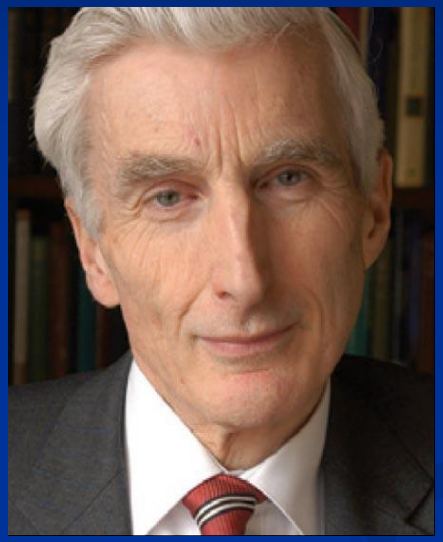
But, perhaps if we spilled ink enough times we would get the face of Lincoln. This leads us to the second explanation, the so-called "**multiverse hypothesis**," according to which there are an enormous number of universes with different initial conditions, values for the constants of physics, and even the laws of nature. Thus, simply by chance, some universe will have the "winning combination" for life; supposedly this explains why a life-permitting universe exists.

Multiverse Hypothesis

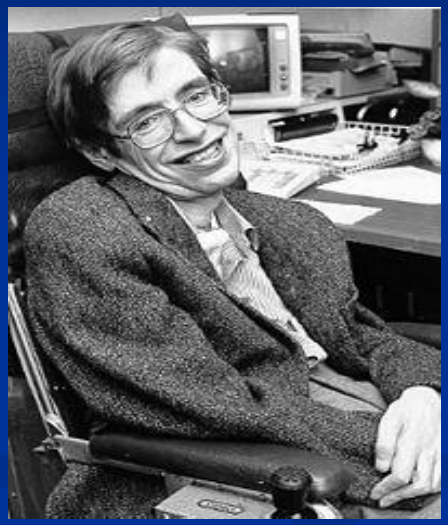
Humans are winners of a cosmic lottery:

Some Advocates of Multiverse Hypothesis

Cosmologist Max Tegmark, Massachusetts Institute of Technology.

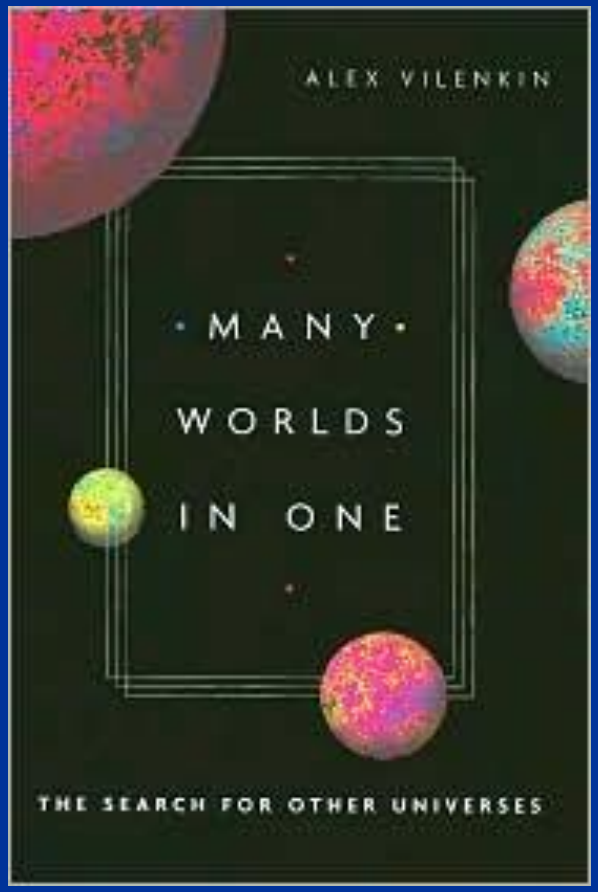


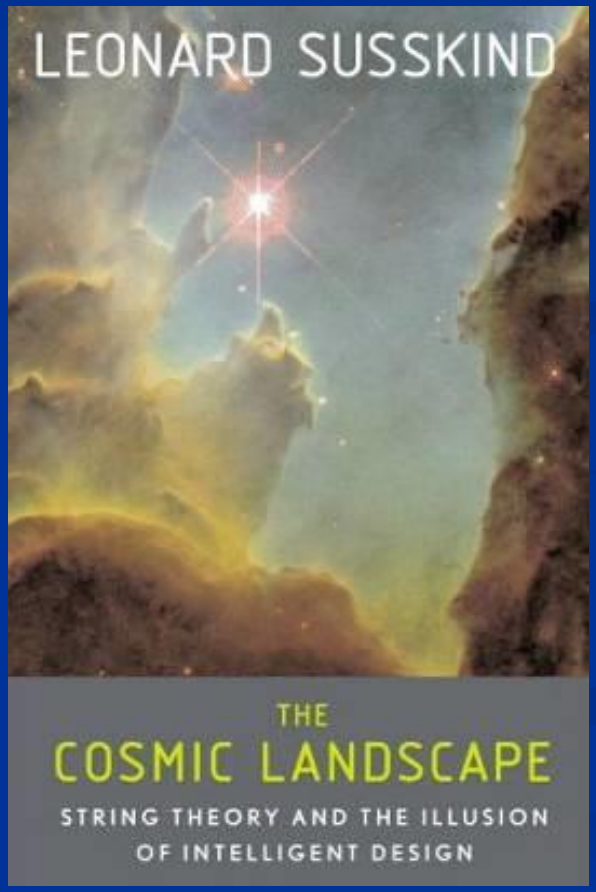
Sir Martin Rees, former Astronomer Royal of Great Britain.

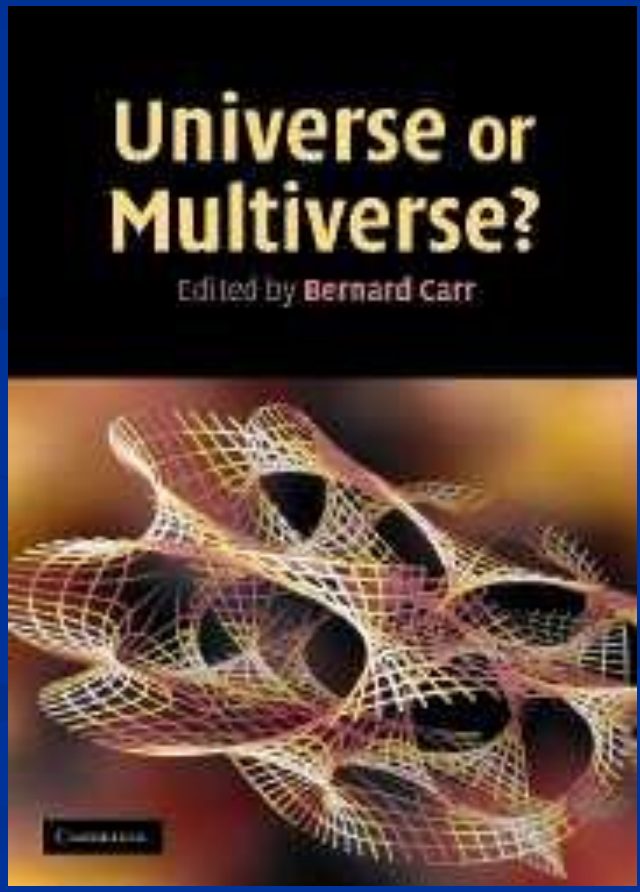


Cosmologist Stephen Hawking, Cambridge University.

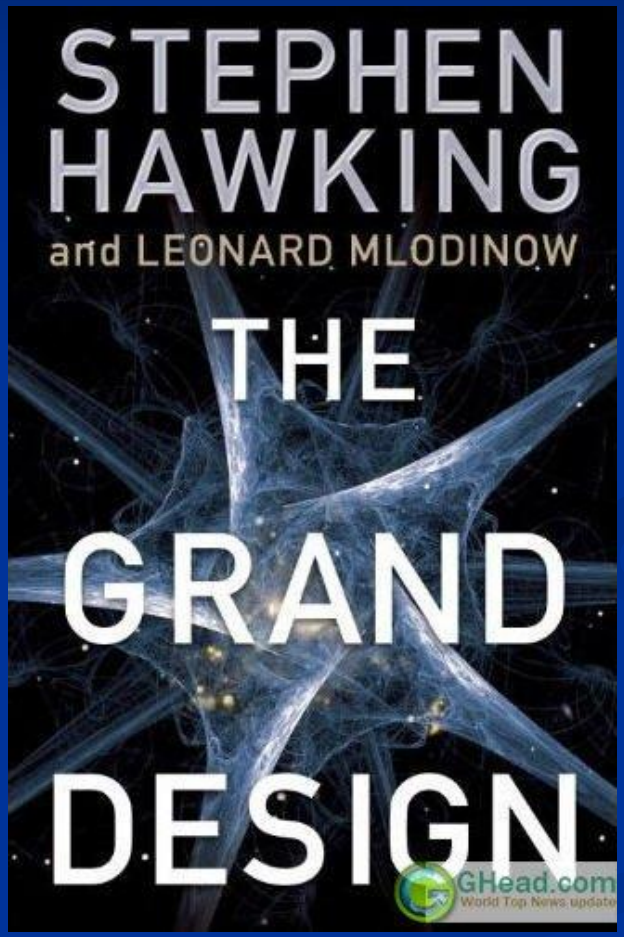
Recent Books on Multiverse







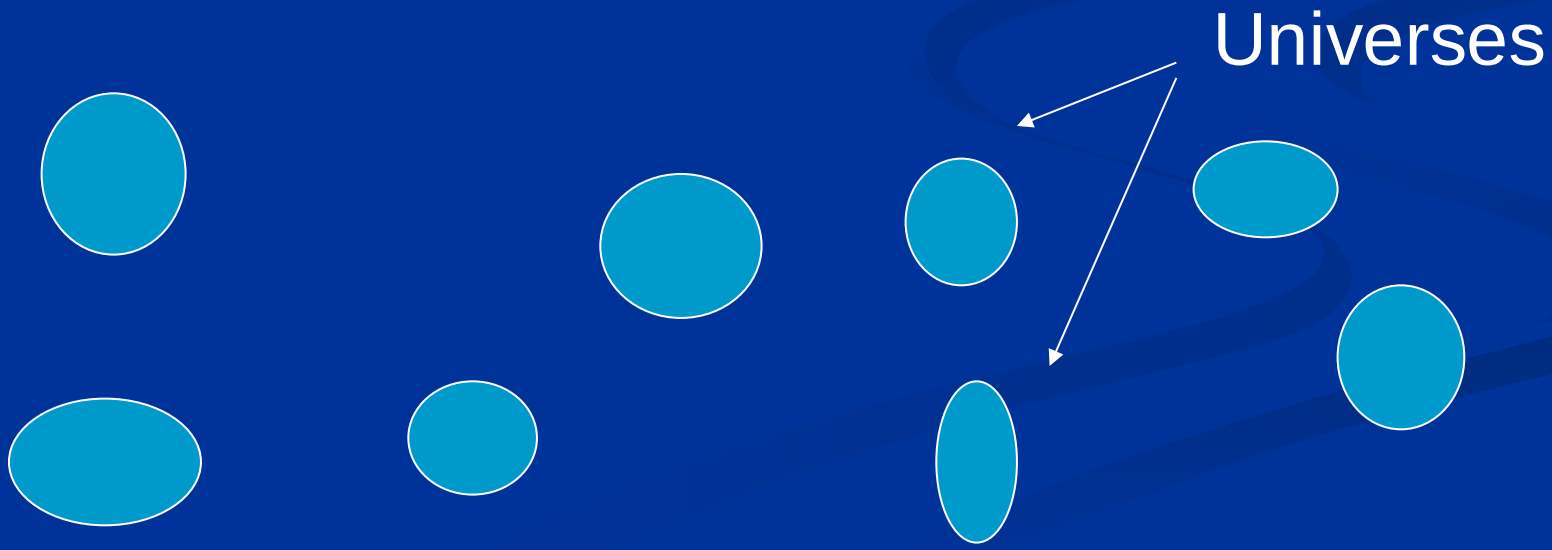
More Recent Books



The multiverse hypothesis comes in two major versions:

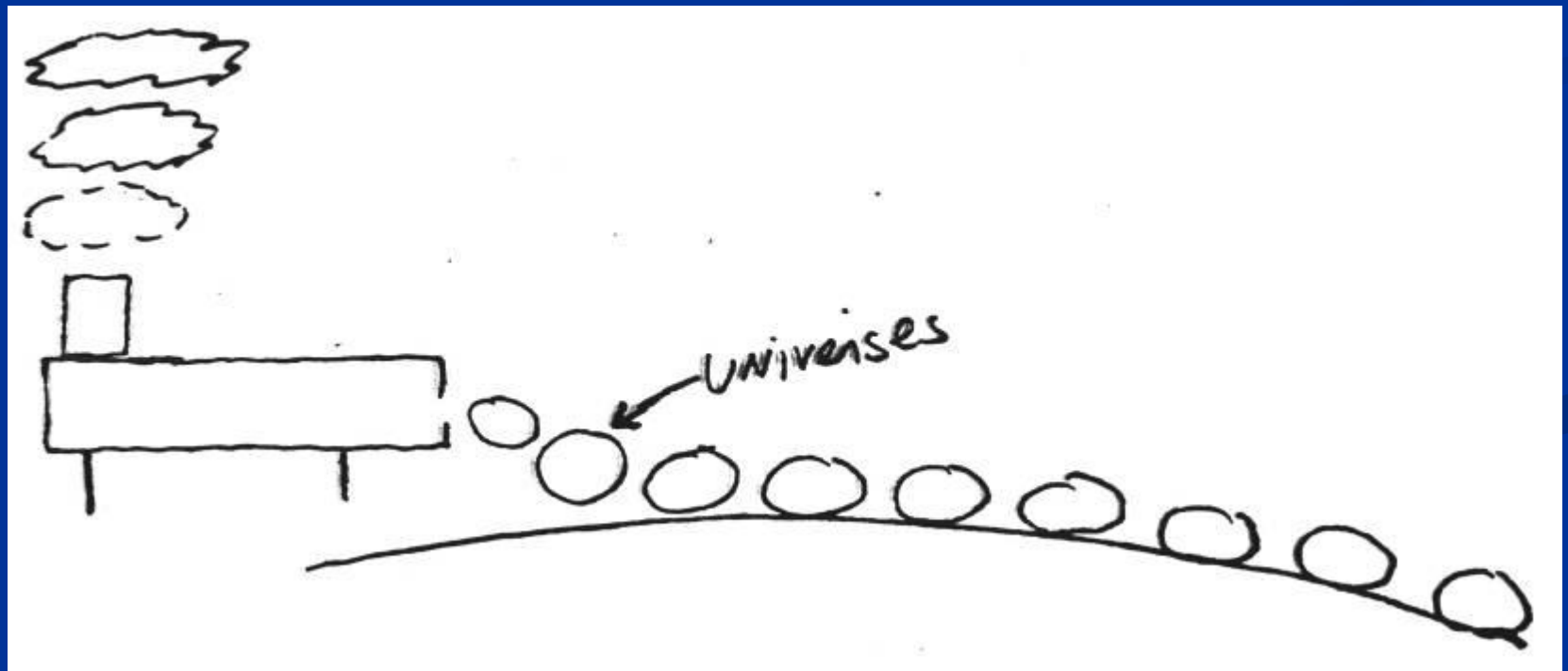
Purely Metaphysical Version

This is the idea that all possible universes exist as a brute fact without any further explanation. Leading proponents: The late Princeton University philosopher David Lewis; cosmologist Max Tegmark. **Not widely advocated.**



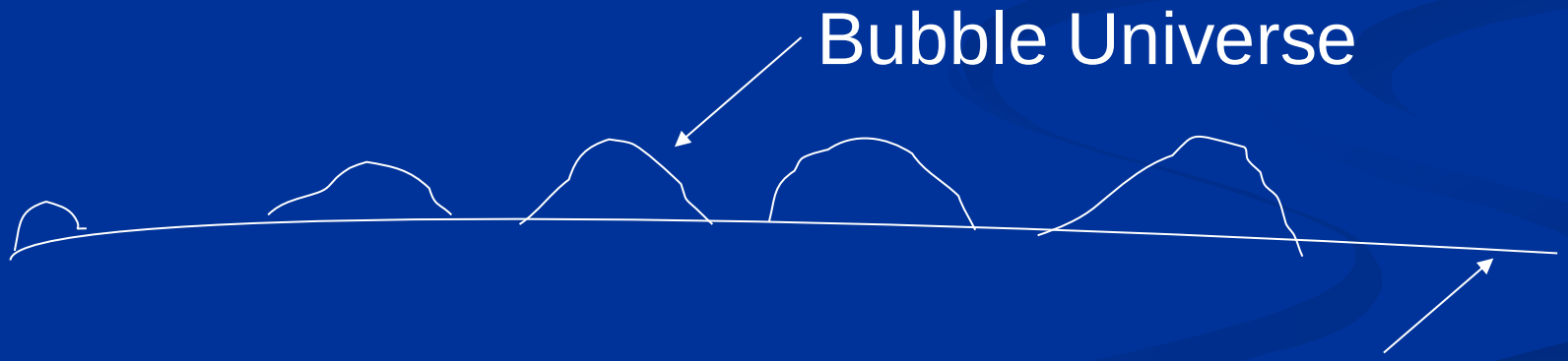
Most Popular Version: Universe Generator Version

This is the idea that the universes are generated by some physical process that I call a "Universe Generator." **Advocated by many leading cosmologists**, such as Stanford University's Andrei Linde and Britain's Sir Martin Rees.



Inflationary-Superstring Version

This is the most physically viable and most widely advocated version of the universe-generator multiverse hypothesis. As a result of an hypothesized inflaton field that imparts a constant energy density to empty space, a multitude of regions of "pre-space" inflate and then form bubble universes, with differing values for the constants of physics, and differing lower-level laws of physics:



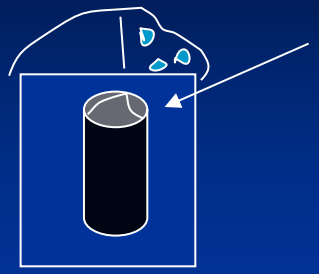
Analogy: Ocean full of soap.

Possible Theistic Responses:

1. Takes more faith to believe in many-universes generator than God.
2. Where did universe generator come from?
3. Universe generator itself would need to be "well-constructed" to produce a single life-sustaining universe.
4. Runs into the problem of "Boltzmann Brains"
5. Does not explain optimality of universe for science and technology.

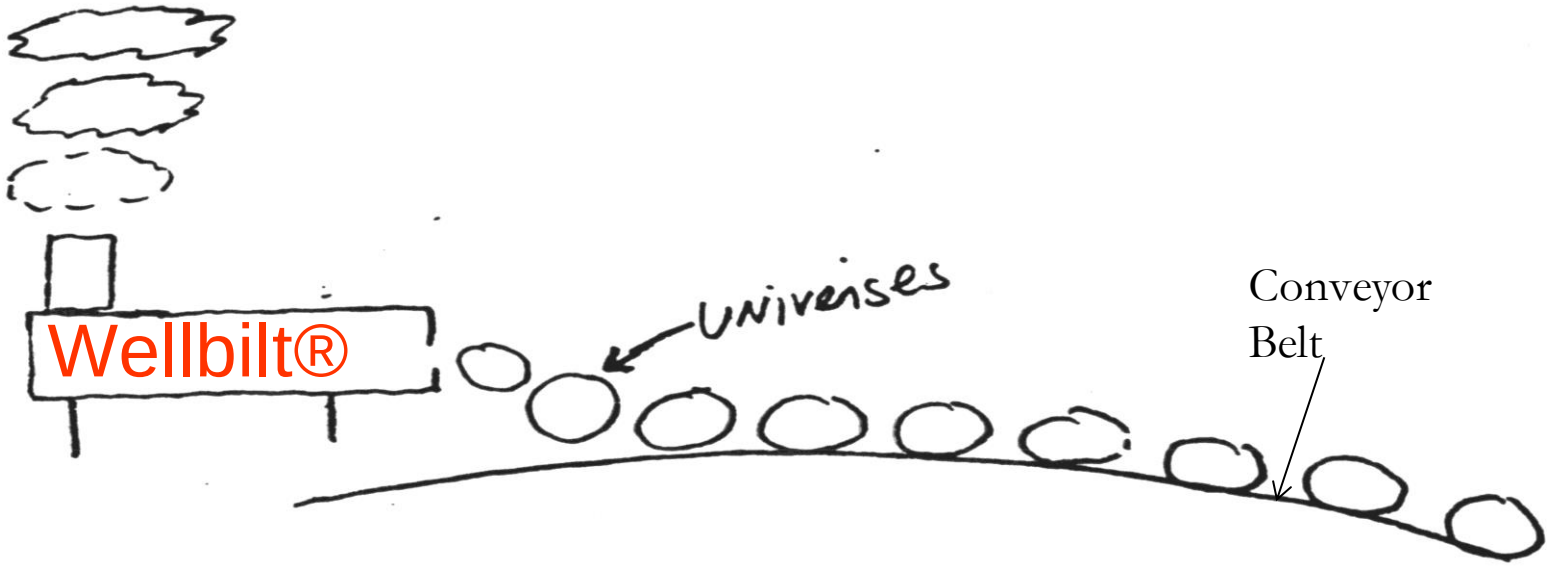
We will focus on the third response:

Bread Machine Analogy



Bread Machine must be precisely constructed (and correctly operated) to produce decent loaves of bread. Further, ingredients must be right (e.g., the amount of yeast, gluten, water, etc.), otherwise loaves come out like “hockey pucks.”

Bread Machine Analogy—Cont.



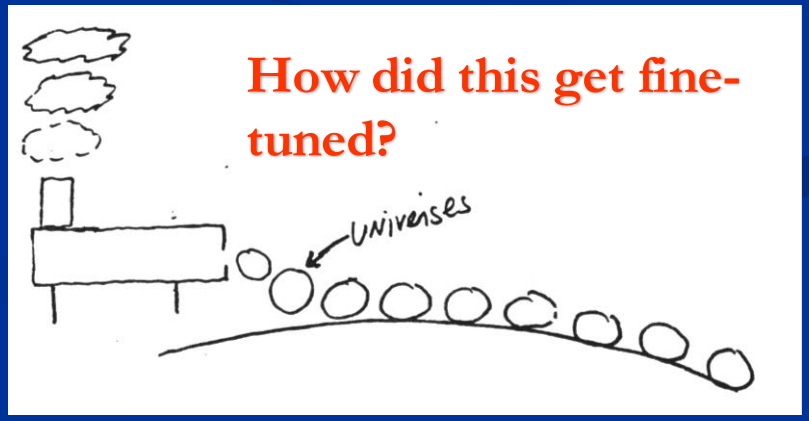
In analogy to a bread machine, it seems that the many-universe generator must have just the right laws and have just the right ingredients (initial conditions) to produce life-supporting universes.

Bread Machine Analogy Verified for Inflationary-Superstring Scenario

If one carefully examines the inflationary superstring multiverse, it requires just the right set of laws and special mechanisms to produce even one life-sustaining universes.

Conclusion

At best, the many-universes generator hypothesis eliminates the **quantitative** case for divine creation based on the fine-tuning of the **constants** for life. The many-universes generator **still requires precisely the right laws, mechanisms, and initial conditions in order to produce a life-sustaining universe.** *So, it largely kicks the issue of fine-tuning up one level to that of the universe generator.*



Conclusions

1. The universe-generator hypothesis does not significantly undercut the fine-tuning argument.

2. Theism is compatible with the many-universes generator hypothesis. [God could have created the universe via such a generator.]

Overall Summary

Three responses to fine-tuning evidence:

1. Theism
2. Multiverse Hypothesis
3. Brute Fact/Chance Hypothesis

Against (2): Multiverse generator requires "design."

Against (3): Because life is special, it is as hard to believe that the universe just occurred by "chance" as that an ink spill gave rise to the picture of Abraham Lincoln. (A different response is to claim that the fine-tuning provides strong evidence in favor of theism over Brute Fact Hypothesis.)

For Further Information

For Further Information, see my Fine-tuning Website at www.fine-tuning.org, www.robincollins.org

Or simply type Robin Collins into Google

For an online debate on issue, see the cosmology section of **"The Great Debate" at www.infidels.org**

LOCATIONS OF ADDITIONAL SLIDES

Location of Additional Slides

Location of Additional Slides

Location of Standard Slides

- Links to Slides:
- Evidence for Fine-tuning:
- Multiverse Hypothesis
- Surprise Principle Argument

CONCERNING FAITH AND REASON

Question: It seems that you trying to make belief in God rest on science. How is that compatible with faith?

Answer: I am not claiming that science is, or should be, the primary reason we believe in God. Rather, I am only claiming that the fine-tuning data provides strong **confirming evidence** for the existence of God. Faith, understood as a special mode of knowing similar to our ethical (and epistemic) intuitions, still plays an essential role. [END]

CAN'T PROVE GOD OBJECTION

Response: I do not claim to prove God, or even that God is the only adequate hypothesis to explain the universe. Rather, I claim that the fine-tuning data provides confirming evidence for the existence of God. Faith, as a special mode of knowing similar to ethical intuition or conscience, still plays an essential role.

[END]

A FURTHER ANALYSIS OF THE BRUTE FACT HYPOTHESIS:

Brute Fact Hypothesis?

- Even though this hypothesis strikes many as highly implausible (think ink spill analogy), we cannot absolutely rule out the possibility that our universe simply exists as an extraordinarily lucky accident.

- BUT, we can say is that the fine-tuning provides significant **evidence** in support of theism over this hypothesis.

How So?

By the **Likelihood Principle**, a standard principle of Confirmation Theory. For our case, this principle reduces to what I call the **"Surprise Principle":**

Surprise Principle Informally stated: Whenever a body of data is much more surprising under one hypothesis than another, the data counts as evidence in favor of the hypothesis under which it is least surprising.

**Note: To avoid certain counterexamples, the hypothesis H1 that is being confirmed should be restricted to those that have either been seriously advocated prior to E or for which we have independent motivation.

Example

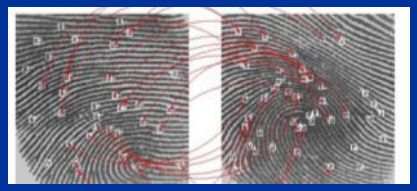
A defendant's fingerprints matching those on a murder weapon is typically taken as evidence of guilt:

→ **GUILTY!**

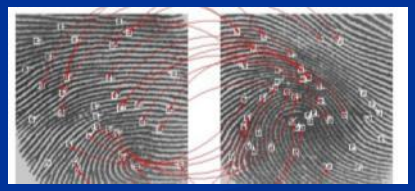
Why?

Because:

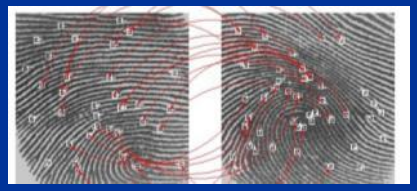
Match **Not** Surprising under Guilt Hypothesis:




Match very Surprising under Innocence Hypothesis:



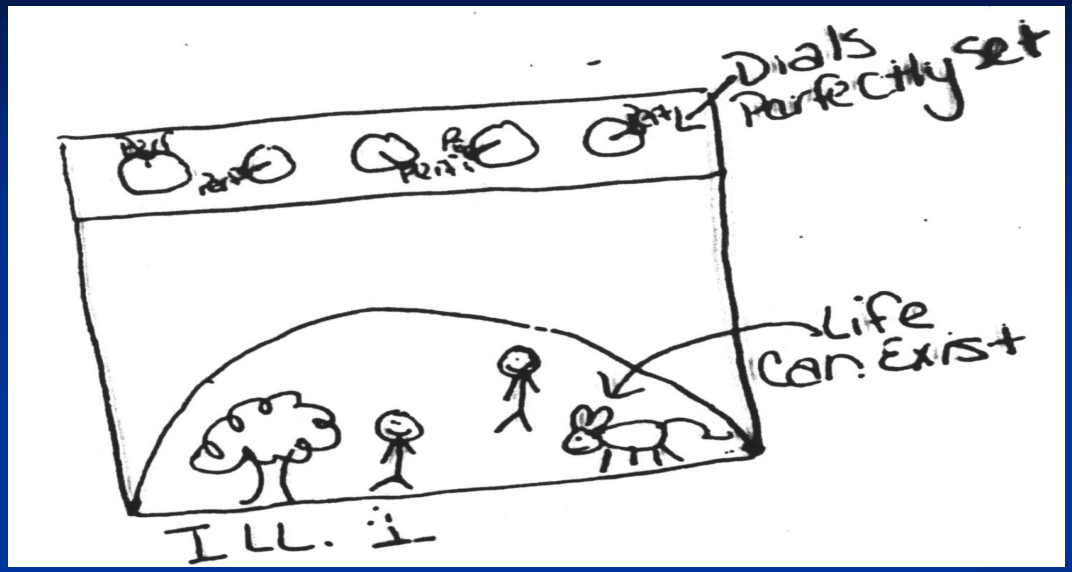

Therefore by Surprise Principle:



Evidence for →

Guilt **over** Innocence

Applied to Fine-tuning Argument



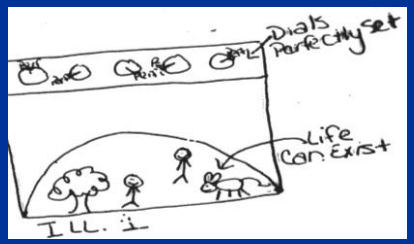
Life-permitting Universe

- **Not** Surprising Under Theism:

- **Very Surprising** Under Brute Fact Hypothesis:

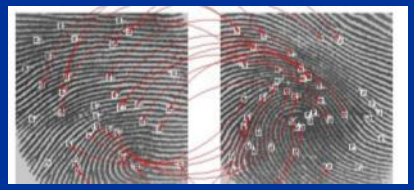
Conclusion

Therefore, a life-permitting universe provides strong evidence of theism over the brute fact hypothesis:



Strong Evidence for → Theism **over** Brute Fact

For same reason that fingerprint match can provide strong evidence for guilt over innocence:



Strong Evidence for → Guilt **over** Innocence

Note:

Just as the matching of fingerprints on a gun do not absolutely **prove** guilt (since, for example, it is possible that they could have matched by chance), the fine-tuning does **NOT absolutely prove** divine creation. It only provides **strong evidence** for divine creation over the brute fact hypothesis.

End

Fine-tuning for Science and Technology

Furthermore, the multiverse hypothesis does not explain the fact that as observers we find ourselves in a universe that is optimal for the development of science and technology.

Why?

The answer has to do with the so-called

Observer Selection Effect:

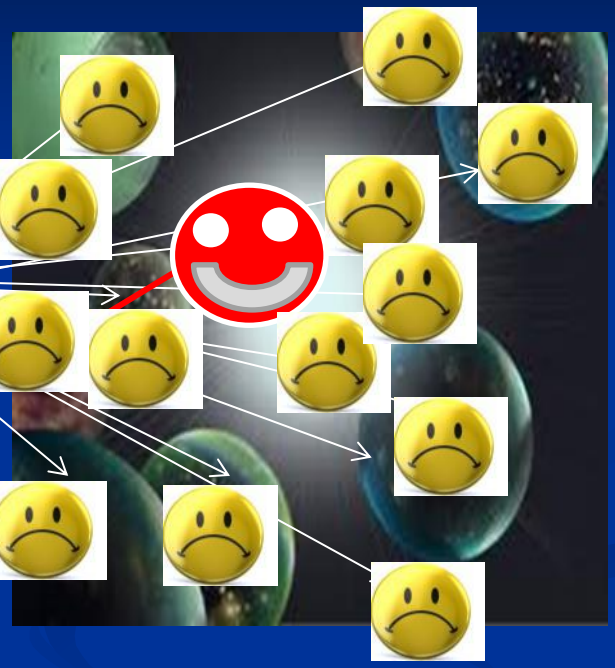
Observation Selection Effect

The **Observation Selection Effect** is crucial to the multiverse explanation. According to this idea, observers can only exist in universes in which the laws, constants, and initial conditions are life permitting. Therefore, it is argued, it is no coincidence that we find ourselves in a life-permitting universe.

Multiverse Cannot Explain

Sad scientist wannabes in poorly discoverable life-permitting universes.

Happy scientist in our universe.

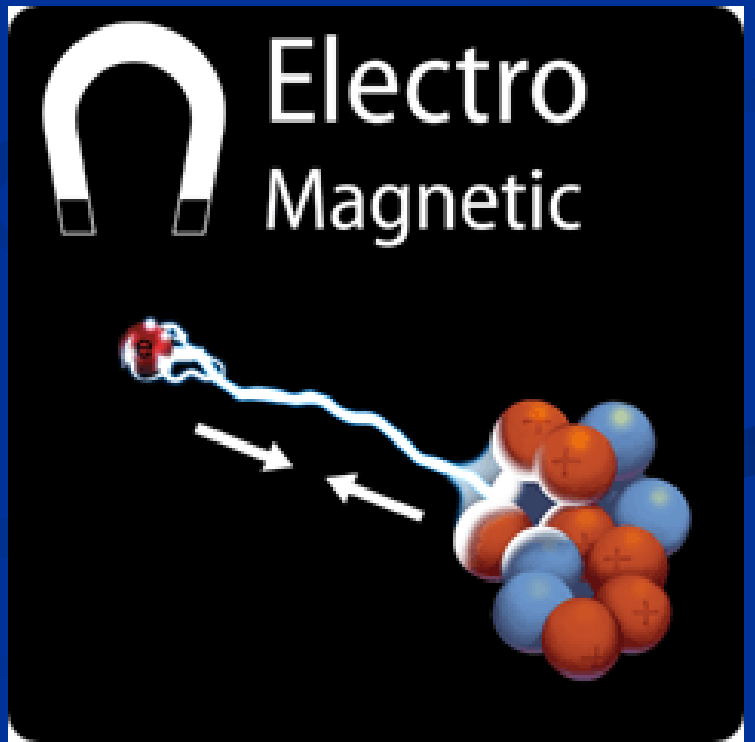


Given that there is only a very small proportion of observer-permitting universes that are as highly discoverable as ours, it is **still very surprising that we find ourselves (as generic observers) in a highly discoverable universe. Thus, multiverse does not take away surprise that we find ourselves in a highly discoverable universe and hence does not explain this fact.**

Example 1: Fine-Structure Constant (α)

The fine-structure constant, α, is a physical constant that *governs the strength of the electromagnetic force*. If it were larger, the electromagnetic force would be stronger; if smaller, it would be weaker.

Electromagnetic force is a unification of the force between electric charges and the force exerted by magnetic fields.



Fine-Tuning Structure Constant and Fire

If the α were slightly larger, open wood fires (or that of any other biomass) would have been impossible. Without such fires it is far less likely that intelligent life forms would learn to forge metals, and thus develop a scientific civilization.

Why Does Increasing α Have This Effect?

This effect can be understood in three steps:

Step 1: In atomic units, the radiation emitted by a wood fire burning at a given temperature is proportional to α^2

Step 2: Therefore: an increase α ⇒ an increase in radiant energy emitted ⇒ more energy leaving the fire ⇒ **a drop in temperature of fire.** (In atomic units, combustion and convection rate effectively do not depend on α.)

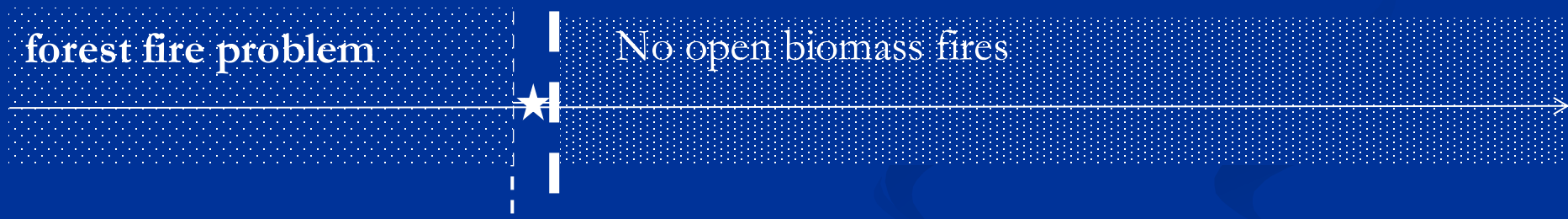
Explanation Continued

Step 3: Therefore: α increased too much (10% - 40%) ⇒ temperature falls below combustion point ⇒ **fire goes out**.

Notice: The heat radiation emitted from completely exposed wood surfaces is already too large for these surfaces to keep burning, a fact which greatly reduces the risk of forest fires thereby making wood more available. If α were more than 40% smaller, this would not be the case.

Upshot

α is within a small optimality range for the use of fire for smelting metals and hence for the development of civilization. This range is very small compared to the possible values of α.



★ ≡ current value of α (~1/137).

Two Other Discoverability Constraints on α

1. Decreasing α would **decrease the maximum resolving power of light microscopes**.

- Interesting "Coincidence": As is, maximum resolving power of light microscopes is 0.2 microns; smallest living cell is 0.2 microns.

2. The efficiency of **electric transformers and motors rapidly drops off with a decrease in α.**

Summary of *Some* Discoverability Bounds on α

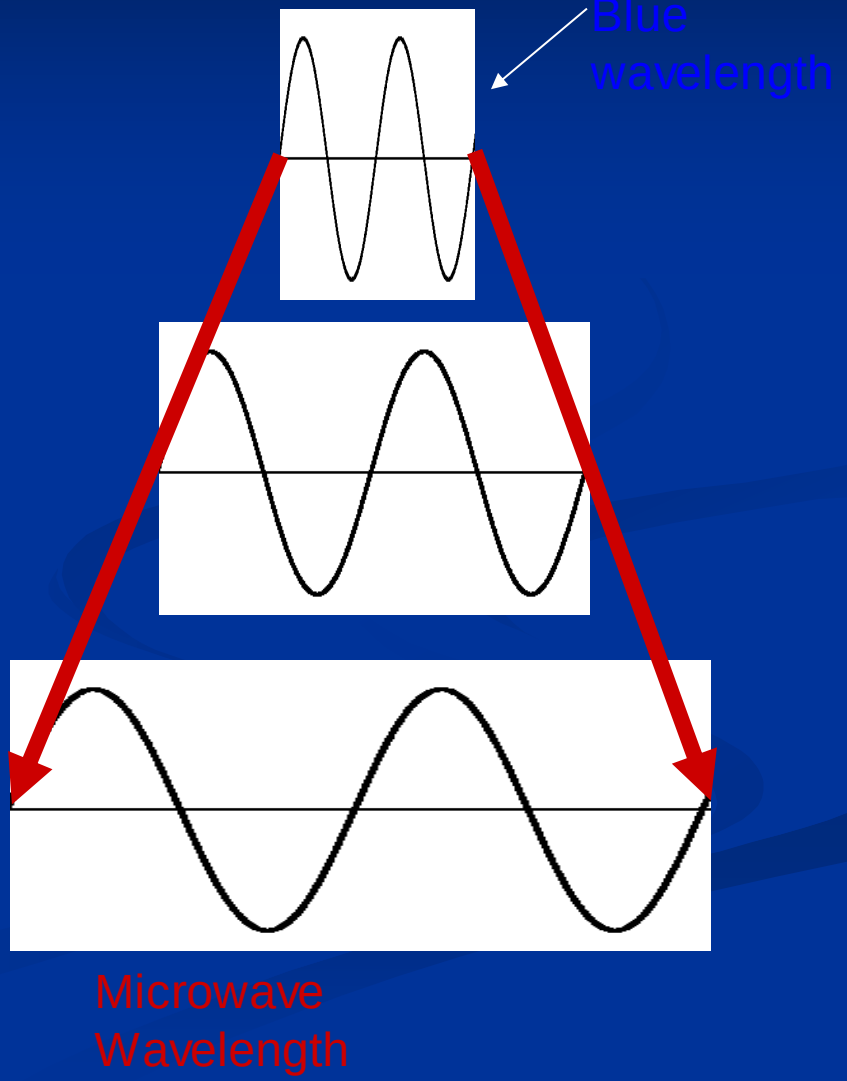
- **Discoverability Constraints:**
- Upper Discoverability (thick dashed): no wood fires.
- Lower Discoverability (thin dashed lines): much larger risk of forest fires; loss of resolving power of light microscope; major loss of efficiency for electric transformers and motors; loss of paleomagnetic dating and use of compass.

Example 2: The CMB

The Cosmic Microwave Background Radiation (CMB). The CMB is microwave radiation that permeates space. It was caused by the big bang.

Why Microwave Radiation?

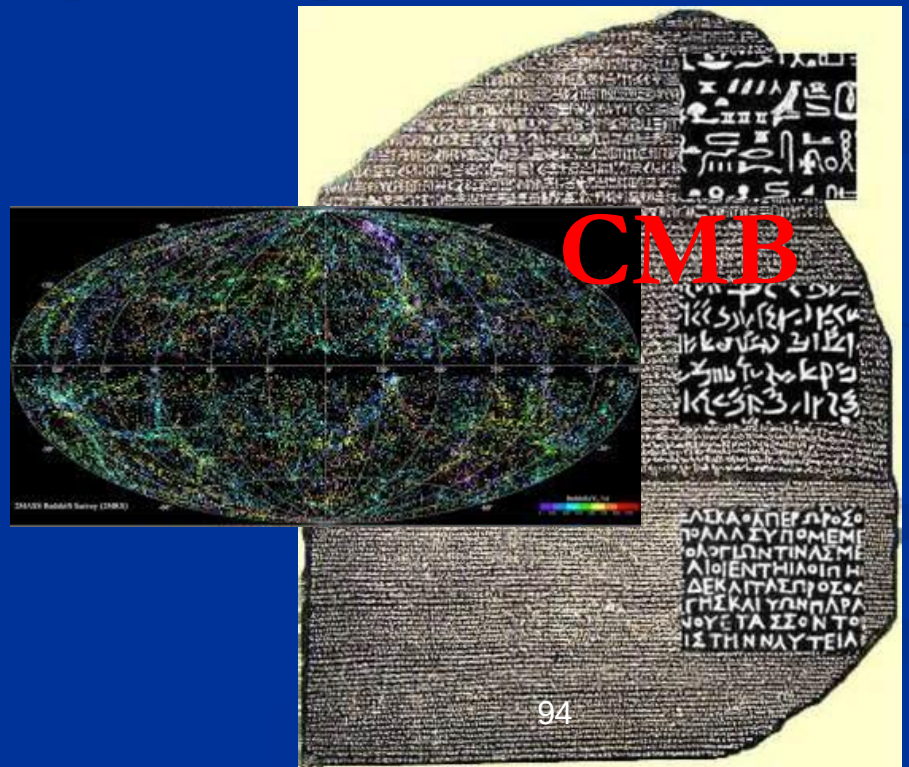
Starting out as visible light, the light waves emitted during the plasma-era of big bang expansion have been stretched by a thousand-fold so that they are now in the microwave region.



Significance of the CMB

The CMB: A key tool of cosmology.

"The background radiation has turned out to be the 'Rosetta stone' on which is inscribed the record of the Universe's past history in space and time." (John Barrow and Frank Tipler, *The Cosmological Anthropic Principle*, 1986, p. 380).



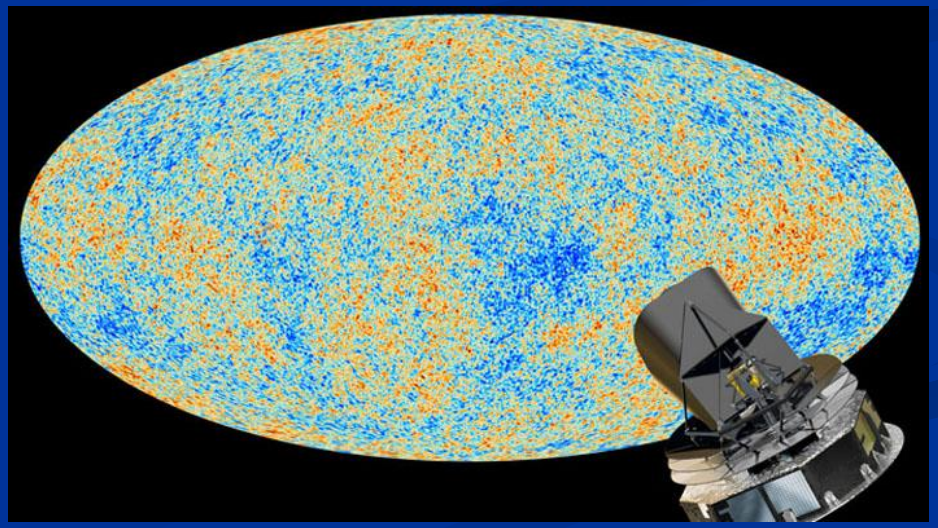
Optimizing CMB for Discovery

The CMB is already fairly weak.

Information encoded in very slight variations in its intensity.

- **Consequently** (within limits): **the more intense CMB is** ⇒ the smaller the variations we can measure ⇒ **the more useful it is for cosmology.**

Figure: Planck satellite measuring variations in CMB of one part in ten million.
Photo Credit: European Space Agency



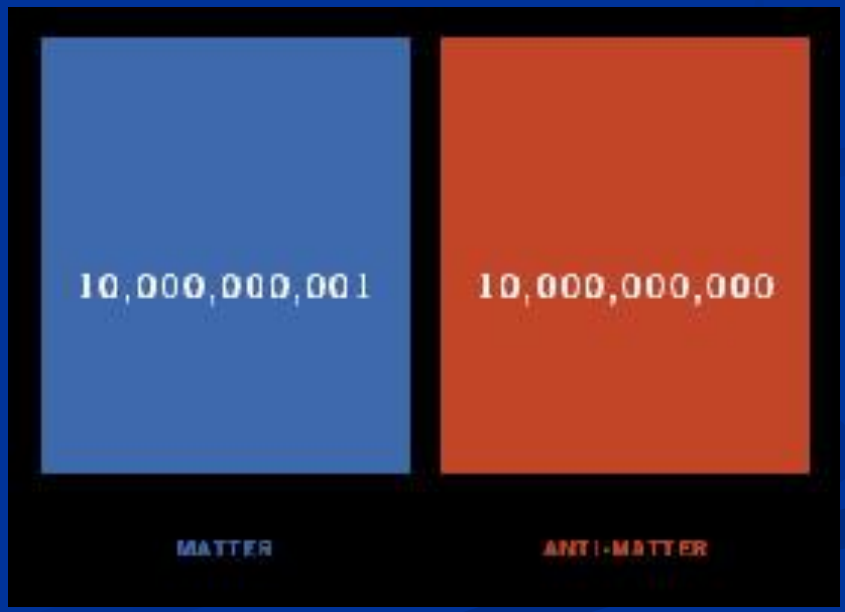
CMB's Dependence on Baryon/Photon Ratio

Intensity of CMB depends on baryon to photon ratio ($\eta_{b\gamma}$):

$$\eta_{b\gamma} \equiv \text{baryon to photon ratio} = \frac{(\#baryons}{\#photons}) = \frac{(\#protons + \#neutrons)}{\#photons}$$

Asymmetry of Matter over Antimatter

The photon to baryon ratio is the result of the slight abundance of matter over antimatter in the early universe. For about every billion and one particles of matter, there was a billion particles of matter. When the particles and antiparticles annihilated each other, this left a baryon to photon ratio of approximately one in a two billion.



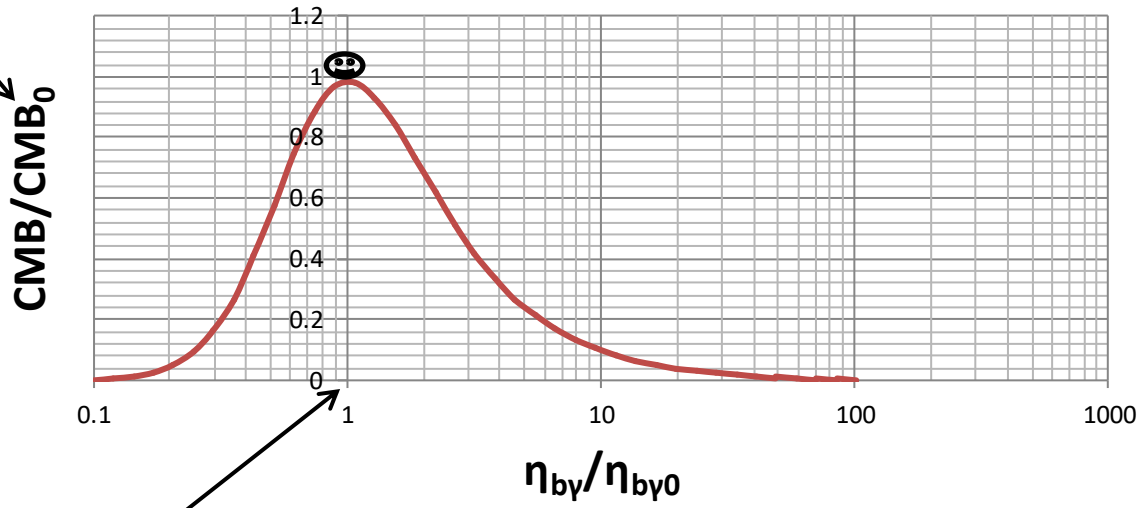
From: http://lbne.fnal.gov/why-neutrinos.shtml

Prediction

Tentative Prediction of Tool Optimality Thesis: The **baryon to photon ratio, $\eta_{b\gamma}$, in our universe should maximize the intensity of the CMB.**

Prediction Correct!

Intensity of CMB of alternative universe relative to ours:



Our universe $\equiv \eta_{b\gamma}/\eta_{b\gamma 0} = 1.$

Note: My calculations for the above graph have been verified by four other physicists/cosmologists.

REALLY BIG PICTURE: BEAUTY AND DISCOVERABILITY

The Really Big Picture
Features of Universe that Suggest Divine Design:

1. The Fine-Tuning of the Cosmos for Life.
2. "Fine-tuning" for Beauty and Elegance of the Laws and Underlying Principles of Nature.
3. The Intelligibility and Discoverability of the Laws of Nature.
4. The Existence of Consciousness.

Let's illustrate (2) and (3) above with a few quotations:

Beauty of Laws

Steven Weinberg, Nobel Laureate in physics and a convinced atheist:

"It is precisely in the application of pure mathematics to physics that the effectiveness of aesthetic judgments is most amazing…. mathematical structures that confessedly are developed by mathematicians because they seek a sort of beauty are often found later to be extraordinarily valuable by physicists." (Dreams of a Final Theory 1992, p. 153).

Later Weinberg says,

"I have to admit that sometimes nature seems more beautiful than strictly necessary" (p. 250).

Intelligibility and Discoverability

- Albert Einstein on Intelligibility:

  "The most unintelligible thing about the universe is that it is intelligible at all."

- Eugene Wigner, a major founder of Quantum Mechanics on discoverability:

  Wrote Major Essay: "The Unreasonable Effectiveness of Mathematics in the Physical Sciences."End

WHO DESIGNED GOD OBJECTION

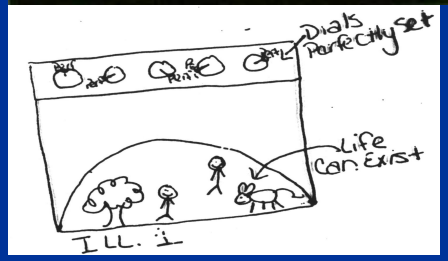
An extraordinarily common objection. In his book, "Atheism: The Case Against God" (1980), atheist George Smith succinctly summarizes the objection as follows:

> "If the universe is wonderfully designed, surely God is even more wonderfully designed. He must, therefore, have had a designer even more wonderful than He is. If *God* did not require a designer, then there is no reason why such a relatively less wonderful thing as the universe needed one."

The idea behind the objection is that since explanation must stop somewhere, we are better off accepting the universe as the "ultimate brute fact" than God as the "ultimate brute fact," since the latter just transfers the "problem of design" up one level.

Objection would hold if:

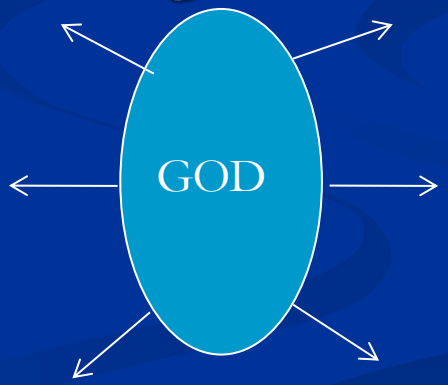
- Anthropomorphic God:



Presumably, if God had a physical brain, or even a finite mind, then the same fine-tuning problem would confront the existence of God's brain or mind: e.g., the matter composing God's brain would have to be organized in just the right way for God to think.

God of Classical Theism not Anthropomorphic

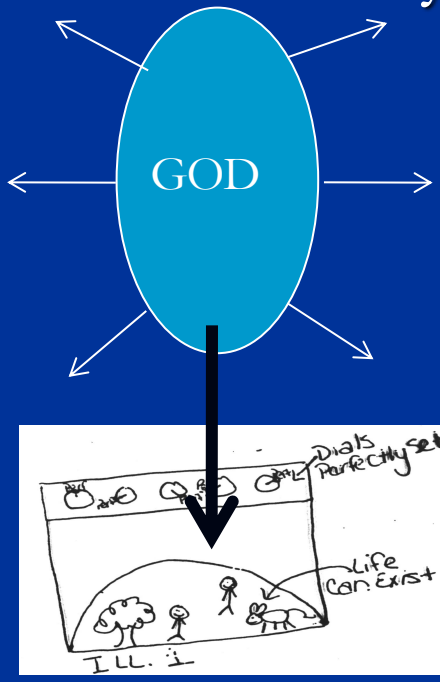
The God of traditional theism, both East and West, has always been conceived of as infinite and unbounded, and thus with little or no internal complexity. Without internal complexity, however, there is no need to be designed or fine-tuned.



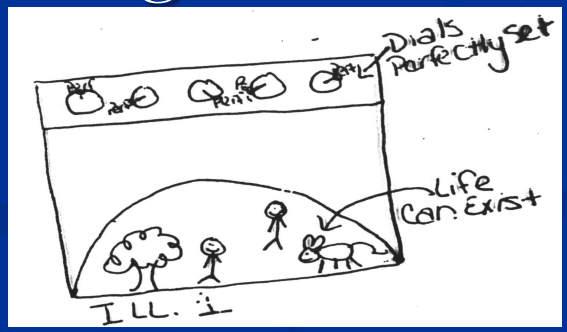
Note: Arrows represent God as unbounded and infinite.

Real Issue

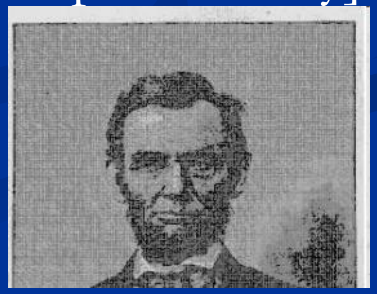
Therefore, the real issue is the plausibility of such an infinite being existing and creating a fine-tuned universe versus such a universe existing as an enormously lucky accident.



Which is more plausible?



A Lucky Accident?
[Ink Spill Theory]



Given the degree of fine-tuning necessary for life, many find it enormously implausible to believe that a life-permitting universe exists as a brute fact. Thus, even though no one has shown that the God hypothesis is coherent, many find it far more plausible.

Confirmation Approach: Political Analogy

- Your choice is between candidate A and candidate B. [Candidate A is analogous to God and candidate B to the non-theistic hypothesis.]

- People have had doubts about both candidate A and B. (Analogous to situation before evidence of fine-tuning).

- New and serious problems come to light with candidate B – e.g., strong evidence of lying and fraud. (Analogous to the new evidence of fine-tuning.)

Political Analogy-continued

Although the new evidence does not directly address your doubts about candidate A, it nonetheless gives you good reason to vote for A over B (given you have to vote).

In the same way, the fine-tuning evidence shows atheism is way more implausible than we might have thought, although it does not *directly* address the prior doubts we might have had about how a being like God could exist. Nonetheless, by significantly decreasing the plausibility of the alternative non-theistic hypotheses, it gives us good reason to believe in God.

[End]

Intelligent Design?
Two Key Differences

1. The-Fine Tuning argument concerns the cosmic conditions necessary for evolution to even take place. Thus, this argument is perfectly compatible with belief in evolution.

2. There is no claim being made that theism is a scientific hypothesis. Rather, it is a metaphysical hypothesis. The point brings up the "God of the Gaps" issue . . .

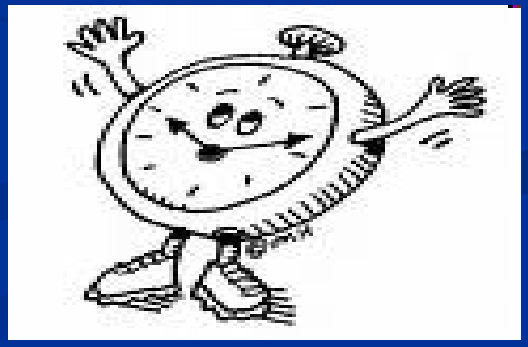
End

God of Gaps Issue:

Is the God explanation being invoked as a substitute for a scientific explanation? No! Scientific explanations always invoke laws and initial conditions, but they cannot themselves explain why the most fundamental laws and initial conditions are the way they are. *One must either accept these as a brute fact or offer another non-scientific kind of explanation* —e.g., either a personal explanation in terms of purpose or some metaphysical principle. . . .

Clock-Universe Analogy

To understand this, think of the universe as analogous to a clock, and scientists as analogous to little beings living in the clock who uncover the laws and mechanisms by which the clock works. They in turn explain events in the clock by appealing to its laws and mechanisms. This itself, however, can never explain **why** the clock exists or is constructed in the way that it is. To explain this, one would ordinarily appeal to purpose – e.g., some personal being constructed the clock this way to tell time.



God Explanation: **Why** does the clock exist? **Why** is it constructed in the way it is?

Scientific Explanation: **How** does the clock work? What mechanism caused the alarm to go off? Etc.

Summary of God of Gaps Issue

A scientific explanation, therefore, provides the **HOW** of the universe's operation, whereas the God explanation purports to explain the **WHY** there is a universe with these sorts of laws.

The "**God explanation**," therefore, operates at another **level** than the scientific explanation, and thus should **not** be considered a competitor.

End

THEORY Of EVERYTHING OBJECTION:

OBJECTION: How do you know that physicists will not develop a new theory, such as the so-called Theory of Everything, that will explain why our universe has the constants it does?

RESPONSE: As astrophysicists Bernard Carr and Martin Rees note, "even if all apparently anthropic coincidences could be explained [in terms of some theory of everything], it would still be remarkable that the relationships dictated by physical theory happened also to be those propitious for life" (Carr and Rees 1979: 612).

[End]

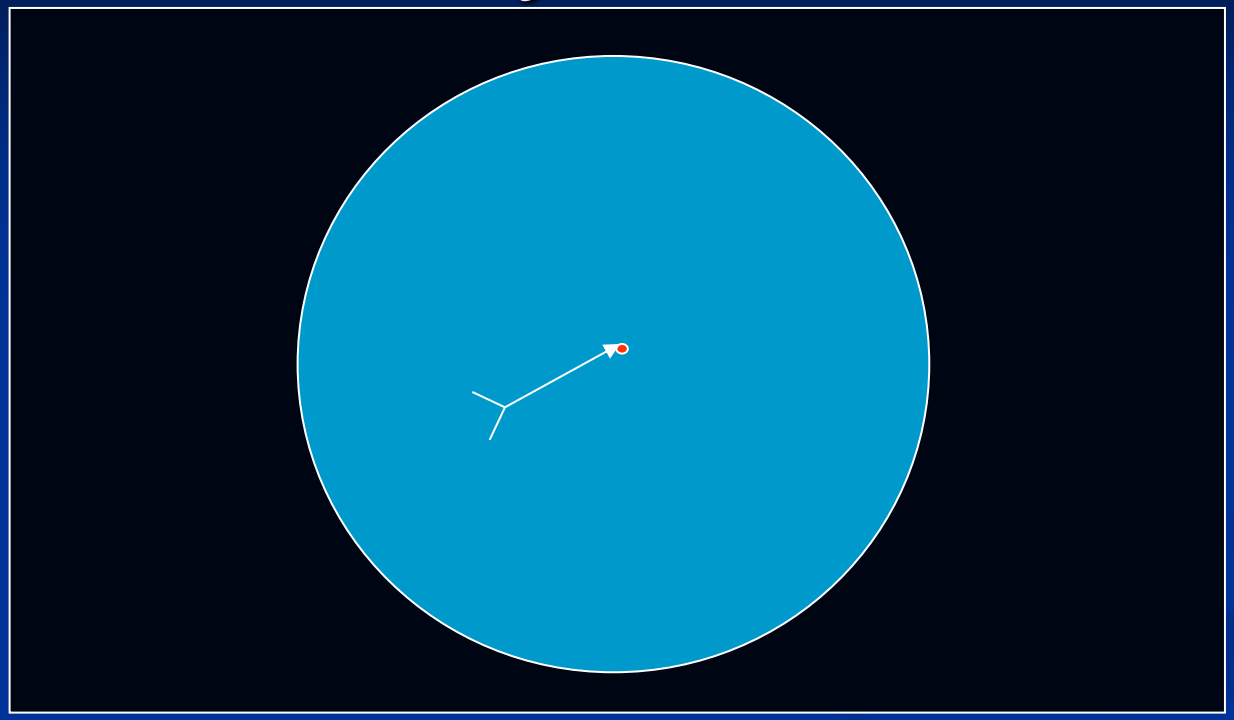
OTHER FORMS OF LIFE OBJECTION

Objection Stated: Doesn't your argument assume that carbon based life is the only form of life there could be?

Response: No. It simply assumes that life requires stable, reproducible complexity. A universe without atoms, for instance, would not even have this. Besides, it is the existence of embodied conscious agents, not mere life, that points to theistic design, since we no reason to think that God merely values non-sentient life, such as viruses or bacteria.

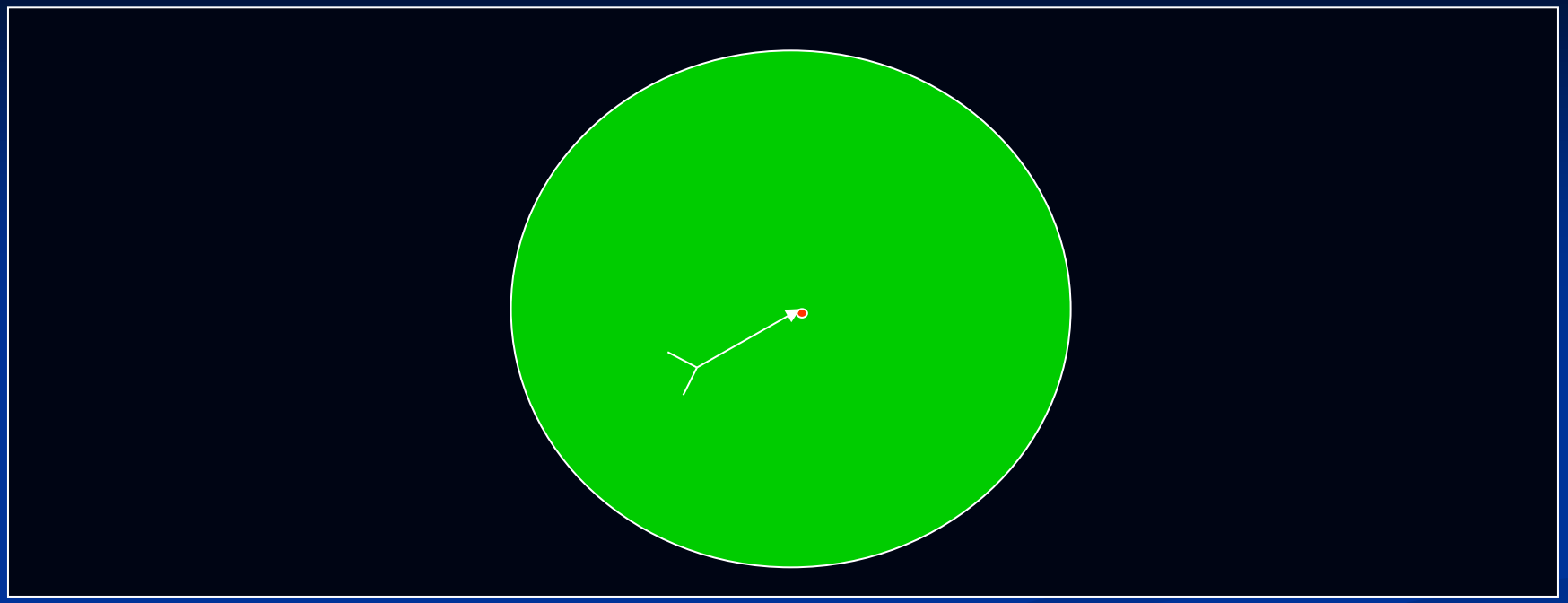
[End]

OTHER LIFE-PERMITTING LAWS OBJECTION



Small red circle in center is life-permitting range for laws, etc., of the universe. The surrounding blue area is the area for which we can determine whether laws, etc., are life-permitting. I call the blue area the epistemically illuminated region. The fact that dart hits the life-permitting "bulls-eye" in the blue area is evidence for the "aiming" hypothesis, even if we do not know how many bulls-eyes are in the dark area. (The epistemically illuminated region also provides the "comparison range" for the constants.) [END]

SCALE OBJECTION



Small red circle in center represents the life-permitting values for the constants of physics. Surrounding green area is the area for which we can determine whether the constants are life permitting. I call this the **epistemically illuminated** region. The fact that the dart hits the life-permitting "bulls-eye" in the green area is evidence for the "aiming" hypothesis, even if we do not know how many bulls-eyes are in the dark area. This epistemically illuminated region provides the "comparison range" for the constants: what is significant is the fact that the region of life-permitting values **(red)** is small compared to the region we can "see" **(green)**.

End.

NO PROBABILITY OBJECTION

Remember, in the fine-tuning argument the relevant sort of probability is epistemic probability (that is, degree of surprise), NOT statistical or theoretical probability. This sort of probability is used all the time in scientific confirmation. Example:

"The strongest evidence for evolution [understood as the thesis of common ancestry] is the concurrence of so many independent probabilities. That such different disciplines as biochemistry and comparative anatomy, genetics and biogeography should all point toward the same conclusion is very difficult to attribute to coincidence" (Edward Dodson, 1984, p. 68).

The argument here is one based on improbability and coincidence, but since evolution only occurred once, it is clearly NOT statistical or even theoretical probability. [End]

WHAT IS SO GOOD ABOUT EMBODIED MORAL AGENTS?

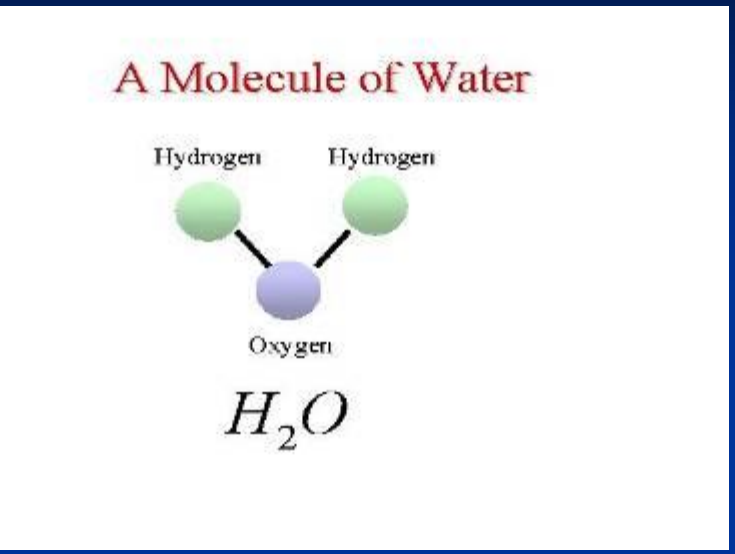
Embodied moral agents can realize certain goods that a reality without such agents could not realize: for example, being vulnerable to one another. Thus, God would have a reason to create a reality that contained embodied moral agents, which would require a system of laws – that is, a universe. [End]

Higher-Level Types of Fine-tuning

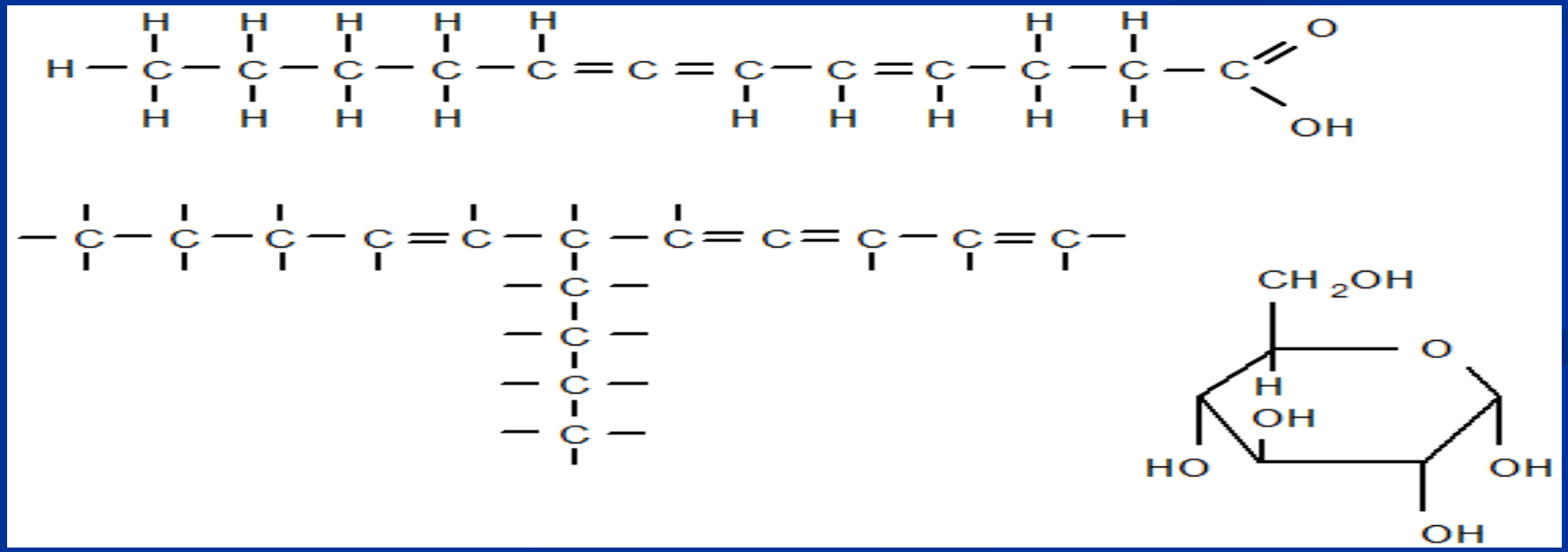
Example:

- "Carbon is so uniquely fit for its biological role, its various compounds so vital to the existence of life, that we may repeat the aphorism, 'If carbon did not exist, it would have to be invented.'" (Michael Denton, *Nature's Destiny*, p. 116).

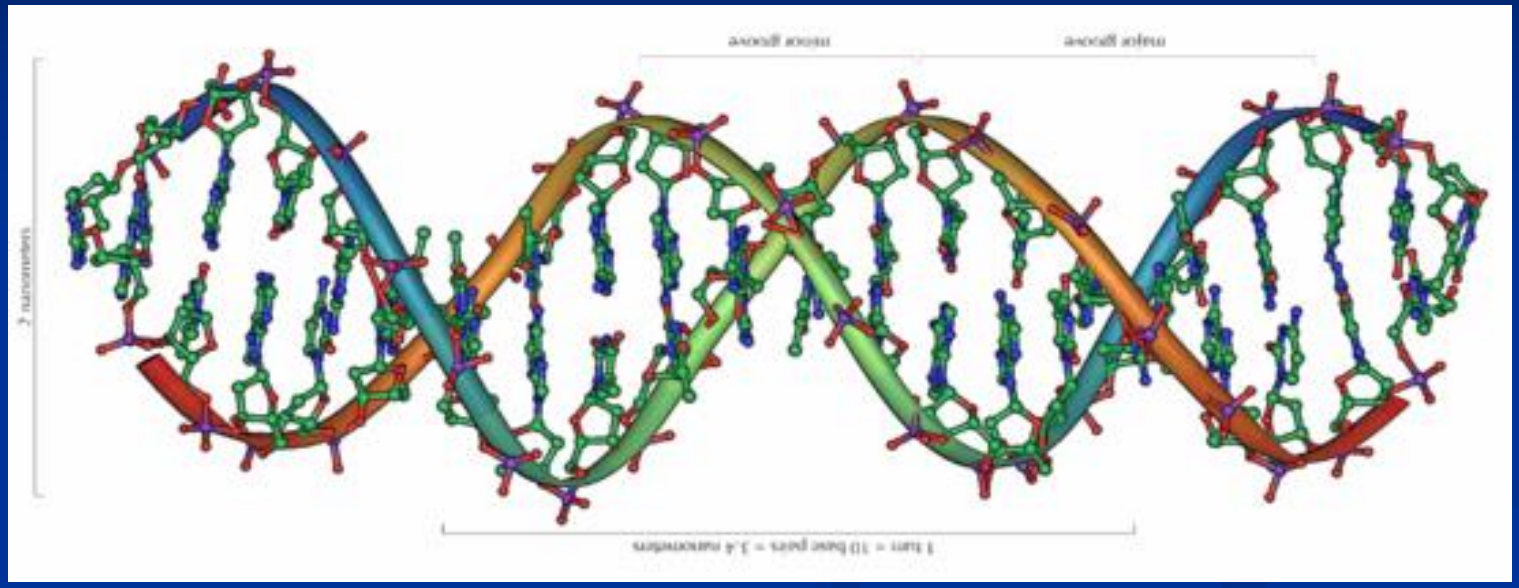
Fitness of Carbon



Compare simplicity of molecule without carbon (e.g., water) with complexity of organic compounds:



Carbon is the Backbone of DNA



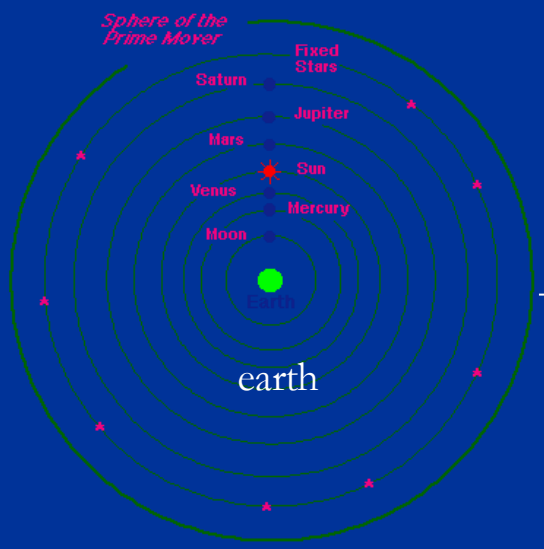
DNA

[End]

IS MULTIVERSE COMPATIBLE WITH THEISM

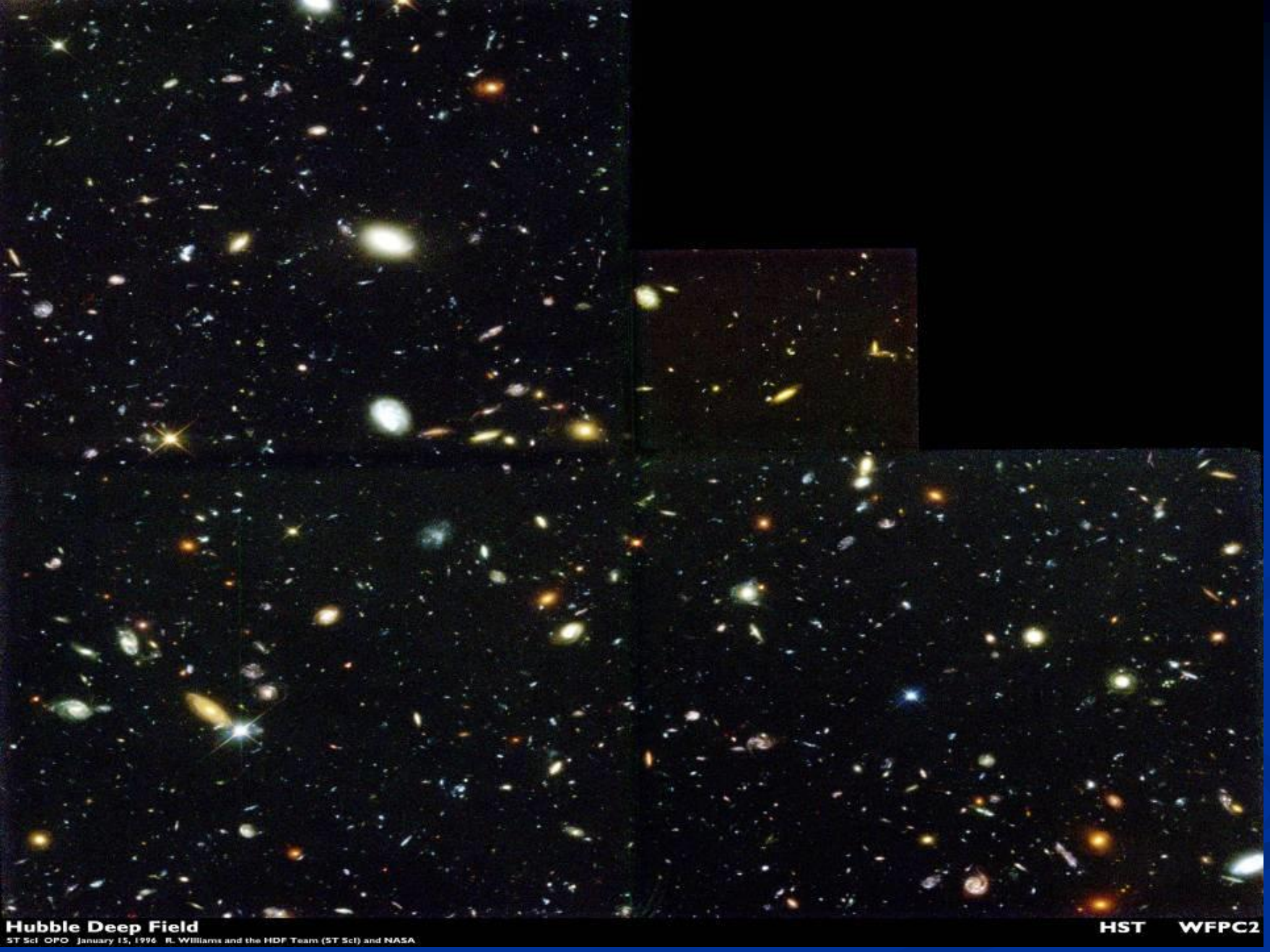
I say yes . . . . It fits in which infinite creativity of God and the historical trend of science.

Humans continue to find that the universe is larger than we previously thought.



Aristotle's Conception of Universe (500 BC – 1400 AD).

Modern Day Universe: more than 300 billion galaxies with 300 billion stars per galaxy.



Hubble Deep Field View of a pinhead size portion of the universe. Each speck is a galaxy.

INFLATIONARY-SUPERSTRING MULTIVERSE TEST CASE

The inflationary/superstring many-universe generator can only produce life-sustaining universes because it has the following four "components" or "mechanisms:":

i) A Mechanism To Supply The Energy Needed For The Bubble Universes. [Actual Mechanism: Inflaton Field.]

ii) A Mechanism To Form The Bubbles. [Actual Mechanism: Einstein's Equation + Inflation Field]

Mechanisms--Continued

iii) A Mechanism To Convert The Energy Of Inflaton Field To The Normal Mass/Energy We Find In Our Universe. [Actual Mechanism: $E = mc^2$ + coupling between inflaton field and matter fields.]

iv) A Mechanism That Allows Enough Variation In Constants Of Physics Among Universes. [Superstring Theory.]

In Addition:

- The background laws of inflationary cosmology/superstring theory must be right in order for even one of the universes that are produced to be (intelligent) life sustaining.
- Examples: As we saw before, without gravity, electromagnetism, or the strong nuclear force, there would be no organisms with enough stable complexity to count as a life form. Without the principle of quantization or the Pauli-Exclusion principle, no complex chemistry. [End]

Extra Slides

REALLY BIG PICTURE: BEAUTY AND DISCOVERABILITY

The Really Big Picture
Features of Universe that Suggest Divine Design:

1. The Fine-Tuning of the Cosmos for Life.
2. "Fine-tuning" for Beauty and Elegance of the Laws and Underlying Principles of Nature.
3. The Intelligibility and Discoverability of the Laws of Nature.
4. The Existence of Consciousness.

Let's illustrate (2) and (3) above with a few quotations:

Beauty of Laws

Steven Weinberg, Nobel Laureate in physics and a convinced atheist:

"It is precisely in the application of pure mathematics to physics that the effectiveness of aesthetic judgments is most amazing…. mathematical structures that confessedly are developed by mathematicians because they seek a sort of beauty are often found later to be extraordinarily valuable by physicists." (Dreams of a Final Theory 1992, p. 153).

Later Weinberg says,

"I have to admit that sometimes nature seems more beautiful than strictly necessary" (p. 250).

Intelligibility and Discoverability

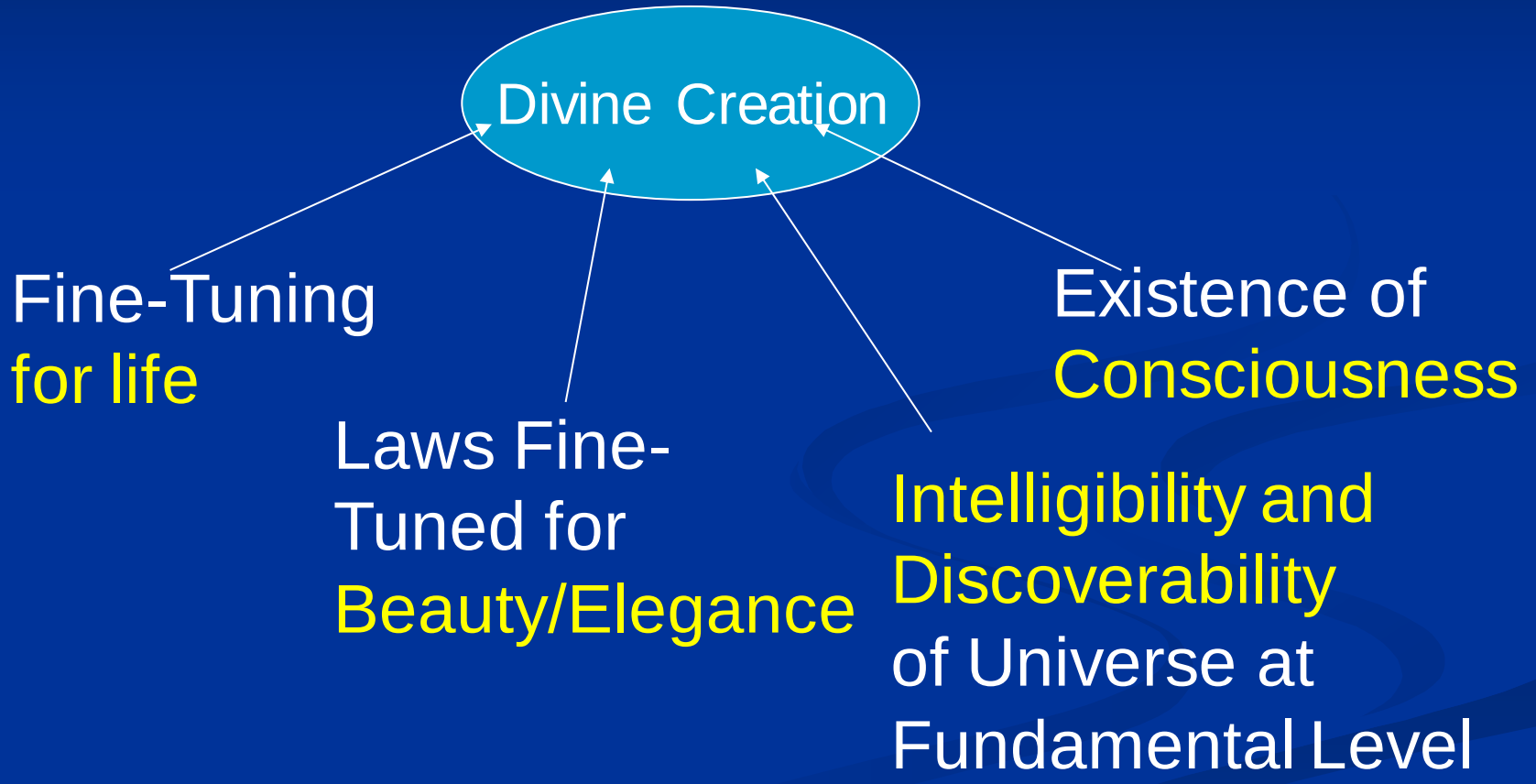
- Albert Einstein on Intelligibility:

  "The most unintelligible thing about the universe is that it is intelligible at all."

- Eugene Wigner, a major founder of Quantum Mechanics on discoverability:

  Wrote Major Essay: "The Unreasonable Effectiveness of Mathematics in the Physical Sciences."

Cumulative Case Argument



Case for Divine Creation Compared to Case for Common Ancestry

As biologists and geneticist Edward Dodson summarizes the case for evolution understood as common ancestry:

"All [pieces of evidence] concur in *suggesting* evolution with varying degrees of cogency, but most can be explained on other bases . . . . The strongest evidence for evolution is the concurrence of so many independent probabilities. That such different disciplines as biochemistry and comparative anatomy, genetics and biogeography should all point toward the same conclusion is very difficult to attribute to coincidence."

Argument for divine creation is similar to this. [End]

LINKED CONSTANT OBJECTION

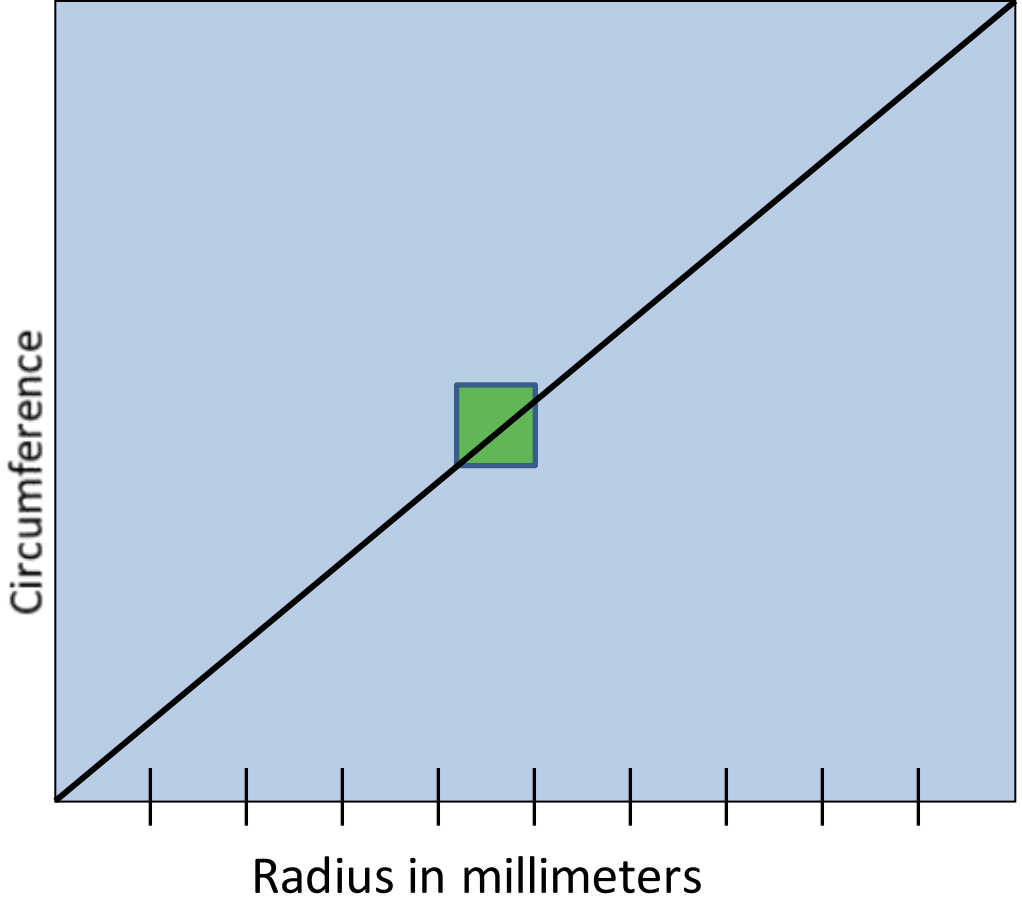
According to Richard Dawkins,

> "physicists have come up with other explanations [of the fine-tuning]. One of them is to say that these six constants are not free to vary. **Some unified theory will eventually show that that they are locked in as the circumference and diameter of a circle.** That reduces the odds of them all independently just happening to fit the bill." (Time, "God versus Science," Nov. 5, 2006).

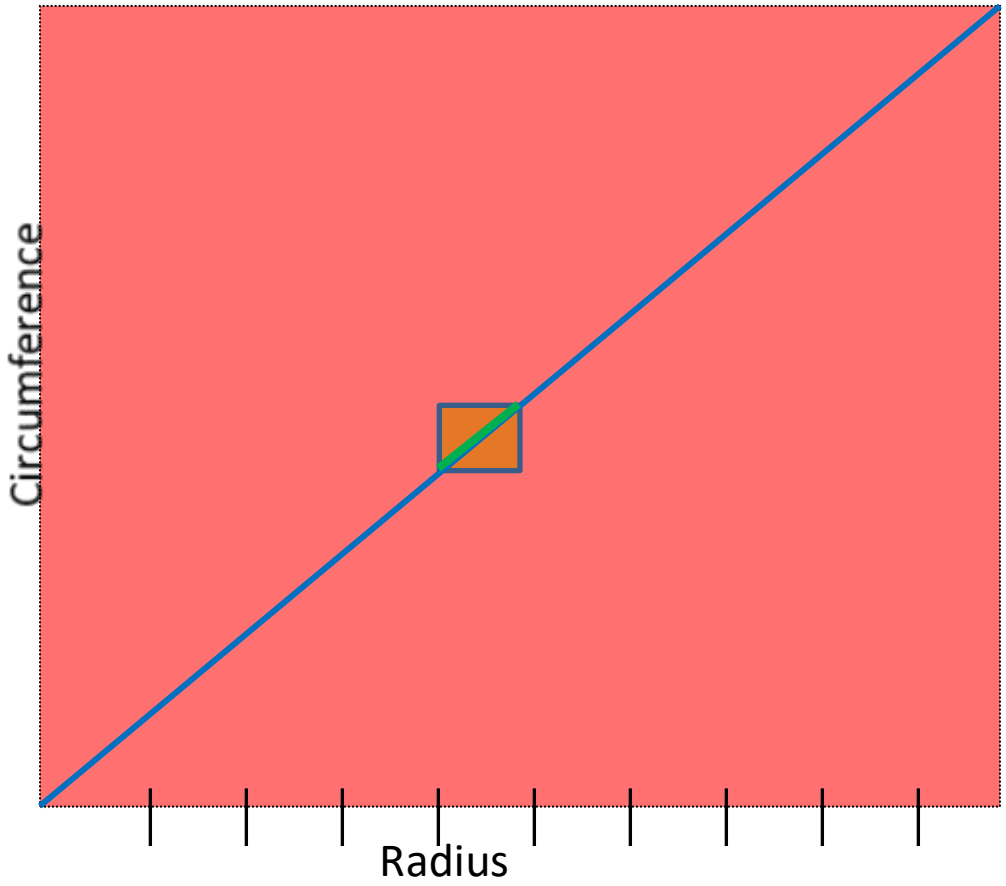
As I will now show, Dawkins argument fails since it does not distinguish between cases in which two parameters are **linked by mathematical necessity from those that are linked by physical laws:**

Bolt Example

Suppose one were told that the radius of a bolt had to be between 4 and 5 millimeters, with the possible ranges that the factory could produce being 0 to 10 millimeters. So, one might conclude, its radius had to be fine-tuned to 1/10. Now, suppose someone else told one that the circumference had to be tuned to 4π - 5π millimeters, with a factory-possible range of 0 to 10π millimeters; this would yield a 1/10 fine-tuning for the circumference. Not realizing that the radius and circumference are related by mathematical necessity, one might multiply the two fine-tunings together, resulting in 1/100 for the total fine-tuning. This is illustrated by next slide:

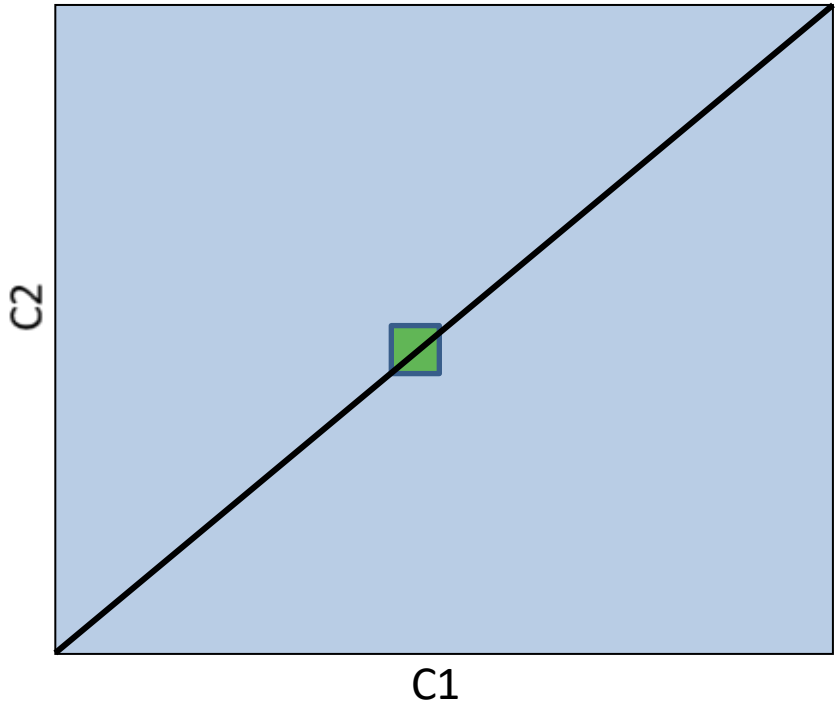


One's Mistaken Representation: Green region represents mistaken requirements for bolt if circumference and radius are truly independent. **Blue + green** region represents all possible values one mistakenly thinks that the circumference and radius could have. The ratio of the **green region** to the entire **blue** + **green** region is 1/100.

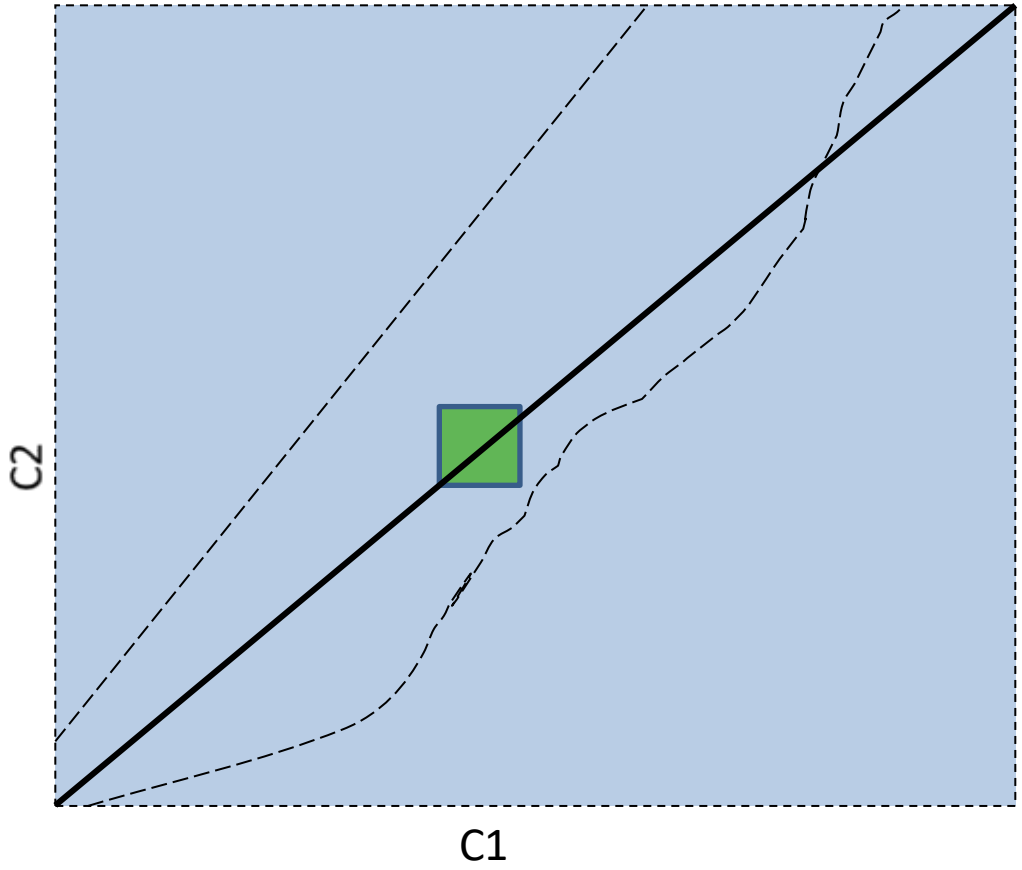


Correct Analysis: Since of **mathematical necessity** the circumference is π times the radius (C = πR), the only jointly possible values for C and R are on the **blue-green line**, with everything else [in red] being impossible. Since the fine-tuning is the ratio of the life-permitting values [**green** part of line in small square region] to the **possible** values [**entire line**], the fine-tuning is actually only 1/10.

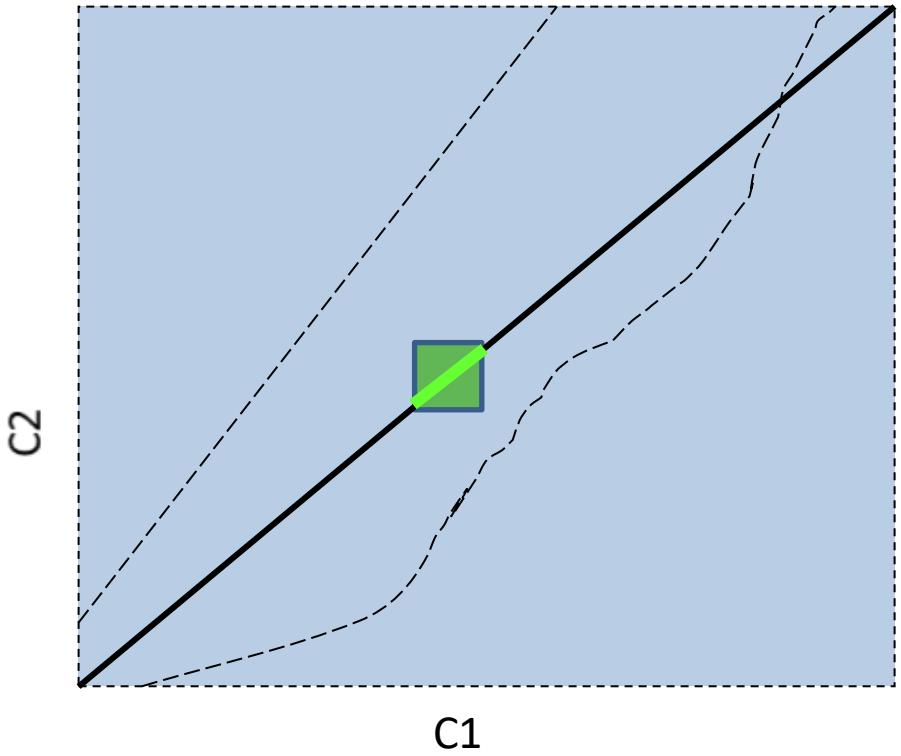
Constants Linked by a Law of Nature



Consider a case of two constants linked by a physical law given by the straight line, with the same fine-tuning (1/10) for both C1 and C2 as for the circumference and radius in the bolt example.



Unlike the case of the circumference and radius of a circle, there are many mathematically possible laws linking C2 and C1, as represented by the **dashed lines**. Most alternative laws will not go through the green area, since it is relatively small.



Given the actual physical law linking C2 with C1 [solid line], there is only a 1/10 fine tuning as before [length of **green** part of line divided by entire length of line]. Nonetheless, unlike the radius and circumference example, there is an additional fine-tuning of the law itself – namely, that the law is such that it goes through the green area. So, there are still two independent cases of fine-tuning: that of the law being such that it goes through the green area, and that given this, the joint value of <C1,C2> falls within the green life-permitting area instead of somewhere else on the line.

Conclusion

Because he did not properly distinguish between parameters linked by mathematical necessity and those linked by contingent laws of nature, Dawkins' analogy and corresponding argument fails.

END

List of Conditions/Constraints for Life

The following slides present a running list of all the conditions that we have solid lines of physical reasoning to think are are necessary for the kind of complexity necessary for embodied conscious agents. The list is divided into the following types of conditions/constraints:

1. Building blocks of material – e.g., atoms that can take part in complex chemistry.
2. Stability of matter

3a. Energy Sources for that life and livable locations – e.g., general conditions for life-supporting stars and planets.

3b. Constraints arising from big bang for star formation

3c. Life-permitting constraints on nuclear fusion in stars.

List of Conditions/Constraints -- Continued

Imaginatively, when looking at the following conditions/constraints, it is helpful to think of some super-being such as Star Trek's Next Generation's Q trying to constructing a life-permitting universe by first creating a law or some other "mechanism"/"adjustment" to institute that condition (e.g., C1 below), and then realizing that a second condition is needed (e.g., C2) and instituting something to make that condition come about, and so forth. Eventually, the being is able to construct a life-permitting universe after instituting the right set of laws, mechanisms, and adjustments to satisfy the 24 separate conditions/constraints listed below.

The super-being begins with building an atom:

Building Blocks for Material Complexity: The Atom

C1: The existence of matter instead of pure energy: Matter/Anti-matter Asymmetry = 50%.

C2: Existence of basic building blocks for nucleus. [E.g., protons and neutrons in our world]. 50%

C3: Existence of something that plays role of electron: 50%. [E.g., A merely negatively charged particle is not sufficient – for instance, if the electron were as heavy as the muon -- the heavy sister of the electron which is about 400 times as heavy as the electron – stable atoms could not exist.]

C4. Some force that plays the role of the electric force to hold electrons in orbit. [Electromagnetic force]. 50%

Building an Atom-- Continued

C5: Existence of some force that plays the role of holding protons and neutrons together [Strong Nuclear Force]: 50%

C6: The force in C5 being short range, instead of long range like gravity and electromagnetism, otherwise nuclei of distant atoms would be pulled together. 50%.

C7: The ratio of the strong nuclear force to the electromagnetic force being sufficiently strong to hold nuclei together. 1/2

C8: A principle to keep electrons in fixed orbits, instead of falling into the nucleus. [Principle of Quantization]: 50%

C9: A principle that keeps all the electrons from piling into the first orbital [Pauli-Exclusion Principle]: 50%

Stability of Matter

C10: A principle that keeps the charges in matter from rearranging themselves to form a super-dense mass [Pauli-Exclusion Principle]:50%

C11: A principle that keeps protons and neutrons from decaying into photons [Baryon Conservation]: 50%

C12: A principle that keeps electrons from decaying into photons/neutrinos [Conservation of Electric Charge]: 50%

Existence of "Embodied Conscious Agents" Supporting Stars and Planets

C13: Existence of universal attractive force between material bodies (instead of, for instance, a universal repulsive force or no force acting between all masses); without this, no stars – and hence no energy sources for life to evolve – and no planets or other significantly large solid objects to support embodied conscious beings. [Gravity plays this role]. = 50%

C14: Planetary Orbit Stability Requirement: universal attractive that force does not fall $1/r^3$ or faster: 50%. [Force of gravity falls off as $1/r^2$]: 50%

C15: Some means of transmitting energy of stars to planets so life can evolve [Electromagnetic force via electromagnetic radiation plays this role]: 50%

Stars and Planets--Continued

C16a*: Strength of gravity (relative to strength of materials) for evolution of beings with sufficiently large brains to be conscious agents: $1/10^{31}$ of range of force strengths in nature. [Note: Strength of materials determined by strength of electromagnetic force and mass of electron via the Pauli-exclusion principle.]

C16b*: fine-tuning of strength of gravity for long, stable stars that can support life: $1/10^{37}$ of range of force strengths in nature.

Conditions Arising from Big Bang For Star Formation

(C17) Density Fluctuations coming out of big bang not being too large (otherwise mostly black holes), but large enough for galaxies and stars to condense out. [Degree of Fine-tuning cannot be estimated because of lack of well-defined comparison range.]

(C18) Curvature of space. Must be fine-tuned to $1/10^{60}$ of zero; Otherwise, either the universe does not last long enough for stars to form or space expands too rapidly for stars to form. [Possibly explained by inflationary cosmology or a law that requires it to be zero. Thus, conservative estimate: 50%].

(C19) Photon/Baryon Ratio: 50%

(C20) Low Entropy: Enormous fine-tuning required. [Might be explicable by new law setting the dis-uniformity in the gravitational field to zero at the beginning; some claim it can be explained by inflationary cosmology; thus a conservative estimate is 50%

(C21)* The fine-tuning of the cosmological constant/dark energy: $1/10^{50}$ [No plausible way of accounting for this except possibly by multiverse] hypothesis.

Conditions Nuclear Fusion for Life Optimality:

(C22)* The fine-tuning of the weak force: $1/10^9$ of range of force strengths. [If weak force is too small, ratio of neutrons to protons → 1, and Big Bang produces almost all helium 4: little or no water and stars would be unstable helium burning stars.]

(C23)* The neutron-proton mass difference: 1/70 of neutron/proton mass. If mass difference is too large, the critical first step in nuclear fusion in stars (p + p → p-d nuclei [deuterium]) is no longer possible.

(C24). Ratio of Strong to Electromagnetic force must be right for stars to produce a life-optimal amount/proportion of carbon and oxygen: 50%. [Often this is claimed to be much more fine-tuned than 50%, but such estimates are based on flawed calculations.]

Other Possible Cases

A. Existence of weak force?

B. Fine-tuning of weak scale?

Definite Quantitative Cases

The literature has almost entirely focused on fine-tuning of the parameters/constants of physics. Below is a summary of the cases listed above (denoted by a *) that I think are both well-established and for which there is no plausible natural, non-ad-hoc explanation in sight:

1. The fine-tuning of the weak force: $1/10^9$ of range of force strengths.
2. The neutron-proton mass difference: 1/70 of the neutron/proton mass.
3. Fine-tuning of gravity: at least $1/10^{31}$ of range of force strengths.
4. The fine-tuning of the cosmological constant/dark energy: at least $1/10^{50}$ of range of values allowed by model.

How Surprised Should we be?

Except for the definitely quantitative cases (e.g., the cosmological constant/dark energy), I put down 50% as an estimate of the epistemic probability for a certain condition/constraint being met. (Epistemic probability can be thought of as a way of measuring the rational degree of surprise, with the lower the epistemic probability, the more surprised one should be.)

50% is a very conservative estimate, since normally we take a specific condition/constraint being met as being much less probable, since there seems to be way more ways for a condition not to be met. [Analogy: . ..]

How Surprised--Continued

Although there is some overlap, most conditions/constraints listed above are largely independent. So, we can multiple the epistemic probabilities together to estimate the total amount of surprise. Even neglecting the quantitative cases, we obtain:

$1/2^{24}$,

which is about one in 16 million. Still very impressive.

END

Dimensionless Constants

First note that the fine-tuning of the constants is always defined in a dimensionless way, since it is the ratio of the life-permitting range to the comparison range. [Examples of fine-tuning of gravity and of cosmological constant.] So, this is never an issue. But a related issue is that when we speak of the fine-tuning of a constant, we are always holding some other constants the same. To avoid duplicating cases of fine-tuning, we must be clear on what else is being held the same.

Dimensionless Constants – Planck Scale

Is it legitimate to vary the strength of gravity? Isn't it always set to 1 when one uses Planck units: that is, units defined by setting c = 1, h =1, and G =1?

Reply: two points:

(1) Plank units are optional. For example, one can set c = 1, h =1, and then determine the scale by setting some other physical constant – e.g., the mass of the muon – equal to 1. So, what this objection only shows that three constants in the Standard Model of physics are taken up in determining units.

(2) If one does use Planck units, varying G when not using Planck units is equivalent to varying the masses in Planck units, along with some other changes – such as the fundamental unit of charge in Planck units. For instance, increasing G by a factor of C becomes equivalent to increasing all masses – such as that of the proton -- by the same factor, while increasing the fundamental unit of charge by square root of C.

(3) END

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