

# **Physics and Faith 3.**

**Rumors of a Designer,  
Creator and Sustainer.**

**Part II. Quantum  
Cosmology. The  
Anthropic Principle**

# Introduction

Last session we considered two contingencies or dependencies in the universe that are unexplained by physics, that might be considered "rumors" of God:

## 1. The laws of physics

- *The Mystery of the Source of the Universe's Rationality.* Why is there an order, any rationality at all to the universe? Where does this order, rationality (the laws of Physics) come from?

# Introduction

**“the universe, in its rationale beauty and transparency, looks like a world shot through with signs of mind, and maybe, it's the "capital M" Mind of God we are seeing”**

- John Polkinghorne

# Introduction

## 1. The laws of physics

- *The Mystery of the Comprehensibility of the Universe's Rationality.* Why are these laws comprehensible to the human mind? And why should such laws appeal to our aesthetic sense of mathematical beauty and elegance?

**“ . . . there is some deep-seated relationship between the reason within (the rationality of our minds - in this case mathematics) and the reason without (the rational order and structure of the physical world around us). The two fit together like a glove.”**

- John Polkinghorne

# Introduction

## 1. The laws of physics

- *The Mystery of the Comprehensibility of the Universe's Rationality.*
- A Christian may speculate that this deep-seated relationship between the *reason within* and the *reason without* may be a reflection that human beings were made in the image and likeness of the source of that rationality, God.

# Introduction

2. The "boundary" of the universe at time = 0 (the "Big Bang") of classical cosmology.

## The Penrose-Hawking Singularity Theorem

- proved that in all cosmological models based on General Relativity, a "singularity" at time = 0 is inevitable
- "singularity" at time = 0: the fabric of space and time is undefined, non-existent

Non-quantum physics (*General Theory of Relativity*) cannot explain what "caused" the universe to "appear" immediately after time = 0:

Contingency of the "boundary" at time = 0,  
the initial space-time singularity:  
*creatio ex nihilo?*

# Introduction

This session we consider two other contingencies or dependencies in the universe that are unexplained by physics, that might be considered "rumors" of God (cont.):

### **3. The Existence of All of Space-Time.**

Why is there something and not nothing?

**4. The Anthropic Principle.** The laws of physics and the "initial conditions" of the universe near  $t = 0$  appear to be incredibly fine-tuned to produce life.

Why?

# Can Physics Explain the Initial Singularity?

## **The Penrose-Hawking Singularity Theorem**

- proved that in all cosmological models based on General Relativity, a "singularity" at time  $= 0$  is inevitable
- "singularity" at time  $= 0$ : the fabric of space and time is undefined, non-existent

But we know Einstein's **General Theory of Relativity** -- the best theory of gravity we have -- does *not* include quantum effects and hence is an *incomplete* theory.

# Can Physics Explain the Initial Singularity? The "God of the Gaps"

**God of the Gaps:** finding rumors of "God" in the "gaps" where our knowledge of physics is *incomplete* risks finding *false* rumors -- for later scientific discoveries and theories may fill in those "gaps" with purely physical explanations.

# Can Physics Explain the Initial Singularity? Metaphysics in the Guise of Physics

*The opposite danger:* proposing a "physical theory" whose significant content:

- 1. cannot be observed or tested, or
- 2. does not fall out as an *inevitable* consequence of testable / observable parts of the theory
  - "not inconsistent with" / "not incompatible with" is *not* enough

A "theory" that suffers from (1) and (2) is *not physics*, it's *metaphysics*

# Can Physics Explain the Initial Singularity?

There is *no* complete or accepted theory of quantum gravity. Some preliminary work however, suggests the "initial singularity" can be explained:

1. Hartle-Hawking theory quantum cosmology
2. Ekpyrotic Universe

# Can Physics Explain the Initial Singularity?

## Hartle-Hawking Quantum Cosmology

Hartle-Hawking *"no boundary conjecture:"*

- the dimension we call time becomes

"fuzzy" and turns into a fourth spatial dimension as we approach "time = 0."

There is thus no "beginning" to the universe -- time becomes meaningless as we "approach" "time = 0"

# **Can Physics Explain the Initial Singularity? Hartle-Hawking Quantum Cosmology**

**So long as the universe had a beginning, we could suppose it had a creator. But if the universe is really completely self-contained, having no boundary or edge, it would have neither beginning nor end: it would simply be. What place then, for a creator?**

--Stephen Hawking

# Can Physics Explain the Initial Singularity? Ekpyrotic Universe

Attempts to find a comprehensive theory of quantum gravity include the use of "string theory," where the fundamental entities that arise from quantum physics are not points, but 2-dimension "string" like objects

In 1990's, a more general class of theories called "**M-theories**" became popular

- M = "membranes," the fundamental entities objects of 2 or more dimensions

# Can Physics Explain the Initial Singularity? Ekpyrotic Universe

## "Braneworld Scenerio:"

- we live in a 3-dimensional *brane* within a higher dimensional space called the *bulk*
- gravity propagates in the *bulk*; what we see is its 3-D projection in our *brane*
- **Ekpyrotic Universe:**
  - "Big Bang singularity" might be explained as a collision between two *branes*
  - such a collision between two *branes* may appear to be acausal when viewed from only one of the *branes*

# Can Physics Explain the Initial Singularity?

If:

- **Hartle Hawking Quantum Cosmology,**  
or the
- **Ekpyrotic Universe**

is correct, then there may a "physical"\* explanation for the initial "singularity" that fills the unexplained "gap" in our physics. There may be no true "rumor" of God here, but just false "rumor," a "God of the Gaps"

\* it may also be true that the Ekpyrotic Universe proposal never turns out to be more than a "metaphysics in the guise of physics"

# Can Physics Explain the Initial Singularity?

**The "boundary" of the universe at time = 0 (the "Big Bang") of classical cosmology**

- can at best be considered a "rumor" of God that lives in the tension between concerns of a "God of the Gaps" and "physics in the guise of metaphysics"

# The Contingency of All of Space-Time

Why should we give any one "point" in space-time (the initial "singularity") any special significance?

Why is there something and not nothing?

What "breathes fire" into the equations and mathematical theories of physics (present or future) and makes the universe they describe manifest, real?

# The Contingency of All of Space-Time

***...creation ex nihilo* means sustaining the universe in existence at all times. One should not think of space-time as "coming into existence" anyway. Rather, one says that space-time (or the universe) simply is....Hence, all moments have a similar relation to the Creator. Either they are all "always there," as a brute fact, or they are all equally created**

- philosopher Willem Drees

# **The Contingency of All of Space-Time**

**God is not a God of the edges, with a vested interest in beginnings. God is the God of all times and all places**

- John Polkinghorne

**God is the creator of the world Now. His act of creation is a continuing act, not just something done fifteen thousand million years ago, but something being done today which will continue to be done tomorrow"**

- John Polkinghorne

# **The Contingency of All of Space-Time**

**"God is holding a fruitful, rationally beautiful world in being"**

- John Polkinghorne

**...for in him all things in heaven and on earth were created, things visible and invisible, whether thrones or dominions or rulers or powers -- all things have been created through him and for him. He himself is before all things, and in him all things hold together.**

- St. Paul, Colossians 1:16-17, NRSV

# The Anthropic Principle

## **The Ptolemaic Principle:**

- we hold a privileged position in the universe (the center of the universe)

## **The Copernican Principle:**

- our position in the universe is *not* privileged
- the part of the universe we see around us is *typical* of the rest of the universe

# The Anthropic Principle

## The Anthropic Principle:

- an alternative principle to the Copernican Principle
  - considers that *we ourselves* are *products* of the universe's evolution, and
- asks what might this be telling us about the nature of the universe or our position in the universe

# The Anthropic Principle

Three versions:

- 1. Trivial Anthropic Principle
- 2. Weak Anthropic Principle
- 3. Strong Anthropic Principle

# Trivial Anthropic Principle

The existence of human beings is data, just like data gathered from the telescope, that physical theories must be consistent with

- e.g. When Lord Kelvin suggested the earth was 10 million years old, evolutionary biologists told him he was wrong because life would not have evolved that quickly

Is "trivial" in the sense that all physical theories must of course be consistent with reality!

*Underlying assumption:* existence of human beings is to be accepted as "brute fact" of no further significance

# Weak and Strong Anthropic Principles

The existence of human beings is extraordinary, because for life to exist at all seems to depend on a series of striking coincidences in the laws of physics and the initial conditions in the early universe

# Weak and Strong Anthropic Principles

Examples of these coincidences:

1. Carbon atom energy levels
2. Dirac's Large Number Hypothesis

# Weak and Strong Anthropic Principles

## Carbon Atom Energy Levels

Elements up to Lithium-7 were produced in the Big Bang; all heavier elements were made later inside stars

Synthesis of heavier elements difficult – the only reason they are produced at all is the extraordinary coincidence that carbon has an energy level that is the same as the energies of three alpha particles (helium nuclei) inside a star, allowing the reaction:

**three Helium-4 nuclei colliding to form  
one carbon-12 nuclei**  
 **$(3\ ^4\text{He} \longrightarrow\ ^{12}\text{C})$**

(cross-section for the process is **resonant**)

# Weak and Strong Anthropic Principles

## Dirac's Large Number Hypothesis

Paul Dirac (1902-1984), one of the founders of quantum mechanics noted that very large dimensionless numbers often arise in particle physics and cosmology

*for example:*

ratio electrostatic force / gravitational force  
between a proton and electron =  $0.23 \times 10^{40}$

ratio of cosmological distance horizon  
("radius of the universe") and "classic  
electron radius" =  $3.7 \times 10^{40}$

# Weak and Strong Anthropic Principles

## Dirac's Large Number Hypothesis

It can be shown from the physics of stars that these large ratios are required for:

- the lifetime of the average star to be in the range of billions of years
- the rate of expansion of the universe to be such that several generations of stars have time to age

*That is:* the laws of physics and the initial conditions of the universe seemed "tuned" to allowing:

- several generations of stars (required to produce heavier elements)
- the lifetime of an average star is sufficiently long to potentially allow a process such as the evolution of life to occur

# Weak and Strong Anthropic Principles

These and other such examples universe appear to be show that the laws of physics and the initial conditions of the universe appear to be incredibly "fine-tuned" for the production of life

The slightest deviations in the physical constants or the laws of physics would have resulted in a sterile universe devoid of stars and life

# Weak and Strong Anthropic Principles

Why is this? **Weak Anthropic Principle** asserts:

- these coincidences are *selection* effects.
- That is, we do live in a *privileged position* in the universe (back to the **Ptolemaic Principle**)
  - there are other universes (**Many Universes Hypothesis**), or
  - other domains or parts of universe (for example, in the **Chaotic Inflation Model**) where the laws of physics or the initial conditions are different, and life never developed

# Weak and Strong Anthropic Principles

## The **Weak Anthropic Principle**

explanations of the **Many Universes**

**Hypothesis** and **Chaotic Inflation** with multiple domains are presently

*metaphysical not physical* explanations, for these other universes or domains are inaccessible to us, and they do not "fall out" as inevitable consequences of any proven theory

# Weak and Strong Anthropic Principles

**Strong Anthropic Principle** asserts that the apparent extraordinary "fine-tuning" is present because life is a *requirement* for the universe. Either:

- the universe was "designed" for life to evolve (= a Rumor of a Designer)
- conscious life is required for the universe to come into existence (**Observer Created Universe**)

# Weak and Strong Anthropic Principles

## **Observer Created Universe:**

- For a particle to come "into existence" from the realm of the quantum mechanical wave function (i.e., for the wavefunction to "collapse," and for the particle to become manifest from the myriad potentialities embodied in the wavefunction), it must be "observed" by a sentient being
- Hence, only a universe in which such beings are possibilities truly come into existence

Proposal has some logical cause and effect problems, but is taken seriously

# Weak and Strong Anthropic Principles

Perspective on the explanation of "many universes" or "many domains" (Weak Anthropic Principle) versus a Designer (Strong Anthropic Principle):

**Execution Parable** of philosopher John Leslie:

- you are blindfolded and about to be executed by ten expert marksmen aiming at your chest
- the officer gives the order to fire
- the shots ring out, and you survive

*What is the rationale explanation for your survival?*

# Weak and Strong Anthropic Principles

Leslie suggests there are only two rational explanations:

- there were many executions that day.

Occasionally even an expert marksman will miss, and you happened to be in the one execution where *all* the marksmen missed

- your survival was intended and the marksmen missed by design

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