

Physics and Faith 2

**Rumors of a Designer,
Creator and Sustainer.
Part I. The Laws of
Physics. The Big Bang**

Introduction

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

1. The laws of physics
2. The "boundary" of the universe at time = 0 (the "Big Bang") of classical cosmology. (Caveat: there are hints physics may soon have an explanation for this "boundary.")

Introduction

Five 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?
- Even if physics does explain the "boundary" at time = 0, the explanation will still just be a theory that cannot explain what "breathed fire" into the equations to make theory a manifest reality, and what "sustains" that reality today

Introduction

Five contingencies or dependencies in the universe that are unexplained by physics, that might be considered "rumors" of God (cont.):

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

Why? Some possibilities:

- a Designer
- Many Worlds
- an "Observer-created" Universe

Introduction

Five contingencies or dependencies in the universe that are unexplained by physics, that might be considered "rumors" of God (cont.):

5. The Ground of Physical Reality of Quantum Physics

- the impenetrable "boundary" of physical being encountered in Quantum Physics: a ground of being teeming with latent possibility and potentiality, not yet manifest, not yet real.

The Laws of Physics

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- 1. The laws of physics**

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The Laws of Physics

The universe has been found to obey laws of great mathematical beauty and elegance

“The book of nature is written in mathematical language”

- Galileo

“the universe appears to have been designed by a pure mathematician”

- astronomer James Jeans

The Laws of Physics

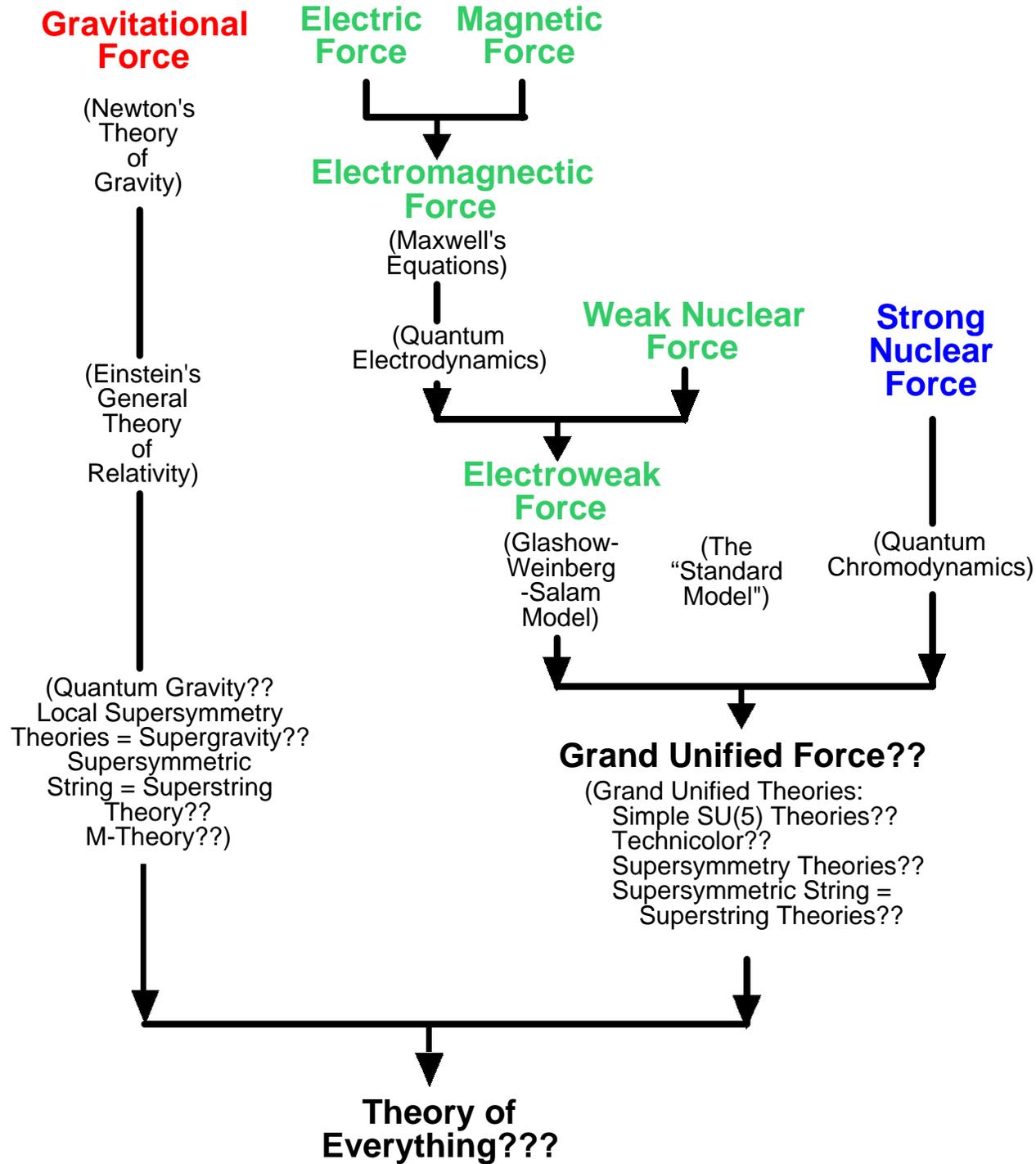
The universe has been found to obey laws of great mathematical beauty and elegance

“ . . . It is more important to have beauty in one’s equations than to have them fit experiment. [Since further developments may clear up the discrepancy]”

- Paul Dirac

“the only incomprehensible thing about the universe is that it is comprehensible”

- Einstein



The Laws of Physics

“The Theory of Everything ... would be much more than just a catalogue of physical laws. It would constitute a truly unified description of the material universe, weaving an intricate web of interconnections between its component parts, each one essential to the overall consistency of the whole . . . The Theory of Everything would be utterly compelling in structure, symmetry and elegance”

- Coughlan and Dodd, in *The Ideas of Particle Physics*, 2nd ed, Cambridge University Press

The Laws of Physics

Questions:

- Why is there an order, any rationality at all to the universe? Where does this order, rationality (the laws of Physics) come from?
- Why are these laws comprehensible to the human mind? And why should such laws appeal to our aesthetic sense of mathematical beauty and elegance?

The Laws of Physics

Characteristics of the Laws of Physics:

- **Universal.** The laws work in all places and all times of the universe.
- **Absolute.** They depend on nothing else, not on the observer, not on the particular "state" of the universe.
- **Eternal.** Their truth is timeless and eternal
- **Omnipotent.** Nothing is immune to them; they are "all-powerful."
- (loosely) **Omniscient.** The laws "know" the conditions of each physical system when they "command" the systems how to behave

The Laws of Physics

These qualities suggest an independent, transcendent existence of these laws.

- indeed, physicists speak of planets "obeying" Newton's laws, as if the laws are "out there."

Part of the mystery of the transcendent nature of the Laws of Physics is their *mathematical* form.

What is the nature of the "reality" of mathematics? In what sense does mathematics "exist"?

The Laws of Physics

The Nature of Mathematics

The nature of the "existence" of numbers, geometric figures fascinated the ancients.

Plato in his "Allegory of the Cave"

- suggested two realms of reality:
 - 1. **sensible world** (the dark cave where we see only shadows)
 - 2. **intelligible world** of Forms or Essences
- the **Shadows** in the Cave – the justice, piety or "chalk-board" triangles that we experience in this life
- the **Forms** or **Essences** – the Form or Essence of Justice, Piety, the perfect Triangle of the transcendent, eternal "intelligible" world

The Laws of Physics

The Nature of Mathematics

Is mathematics:

- *a purely human invention*, a product (or aberration) of the peculiar structure of the human brain?

or:

- *Platonic?* Something which exists in a transcendent realm that mathematicians "discover?"

The Laws of Physics

The Nature of Mathematics

Example: Question: "True or False: 23 is the smallest prime number greater than 20?"

(Answer: true!)

- was this question true only after the evolution of the human brain (prime numbers being an invention of the human mind)?
- or was this question true before human beings ever evolved?

The Laws of Physics

The Nature of Mathematics

Most mathematicians sense their work as "Platonic," as the exploration of transcendent landscape of mathematical objects.

"There often does appear to be some profound reality about these mathematical concepts, going quite beyond the deliberations of any particular mathematician. It is as though human thought is, instead, being guided towards some eternal external truth – a truth which has a reality of its own, and which is revealed only partially to any one of us."

- Roger Penrose, Oxford mathematician

The Laws of Physics

The Nature of Mathematics

The nature of mathematical discovery may offer evidence of mathematics' existence in a "Platonic" realm.

I imagine that whenever the mind perceives a mathematical idea it makes contact with Plato's world of mathematical concepts... When one 'sees' a mathematic truth, one's consciousness breaks through into this world of ideas, and makes direct contact with it..."

- Roger Penrose, Oxford mathematician

The Laws of Physics

The Nature of Mathematics

The breakthrough is often sudden and dramatic and unexplainable.

Example: S Ramanujan

- Indian mathematician born in the late 19th century from a poor family
- taught himself mathematics
- was able to write down a large number of mathematical theorems without proof – as if he had an extraordinary ability to explore the Platonic mathematical landscape, discover and retrieve the realities preexisting there
- his results came to the attention of British mathematician G. H. Hardy who was able to prove some of them with great difficulty

The Laws of Physics

The Nature of Mathematics

Further suggestions of mathematics' "Platonic" nature includes:

- Kurt **Gödel's*** **Incompleteness Theorem** 1931
 - given a set of mathematical axioms, there are propositions that *cannot* be proven as true or false. There exist *undecidable propositions*.
 - Gödel felt true undecidable propositions must already exist in the "Platonic" realm
- the discovery of mathematical structures that cannot be fully comprehended by any person or even fully revealed on a computer
 - example: the **Mandelbrot Set**

* Science, Vol. 298, page 1899, Dec. 6, 2002 has an article on Gödel

The Laws of Physics

Why is there an order, any rationality at all to the universe? Where does this order, rationality (the laws of Physics) come from?

“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

The Laws of Physics

Question:

- Why are these laws comprehensible to the human mind? And why should such laws appeal to our aesthetic sense of mathematical beauty and elegance?

The Laws of Physics

The human brain presumably formed through evolution in response to environmental pressures (hunting for food, avoiding predators, etc.)

Why should the human mind be capable of discerning, understanding and appreciating the mathematical beauty of the laws of physics?

The Laws of Physics

“ . . . 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

A Christian may speculate that this deep-seated relationship between the reason within and the reason without may be a reflection of human beings being made in the image and likeness of the source of that rationality, God.

The Boundary of Time = 0

Introduction

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

The Boundary of Time = 0

Cyclic Versus Linear Cosmology

Humanity has not always conceived of

- time as linear, or
- history as a progressive process

The Boundary of Time = 0

Cyclic Versus Linear Cosmology

Cyclic cosmology was common in:

- China
 - all events replicas of the cyclic interplay of Yin and Yang
- India
 - Hindu system of cycles within cycles of immense duration
 - 4 Yugas = 1 Mahayuga of 4.32 million years
 - 1000 Mahayuga = kalpas
 - 2 Kalpas = one day of Brahma
 - 100 years Brahma = one life cycle of Brahma = 311 trillion years
- Mayan civilization
- Egypt
- Babylon

The Boundary of Time = 0

Cyclic Versus Linear Cosmology

Linear Cosmology in Genesis:

- God created the universe at some specific moment in the past
- Universe has been progressively unfolding since that point
- The Creator is separate and independent of his Creation

Questions arise:

- what was God doing before creation?
- what made God, after existing for an eternity, decide to create a universe?
- why did God choose to make the universe when God made it?

The Boundary of Time = 0

God, Time, and Space

Issues raised by such questions: What is the relationship between:

- God and time?
- God and matter & space?

The Boundary of Time = 0

God, Time, and Space

Did God create the world:

- *in time?* (so that it is reasonable to ask what was God doing before he created the universe), or
- *with time?* (so such a question is meaningless!)

Augustine (354-430): God made the world "*with* time and *not in* time."

The Boundary of Time = 0

God, Time, and Space

Possible relationships of God and Matter & Space:

Deism: God a clockmaker who made the world like a clock, wound it up and is sitting back watching it go

Theism: God made the world wholly other but continues to be involved in its daily operation

Panentheism: the universe is part of God, but part of God is also separate from the universe

Pantheism: universe, nature *is* God.
Everything is part of God; and God is in everything

The Boundary of Time = 0

The Unity of Space-Time

Einstein's **Special Theory of Relativity**

appears to support Augustine: space and time are a single fabric; hence time seems to be part of the created universe

In particular, Special Relativity asserts:

- The universe consists of a single fabric of "space-time" consisting of innumerable space-time "events" (a "block" universe of space-time)
- The "labeling" of a space-time "event" will depend on how fast the labeler is moving: there is no such thing as absolute or universal time

The Boundary of Time = 0

The Unity of Space-Time

The unity of space-time in Einstein's **Special Theory of Relativity**: Stand on the ground and watch a rocket ship go by:

- Clocks in a speeding rocketship will appear to run slower (**time dilation**) than your clocks
- Yardsticks in a speeding rocketship which lie along the rocket's direction of motion will appear short (**Lorentz contraction**) compared to your yardsticks
- Two events on opposite sides of a room in the rocketship that occur "at the same time" to people in the rocketship will not appear to occur to you "at the same time." (**relativity of simultaneity**)

The Boundary of Time = 0

The Unity of Space-Time

The theory of relativity should not be interpreted as saying that everything is "relative" or (as some in the humanities seemed to have taken as its message), that everything is "subjective," dependent on the point of view of the observer

While relativity does tell us that quantities we once considered as universal and absolute for all observers are in fact "relative" -- quantities such as the length of an object, time, simultaneity – it replaces these quantities with another universal and absolute quantity: the **"timelike interval"**

The Boundary of Time = 0

The Unity of Space-Time

The "Timelike interval" is a quantity that consists mostly of the time of an event, but with a little of the spatial dimensions of the event subtracted out

This "timelike interval" is the same for all observers in the universe

- The amount of time and the amount of spatial dimension that goes into the computation of the timelike interval may vary from observer to observer, but the result is the same for all observers. The "timelike interval" is universal and absolute

The Boundary of Time = 0

The Big Bang

Until very recently, most scientists in the modern era have believed the universe was static and eternal

There were hints of problems:

- If the universe was *eternal*, why hadn't gravity pulled everything to together?
- If the universe was *infinite and eternal*:
 - wouldn't the forces of gravity add up to be infinite?
 - wouldn't the surface of the sky be as bright as the surface of a star (Olber's Paradox)

The Boundary of Time = 0

The Big Bang

- Models of the Universe based on Einstein's **General Theory of Relativity** (his theory of gravity that superceded Newton's theory) also had the problem of the universe collapsing on itself
- Einstein had to introduce a "fudge factor," the **cosmological constant** to keep the universe static
 - **cosmological constant**: an anti-gravity force that kept the universe from collapsing upon itself

The Boundary of Time = 0

The Big Bang

- 1920's:** Edwin Hubble presented evidence the universe was not static, but expanding (fabric of space itself is expanding, stretching)
- extrapolating back from the present rate of expansion suggests that the fabric of space originated some 15 billion years ago, its matter in the form of a great fireball of unimaginable density, temperature and pressure
- 1965:** the 3 degree K background radiation (the redshifted glow of the primeval fireball) detected

The Boundary of Time = 0

The Big Bang

- 1. Planck Era** (the beginning of the universe to 10^{-43} sec from the beginning)
 - During the **Planck era**, quantum gravity effects dominated
 - Since we lack a theory of quantum gravity, we can only speculate about the conditions during this time
- 2. The Era of the Great Unification** (from 10^{-43} sec to about 10^{-35} sec from the beginning of the universe)
 - During this time the **Electroweak Force** and the **Strong Force** are combined in the **Grand Unified Force**

The Boundary of Time = 0

The Big Bang

3. **The Quark Era** (from 10^{-35} sec to 10^{-6} sec from the beginning of the universe)
- Quarks, anti-quarks and gluons (the particles that mediate the **Strong Force**) dominate the universe)
 - At 10^{-10} sec (The **Electroweak Time**), the Electroweak Symmetry breaks and the **Electromagnetic Force** and the **Weak Force** appear as distinct forces
 - For the first time, the elementary particles making up matter have the properties we observe in elementary particles today.

The Boundary of Time = 0

The Big Bang

- 4. Hadron Era** (from 10^{-6} sec to 10^{-4} sec from the beginning of the universe)
- At 10^{-4} sec, the universe has cooled enough that quarks, antiquarks and gluons can no longer roam as free particles. Combinations of quarks form, called **hadrons**. There are two types of **hadrons**:
 - **baryons**: composed of 3 quarks or 3 antiquarks (e.g. proton, neutron)
 - **mesons**, composed of 1 quark and 1 antiquark (e.g. pion)

The Boundary of Time = 0

The Big Bang

- 5. Lepton Era** (from 10^{-4} sec to 3 sec from the beginning of the universe)
 - At 10^{-4} sec, leptons (e.g. the electron, positrons, muons, neutrinos) begin to dominate the universe

The Boundary of Time = 0

The Big Bang

- 6. Photon Era** (3 sec to 2 million years from the beginning of the universe)
- At 3 sec, photons begin to dominate the universe.
 - Near the end of the **photon era** (at about 800,000 years) electrons begin to combine with nuclei and form electrically neutral atoms. The universe becomes transparent (The **Recombination time**)
 - What we measure as the 2.7 degree cosmic microwave background is the redshifted glow of the photons that filled the universe before the recombination time.

The Boundary of Time = 0

The Big Bang

- 7. Matter Era** (2 million years to 15 billion years from the beginning)
 - After radiation and matter had "decoupled" and the universe had become transparent, large scale density fluctuations in matter began to grow that lead to the formation of galaxy clusters and galaxies.

The Boundary of Time = 0

The Big Bang

The Penrose-Hawking Singularity Theorem

- proved that a "singularity" at time = 0 is inevitable so long as gravity remains an attractive force
- singularity at time = 0: the fabric of space and time becomes undefined, non-existent

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

The Boundary of Time = 0

The Big Bang

Contingency of the “boundary” at time = 0:
The initial space-time singularity:
creatio ex nihilo?

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