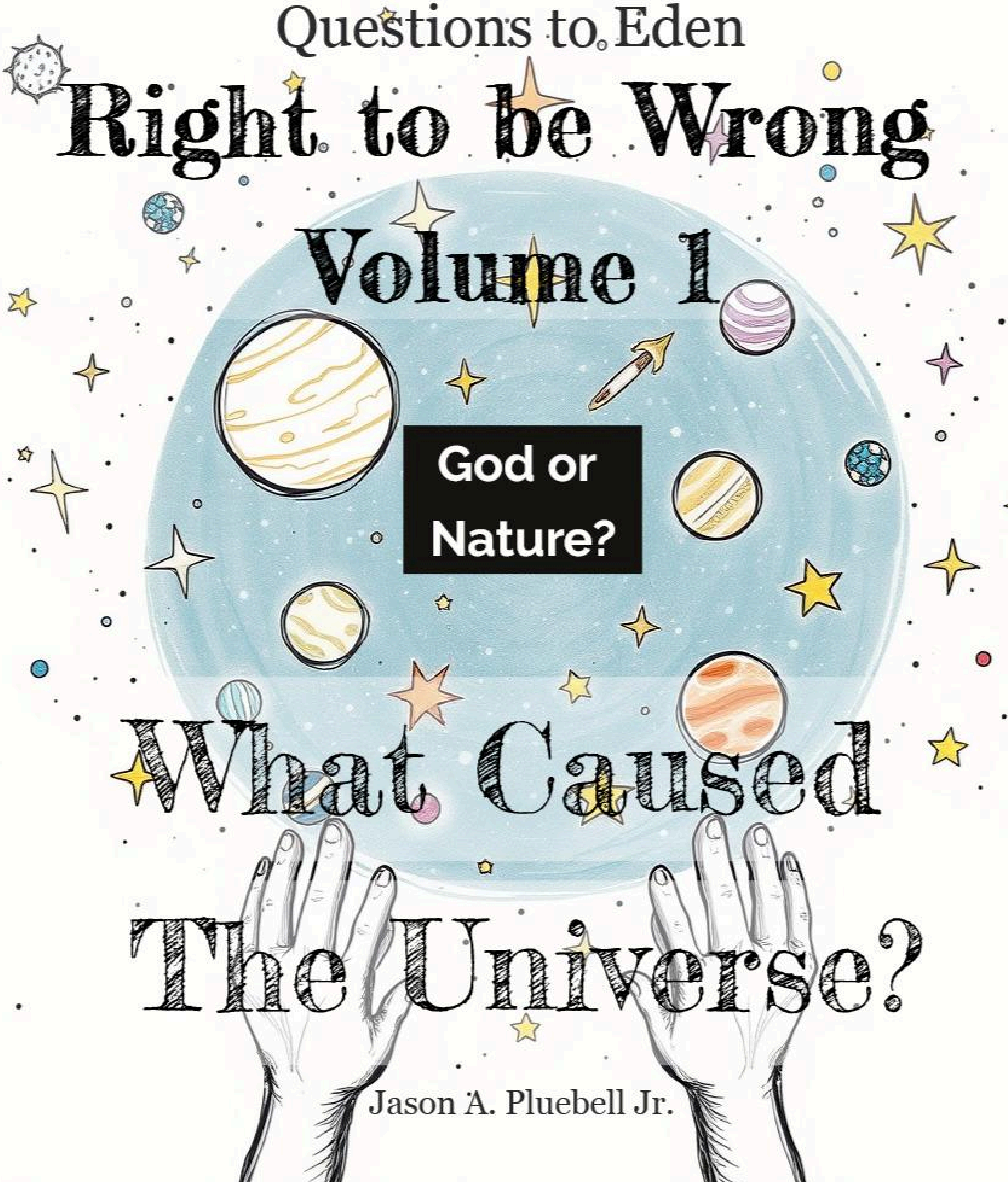
Questions to Eden

Right to be Wrong

Volume 1



God or Nature?

What Caused The Universe?

Jason A. Pluebell Jr.

You Have a Right to be Wrong

This series is a collection of my core articles at ptequestionstoeden.com, an online blog that offers apologetic and informative articles about Christianity. In researching, I have decided to write a series of short volumes covering the evidence for God's existence in a small handbook fashion.

If a person wanted to investigate the idea of a God existing, and moreover who that God may be, the best place to start would be, well, the start. By examining the current evidence we have concerning whether the universe had a beginning, we can determine if the task of finding God is even worth considering. After all, if the universe never began, then why think it had a creator? Indeed, the idea of being external to the material world, and the material world running down seems to imply that the material world has a cause grounded in the transcendent being.

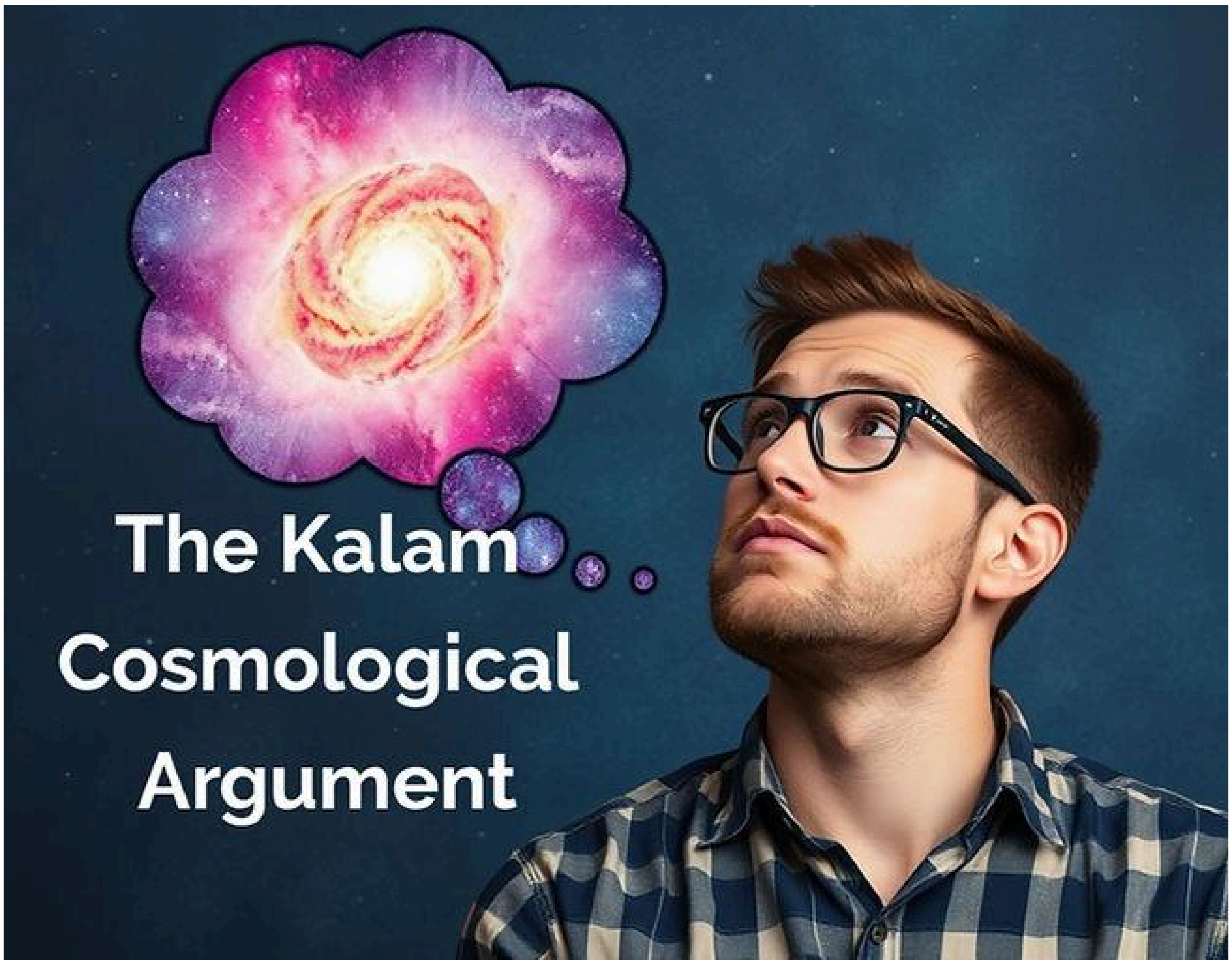
What I have done is taken the time to read, and think about these ideas, and attempt to describe the implications of the evidence in an easy-to-understand manner. Hopefully these books serve as a resource any layperson can pick up and read, and get to know Jesus Christ. I must also mention that I do not take any credit for the work I have provided here, after all I am standing on the shoulders of many people. Before we begin examining if the universe did have a beginning, and what that cause may be, I must mention one more thing. I must thank *Stephen C. Meyer* for providing an amazing resource for almost any person to use. His book *The Return of the God Hypothesis* offers an amazing and wonderful, and in depth discussion on the idea of a God existing, and the evidence for it. I have used this book heavily throughout this volume, along with some other books and authors cited when needed. I must also thank popular voices and authors like *Hugh Ross*, *Frank Turek*, *J. Warner Wallace*, *William Lane Craig*, *John Lennox*, *James M. Tour*, *William A. Dembski*, *Durwood B. Hatch* and so, so many others. Without the hard dedication these God fearing men have pushed through, neither this volume, nor my blog would have been possible.

Moreover, the issue at hand is no subjective matter. Yes, you can still believe in an eternal universe, but if the universe itself had a beginning, then you are doing so on no basis of sound reasoning. God created you with free will, and that means that you have a **Right to be Wrong**. So without further ado, let's see if we can discover what caused the universe to come into existence.

Chapter 1

What is The Kalam Cosmological Argument?

Does it make sense for the universe to be eternal?



A Universe Eternal?

For millennia, humans have grappled with the concept of the universe being self-existent and infinite. With every past event being preceded by another, on and on into infinity. Among ancient men, there were two predominant views of the state of the universe. The Greeks believed that matter and energy were self-existent and eternal, and that the gods organized them into the planets and heavenly bodies. Then the Hebrews, who held the view that the universe was not in itself eternal, but that God had created all of it some time in the past "In the beginning, God created the heavens and the earth" (Genesis 1:1). Like most people in our relativistic culture, why can't both of these views be true? The claim about whether the universe is past eternal or incomplete is no matter of a subjective truth claim. The claim is centered around the real object we can observe, the universe, and is in no way based on the preferences of an individual. This is like saying the claim that water is necessary for your survival is a subjective claim; it can be tested, and we can see that water is indeed essential to human survival (because without it, you would die).

Similarly, we can observe the universe and try to determine if we can conclude that it had a beginning in the finite past or if it is actually an infinite regress. Only one claim about the universe's objectivity can be actually true, and that is what I will try to clarify in this article series about the Origins of our Universe.

For Starters…

Before we begin analyzing the evidence for this, we must understand the argument. To this, I will provide a short overview of the *Kalam Cosmological Argument* for the beginning of the universe. Also, before we begin, we must understand that at the core of this argument is not a focus on proving God's existence, but rather that the universe is not eternal. What we can, and will do, is examine the evidence and reason back to a cause, from its effects to see if we can reveal the nature of what caused the first cause; the beginning of space, time, and matter.

Context of the Argument

When Western philosophy took off, the two views came into contact at long last. This resulted in a debate that lasted about a millennium among Jews, Muslims, and Christians. The debate seemingly ended with the famous *Immanuel Kant* (A.D. 1724-1804) claiming that "since both sides have convincing arguments, it reveals the bankruptcy of reason itself." Despite the silence, the argument has returned to the scientific and philosophical scene with vengeance.

The argument has deep roots in Islamic theology, and *William Lane Craig* dubbed it the *Kalam* (Arabic for medieval theology) *Cosmological Argument*.

> “The Cambridge Companion to Atheism (2007) reports, “A count of the articles in the philosophy journals shows that more articles have been published about . . . the Kalam argument than have been published about any other . . . contemporary formulation of an argument for God’s existence. . . . theists and atheists alike ‘cannot leave [the] Kalam argument alone’ (p. 183).” (*Craig*, "The Kalam Cosmological Argument", 2.).

The 12th-century Islamic theologian Al-Ghazali is the pioneer of the argument. He was concerned with seeing other theologians of his day being influenced by the Greek philosophers, which led them to deny that Allah created the universe. After deeply studying the teachings of the Greeks, he composed a massive critique of their eternal matter views in his works called *The Incoherence of the Philosophers*. In it, he argues that believing the universe is eternal is absurd.

He says that since nothing begins to exist without a cause for its beginning, there must be a creator of the universe. “Every being which begins has a cause for its beginning; now the world is a being which begins; therefore, it possesses a cause for its beginning. (*Al-Gha-zalı-*, Kitab al-Iqtisad fi’l-I’tiqad, cited in S. de Beaurecueil, “Gazzali et S. Thomas d’Aquin: Essai sur la preuve de l'existence de Dieu proposée dans l’Iqtisad et sa comparaison avec les ‘voies’ Thomiste,” Bulletin de l’Institut Francais d’Archaeologie Orientale 46 (1947): 203.)"

An artists sketch of Al-Ghazali:
https://www.ghazali.org/works/port.htm

Premises of the Argument

The argument has three very simple and easy-to-understand premises, and we will look at the evidence for the validity of all of them in this series. The argument goes like this:

1. Whatever begins to exist *has a cause of its beginning*.
2. The Universe *began to exist*.
3. Therefore, the Universe *has a cause for its beginning*.

We will now discuss each premise in some detail below.

1. Whatever Begins to Exist Has a Cause of its Beginning

William Lane Craig offers a useful summary of this premise: "If the universe began to exist, then it had a cause for its beginning" with the term "universe" referring to all contiguous spacetime reality, even subatomic particles that are the results of quantum decay processes (words taken from *Craig,* "The Kalam Cosmological Argument"). This means that to hold to the belief that the universe didn't have a cause for its beginning is to hold to the universe coming into existence from absolutely nothing.

Quantum decay does not produce particles from "nothing"; what occurs is the conversion of one type of matter into another, with the energy remaining constant throughout. There are major issues with holding to the possibility of something coming from nothing. Something simply cannot come from nothing by definition. To deny premise 1 is to think the universe appeared with no reason or cause, which is more absurd than magic. If something came from nothing, then there ceases to be an explanation for how and why anything comes into existence. In other words, why did only the universe come from nothing? Why aren't kangaroos appearing in Minnesota, or hot dogs in Sweden? Why is "nothing" so selective to only universes? “What makes nothingness so discriminatory? There can’t be anything about nothingness that favors universes, for nothingness doesn’t have any properties. Nor can anything constrain nothingness, for there isn’t anything to be constrained! (*Craig*, The Kalam Cosmological Argument, 3)."

To deny premise 1 is to also deny the holistic human experience and all scientific evidence that confirms it. Cosmology itself is based on the foundational presupposition that there were initial causal conditions to the universe's origin. Cosmology agrees with premise 1.

2. The Universe Began to Exist

The second premise is the debated one. You will not find many people claiming things come into existence from nothing; you will find far more people holding to a beginningless universe. This article is not going to go over the evidence supporting this premise, that is for the next article. Here, I will go over some philosophical issues and briefly mention some scientific evidence, with the next article going into more detail on the evidence itself.

Actual and Potential Infinites

If the universe never began to exist, then the past is infinite. There have been an infinite number of events preceding today. How did today come about, then, if the past has an actually infinite number of events leading up to today? It makes no sense, logically speaking.

Potential Infinites are where infinity serves as a max upper limit that can *never* be reached. A good example is choosing a distance and dividing it in half. Say we divide one meter into 50 centimeters. Then we divide that in half, and again, and again. The number of times you can divide that distance is infinite, but you will never reach a limit where you cannot surpass infinity. Or simply if a man in a chair began counting, starting from one, he could keep counting forever without reaching the limit of infinity.

Actual Infinities are an *actual* number of infinite things. But an actual infinite number of things cannot exist in the material world. If I had a chest full of an infinite amount of lollipops, and I ran an event with 5,000 attendees, and each one received a lollipop upon entry. How many lollipops would be left in my chest? Would I not have an infinite amount remaining? Moreover, what if I needed to remove one-third of my supply to pay my lollipop tax to the candy government (at 33% of my lollipops)? Would I not still have an infinite amount remaining, and wouldn't my one-third division also result in an infinite amount of lollipops?

A division of infinity results in more infinities. Therefore, the existence of an infinite number of past events would never result in today happening; the past cannot be infinite.

Successive Addition Does not Create Actual Infinites

The amount of past events has been accumulated, one event after another, for infinity. Two days ago I went to work, the next day I went to work again, and the next day I had off work, and so on. But you cannot reach an actual infinity by adding one by one; an infinite series of things cannot happen one thing at a time. Today can never be reached if there were an infinite number of past events. If the past were an infinite series of events, and no series of addition can reach an infinite limit, the past cannot be infinite.

Has Math Refuted This?

Some have said that modern set theory refutes this defense of a past incomplete universe. "Past incomplete" simply means the past is not eternal; it has a finite nature. The set of natural numbers, like 1, 2, 3, and so on, has an infinite number of members within it. It also says that you can reasonably talk about infinites if you adopt certain axioms without creating giant gaps in logic. While set theory makes use of infinities in ways of arithmetic, it does nothing to show how actual mathematical entities can really exist.

Some also claim that we cannot understand infinities; therefore, we obviously are going to conclude they cannot actually exist. But this reveals a misunderstanding of our argument. Set theory is a very well-developed and understood branch of mathematics, so to say we deny the existence of actual infinities based on ignorance is bogus. We deny their existence because of what we know about infinities and how they work. Since actual infinities cannot exist, an infinite past cannot exist either.

Premise 3: The Universe has a Cause… Falsifiable Claims?

The claim that "the universe is eternal" is an objective truth claim, where we can examine the object of the universe and see if we can determine if that statement is true. This is where scientific evidence, such as the Cosmic Background Radiation, the Distance Light Red-shift, mathematical models, philosophical problems, and other observable evidence, come into play. In the next article, we will discuss the scientific developments in concluding with high confidence that the universe had a cause for its beginning in the finite past.

Did God Have a Cause?

Now, assuming the premises are true, and that we can conclude that a God did create the universe, some will ask if the creator had a creator who created him that was created by another creator, which was created by whom? In other words, did the first cause have a cause that caused it that was caused by another cause preceded by more causes that were caused by what? At first glance, this seems like a reasonable concern, but it has some flaws in the understanding of God's nature. If we think a little longer about what the universe's beginning means, it means that space, *time*, and matter all began. Before that, no time was present. The theological term for this aspect of God's nature is His Aseity (God's Self Existence). This describes how, since God created time and time requires a beginning, and a beginning requires a cause, God does not require a cause for His beginning because He has none. God exists outside of time, and that means time does not in toto influence Him, nor does He have any dependence for His existence.

This is ultimately a category error; it equates God with causal entities. But the premises never state "everything has a cause for its existence," but that everything that has a beginning to its existence has a cause for its beginning. God is not in that category of being; He created the category itself! So to ask "Did God have a cause?" is to make a category error.

Conclusion

With a brief overview of what the Kalam Cosmological argument posits, we can now delve into what the actual heavens say when we ask, "Is the universe eternal?" Be prepared to learn about the history of science. We will discuss the many universe models that have been made over the years, their strengths and weaknesses; the Big Bang model; Quantum causes; Other Issues with an eternal universe; the BGV Theorem; Then reasoning to a cause from its effects and whether that cause was personal or not.

Be aware that this argument only establishes the impossibility of an infinite universe in philosophical terms. In further articles we will discuss further philosophical arguments and scientific and mathematical evidences for a finite universe. As well as the issues with multiverse models.

To further clarify, the Kalam Cosmological Argument does not "prove" the Christian God exists, but rather offers an argument that the universe had a beginning on philosophical grounds. As we will discover later, things cannot cause themselves to exist, and we will go deeper into the quantum origin models.

Moreover many claim this argument is special pleading in some way. Often they reference William Lane Craig's formulation and conclusion of the Christian God being the cause, and that the pleading occurs with that logical leap. What they misunderstand is that even Craig acknowledges the previous reality mentioned above, what he does do is delve into more philosophical arguments and scientific confirmations that support a cause with the nature of God as revealed in Scripture and through the person of Jesus Christ. There will be a section responding to popular arguments against a past incomplete universe, offering the refutations to such critiques.

May you read the opening verses of Genesis in a newfound light. That in the beginning (time), God created the heavens and the earth (space and matter: the universe).

> **"By faith we understand that the universe was formed at God's command, so that what is seen was not made out of what was visible (Hebrews 11:3)."**

Knowing that God has revealed His truth through His Word, and His "booke" of nature. Amen.

Now What?

Since we have looked at the main philosophical argument for the beginning of the universe, what do we do now? Well, we need to first establish the validity of the second premise. By examining the discoveries man made leading up to the war over cosmology, we can then determine if the universe really did have a beginning. And if it did, we should be able to look at the effect of that cause (the universe) and decide which hypothesis offers an adequate explanation. We may also examine the nature of the effect, and reason back to a minimum nature of the cause, and hopefully from that we can determine if a God really did cause the universe to come into existence.

Chapter 2

Did the Universe Have a Beginning?

Is the second premise of the Kalam Cosmological argument correct?

For many centuries, scientists and philosophers have pondered the possibility of a temporal universe. At first, they tried to answer the questions from logical and theological principles. People like *Aristotle* (4th century BC) saw time as a sequence of connected events, and that if the universe began, it would have started by the end of a prior event. He thought that to postulate time as having a beginning was absurd. During the Middle Ages, many Jewish and Christian philosophers affirmed the idea of creation *ex nihilo*, or from nothing. People like Augustine, Aquinas, Maimonides, Bonaventure, and many others affirmed this view (Stephen Meyer, *Return of the God Hypothesis*, Pgs 69-70). Many theologians from this period argued from the Kalam Cosmological Argument by showing the absurdity of actual infinities existing in the physical world (See What is The Kalam Cosmological Argument?). If a man tried climbing from an infinitely deep pit, he would never be able to escape because he would have an infinite distance left.

Then scientists began wondering if the universe contained an actually infinite amount of matter and space. Some held to a finite universe, but with infinite space, such as Issacc Newton. But some recognized that an infinitely large universe would exhibit a uniform distribution of stars that would light the entire sky, concluding that if space extended infinitely, every line of sight would terminate with a light source. This paradox was named the "Olbers' Paradox," named after Heinrich Wilhelm Olbers. Some folks offered explanations, such as the starlight exhausting before it reached Earth due to a substance called "Ether" that was absorbing all the light. Nonetheless, it wasn't until Man began looking at the heavens with even greater instruments than before that he discovered the answer to this age-old question.

In this article in the Origins of the Universe series, we will look at the scientific discoveries that led to the ultimate discovery that the universe had a beginning at some point in the past.

Distant Starlight Red-shift

Nebulae: Gaseous regions of space visible to the naked eye or a telescope that consist of stars that light up the gases.

Entering the 20th century, many affirmed an infinite age to the universe for various reasons, including Newton's framework of infinite space, which some implied as infinite time as well, and Uniformitarian dates for the age of the Earth being extrapolated to the universe, and other deep time theories. This position was simple and had few issues because there was no need to posit an origin if there was none. But it wasn't long before an astronomer at Harvard College Observatory claimed the entire universe contained our Milky Way. He measured the size of the Milky Way to be about 300,000 light-years across, but many scientists began leaving this model because of observations of objects called *Spiral Nebulae*. In 1715, British astronomer *Edmond Halley* described six individual nebulae, but later telescopes and better photos offered evidence that these clouds contained many different clusters of stars.

This eventually gave birth to a debate between Harlow Shapley and the astronomer *Heber Curtis*. The debate took place at the Smithsonian Institute in 1920, where they discussed whether these nebulae were either inside or outside the Milky Way. As expected, Shapley argued that these clouds existed inside the Milky Way. It wasn't until several years later that *Edwin Hubble* settled the debate, but his work relied on the prior work of another astronomer.

Illuminating The Calculations

Harvard College Observatory would hire women to scan photographic plates to make records of stars and observations. This is where *Henrietta Leavitt* (1869-1921) began working, examining plates. Photographic plates were used because they could be exposed to the sky for extended periods, catching objects the human eye could not normally see. These plates enabled astronomers to make even more accurate observations of the night sky. Leavitt was deaf, but had a knack for analyzing the smudges left on the plates to find and catalogue stars. During her work analyzing plates, she made a discovery. Leavitt discovered a specific star called a *Cepheid Variable Star*, a type of pulsating star. She found that the brightness of these cepheids in a nebula called the Small Magellanic Cloud oscillates with a period that correlates with the magnitude of their brightness. In other words, the brighter the star, the longer the pulsation period; and the longer the pulsation, the greater the apparent brightness.

Apparent brightness is measured by using a photometer, which measures the amount of photons that arrive in an observed area per second. *Absolute Brightness* is measured using standard distance measurements. The absolute brightness only varies with pulsation, whereas the apparent brightness varies with pulsation *and* distance. Stephen Meyer offers an analogy to aid us in understanding why this matters to an astronomer:

> "...imagine looking at a light coming from a lamppost through the fog while walking through a park at night. If you see a light in the park that looks extremely bright to you, you might attribute that apparent brightness to the light being extremely close at hand. Or you might attribute the brightness of the light to an extremely high-output lightbulb located on the other side of the park. (Meyer, Return of the God Hypothesis, Pgs 76-77)". Unless you know the distance to the light source, you have no way to calculate the actual brightness at the source from what you're seeing from a distance.

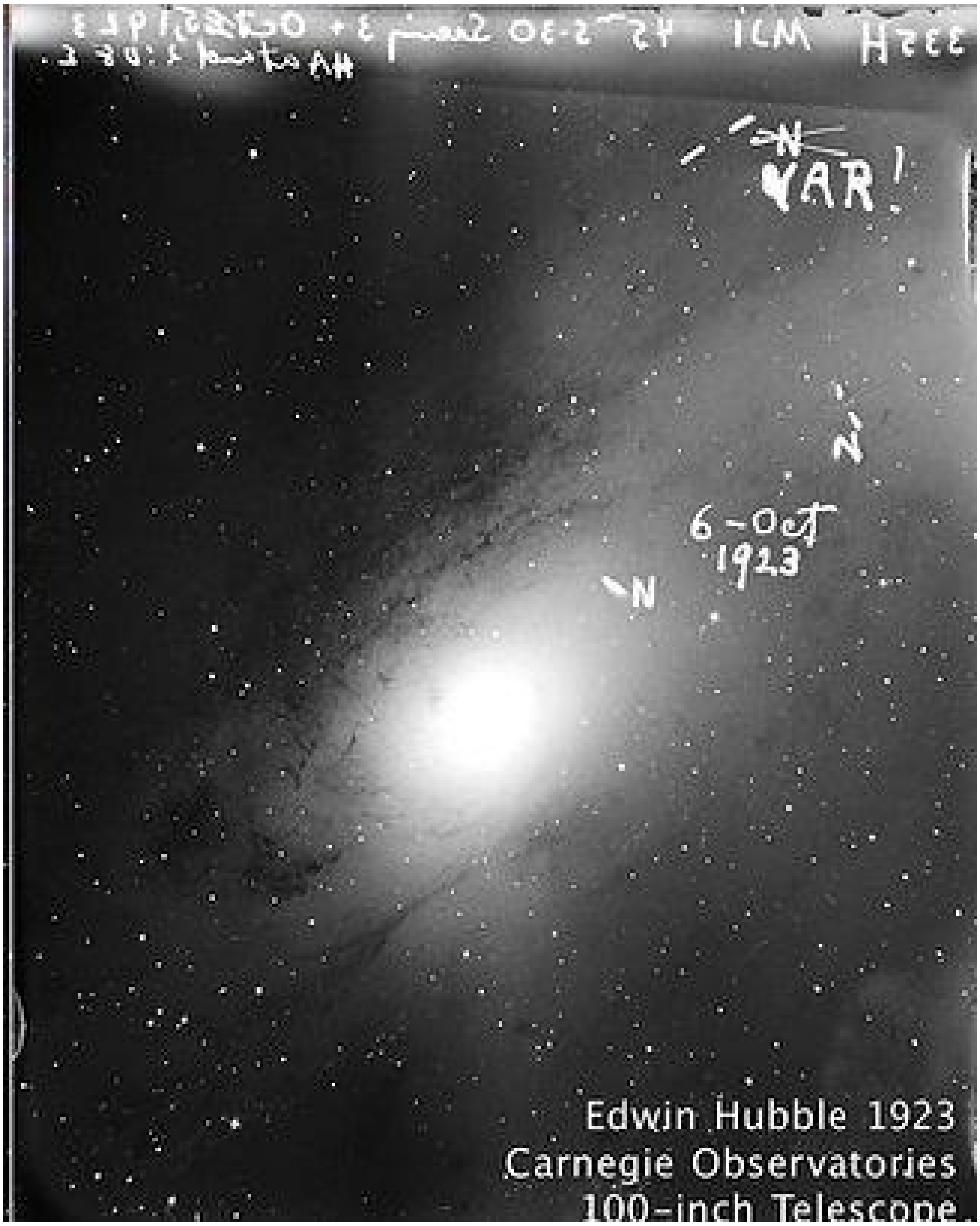
Astronomers faced a similar issue using apparent brightness to calculate the absolute brightness and distance of a star. They can measure the apparent brightness of a cepheid variable star, and they also know that light intensity dissipates with the distance travelled, specifically by the inverse of the square of the distance, or $1/d^2$. But they can only calculate absolute brightness if they know the distance to the star they see, and the distance to the Magellanic Cloud was not known, so Laevitt was not able to calculate their absolute brightnesses from their apparent brightnesses. She could, however, plot the relationship of how both apparent and absolute brightnesses varied with the period of pulsation of the cepheids. Thus, to calculate the distance of the cloud, there must be a cepheid somewhere that has a distance we can calculate.

In 1913, Danish astronomer *Ejnar Hertzsprung* used a method called statistical parallax to determine the distance to 13 individual cepheids that were relatively close. Normal Stellar Parallax measures the position of a star in the sky at six-month periods, when the Earth is on one of two sides of the Sun. The method uses trigonometric formulas to determine the distance via the differences in angular displacements at the two six-month periods. But Statistical Parallax, "assumes that stars move in random directions, so the distribution of radial velocities, V_r, (velocity moving directly toward or away from earth) and the distribution of tangential velocities, V_t, (velocity perpendicular to the radial velocity) are roughly the same. The radial velocities can be calculated using the Doppler shifts in the stars' emitted light. The tangential velocities cannot be measured, but the angle, θ, that a star moves across the night sky over some time interval, t, can be. (*Return of the God Hypothesis Extended Research Notes*, Note 4d. A.Final Extended Research Notes)."

Hertzsprung first found a cepheid in the Magallanic Cloud with the same period of pulsation as the ones he found near the sun. Since all cepheids with the same pulsation have the same absolute brightness, he was able to find the absolute brightness of whatever cepheid he was observing. He calculated the distance to be about 30,000 light-years away, but since nobody knew the extent of the Milky Way yet, there was no way of knowing if it was part of our galaxy or not, or if the universe only contained ours (Meyer, *Return of the God Hypothesis*, Chp 4 Note 35).

Another Galaxy…

Now we return to Edwin Hubble, who began working at the Hooker Telescope in California in the 1920s. He specifically observed a 40-minute exposure of M31, the Andromeda Nebula. Hubble saw some Novae, which turned out to be two novae and a cepheid star (Novae are stars that increase in brightness, then decrease gradually over a long period of time).

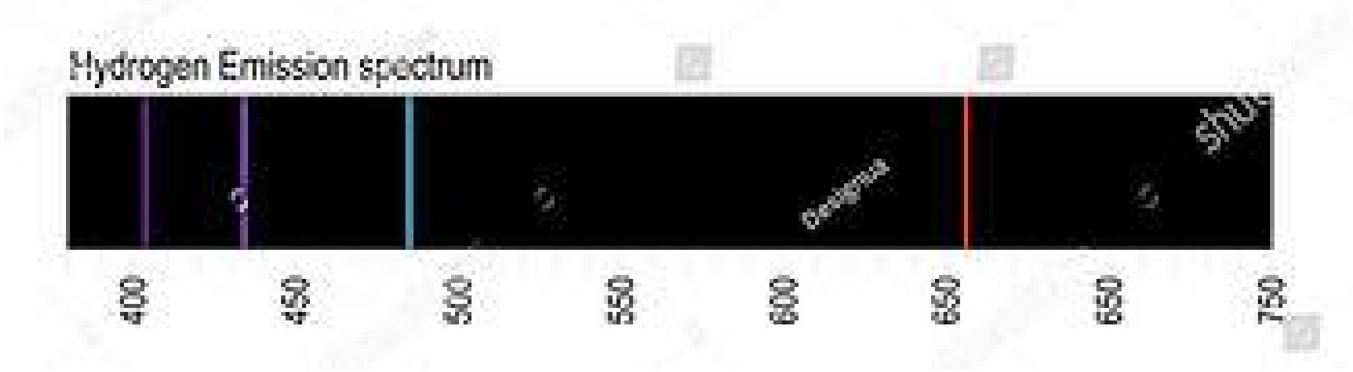


Hubble's 40 Minute capture of M31, the Andromeda Nebula.

Then, using Leavitt and Hertzsprung's methods, he recorded that the Cepheid in Andromeda brightened and dimmed over a period of 31.415 days and calculated its absolute and apparent brightnesses, which enabled him to determine its distance. He concluded that the Andromeda Nebula was 900,000 light-years from Earth, though modern measurements establish it at 2,500,00 light-years away. Hubble claimed that Andromeda was not a nebula, but actually another galaxy, and that the universe was much bigger than what Shapley had proposed in 1920.

Starlight Red-Shift

In 1912, an astronomer named *Vesto Slipher* utilized a 24-inch telescope and the spectroscopic method to study light from astronomical bodies. When an atom absorbs energy, the electrons become excited and jump to higher energy levels. They then decay back to more stable energies, emitting a photon in the process that releases the energy they have gained. The energy of the photon is proportional to the frequency and inversely proportional to its wavelength. The equation for finding the energy of a photon is $E = hf$, where f represents the frequency of the light and h represents Planck's constant, a fundamental physical constant used to calculate the energy level from the frequency. The study of the light emitted and absorbed by chemical elements, their wavelengths, frequencies, and colors is called *Spectroscopy*. When a certain element absorbs energy, it releases photons with specific frequencies and wavelengths due to each element's unique energy level.



Shutterstock image of Hydrogen's Spectral Pattern.

When light is pointed at a prism, its wavelengths are all divided, creating what we see as a rainbow, which represents only a small portion of the electromagnetic spectrum, or the full range of the wavelengths of light. What we see in the rainbow is the portion called the visible light spectrum. The full spectrum includes radio waves, microwaves, infrared, visible light, ultraviolet, X-rays, and gamma rays (listed from longest to shortest wavelength). This can either be a spectroscopic emission or absorption of light by a chemical element. In a spectrometer, the patterns of the emitted wavelengths are called spectral lines. Astronomers use this to determine the chemical composition of stars and galaxies via the light they emit. Which leads me to a kind of off-topic tip. When astronomers discover an exoplanet that they claim has possible life, they are not actually looking into a telescope and seeing a blown-up image of the planet.

When an exoplanet (a planet that orbits a star outside our solar system) is detected, it is detected by means of observing a star's behaviour and brightness changes to *infer* that a planet is there. It is then that they use spectrograph readings to determine the atmospheric makeup of the planet. Nowhere does anybody actually have a view of a planet, and the pictures seen in YouTube videos and news articles are just an artist's imagination, not what is actually there. It's more analogous to seeing the lampost in the fog flicker, then inferring that a moth may be smacking into the bulb.

Anyhow, Slipher used this method to study the spectra of astronomical bodies. In 1912. He began measuring the light from several spiral nebulae and found specific element patterns for each one. But he noticed something strange about the patterns; the lines of the nebula were all shifted towards the red end of the spectrum. In simpler terms, the patterns he observed were at a redder placement than what would be observed from elements on Earth: the light had longer wavelengths. This is known as the *Doppler Effect,* where wavelengths are shortened if they originate from a source moving towards an observer and stretched if they come from one moving away. Thus, if we observe a galaxy with red-shifted light, we conclude it is moving away from us. Slipher saw that stars that we know are in the Milky Way *may* have a blue or red shift, but that "more indistinct" nebulae exhibited a greater red shift, implying they were moving away from us. By 1914, Doppler shifts had been recorded for 13 of the brightest galaxies, but the record was dominated by red-shifted galaxies as opposed to the expected equal mix of red and blue.

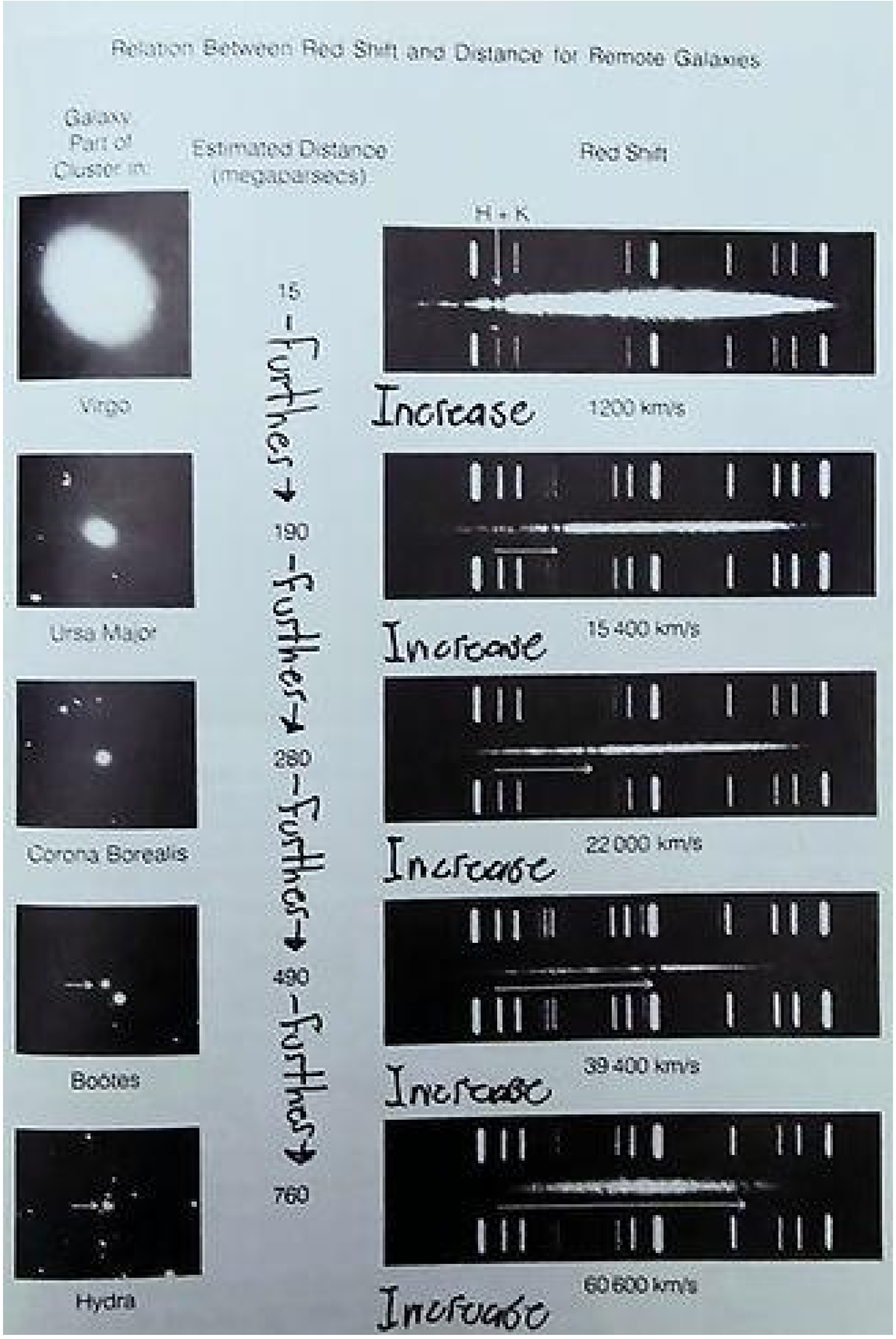
Hubble's Constant

As Edwin Hubble examined Slipher's red shift records and other work from Milton Humason, he found that more distant galaxies had greater red shift. Around 1920, he began further Doppler shift observations at the 2.5-m reflector at Mt. Wilson, and by 1925, he recorded 45 Doppler-shifted galaxies. In 1936, he noted that red shifts completely dominated the catalogue:

> "The numerical values of the new velocities were found to be surprisingly large and of an entirely different order from those of any other known type of astronomical body. (William K. Hartmann, *Astronomy: The Cosmic Journey, Fourth Edition*, Pg 554)"

There were red shifts with recession speeds as high as 1800 km/s on this list. In 1928, an American physicist named *H. P. Robertson* noticed that the more distant a galaxy, the greater the red shift, with the red shift directly proportional to distance.

This suggested that the further away a galaxy was, the faster they were receding from us. His discovery of the relationship between recessional velocity and galactic distance has been named "*Hubble's Constant*".



A graph of remote galaxies and their redshift-distances. Hale Observatory (William K. Hartmann, *Astronomy: The Cosmic Journey, Fourth Edition*, Pg 557). Apologies for my messy markup.

This discovery further implied that the universe was experiencing some sort of outward expansion. If a galaxy were five times as far as another, it would be receding five times faster. Hubble found that the rate of recession of a galaxy was directly correlated to the distance it is from us. Taking this into consideration, at any time in the past, galaxies would have been closer together. As you go further back, all the matter in the universe would have to necessarily converge at a single point where the universe began. Hubble's Constant (H) lies somewhere between 77 ± 14 Km/s per megaparsec. One megaparsec is about 1.92 x 10^{19} miles (or 1,920,000,000,000,000,000 miles). This means that a galaxy 1 Mpc away will recede on average about 77 km/s. One that is twice as far will move 154 Km/s, and one 10 Mpc away will recede at 770 Km/s.

A Banging Beginning: The Big Bang Model

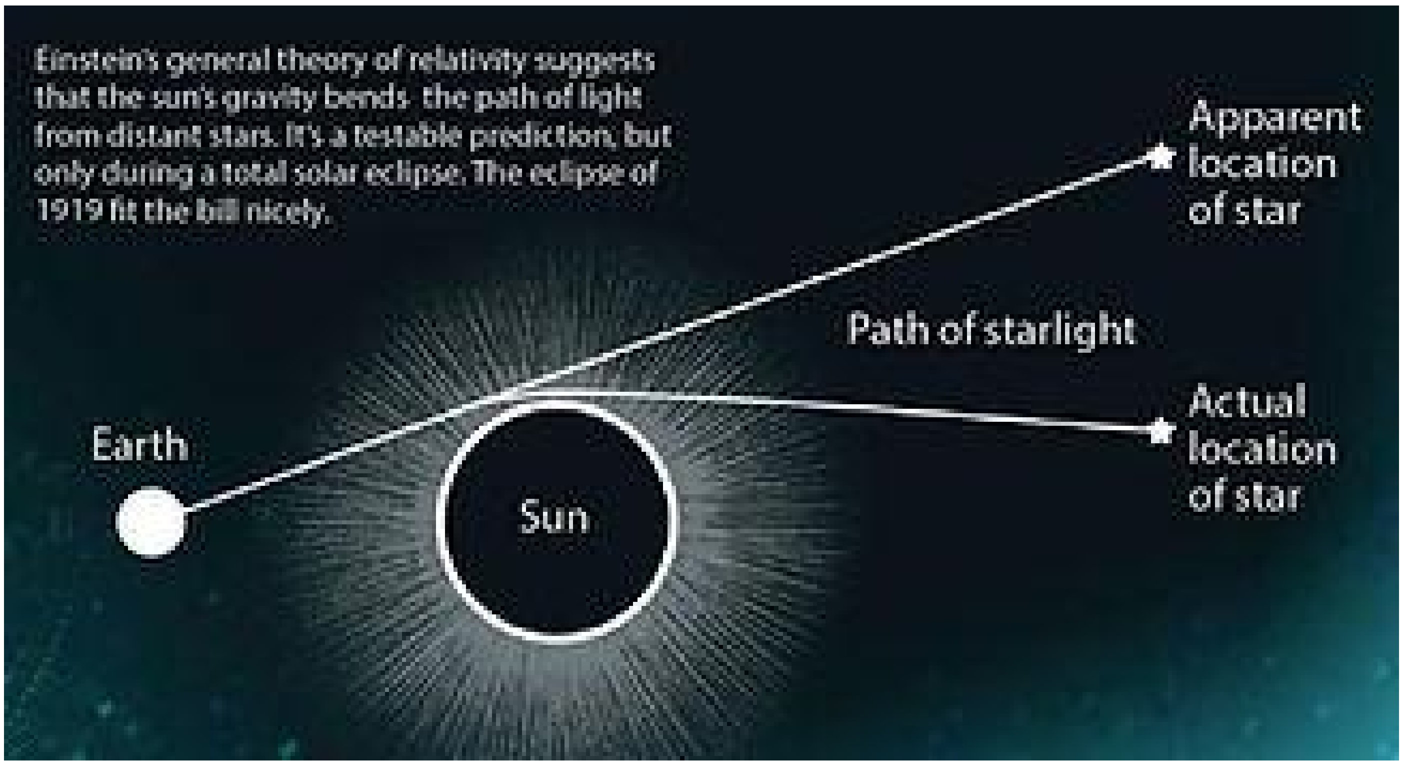
During this period, and some time after it, there were not just advancements made in observational data that led to the conclusion of an expanding, finite universe. There was also a ton of advancement in mathematical theorems. Advancements that eventually led to the first universe models discussed here, namely, the Big Bang and Steady-State Model, were created by Fred Hoyle, Thomas Gold, and Hermann Bondi in 1948.

General Relativity

Albert Einstein is one who at first rejected a temporal universe and thought an expanding universe was absurd and unrealistic. In 1905, he created his theory of Special Relativity, which states that distance and time are relative in the sense that two observers moving at different velocities perceive time and space differently. The effects are only noticeably felt at near light speeds. The theory states that the perception of time, depending on the speed of the observer relative to an object, is known as time dilation. Time dilation has been confirmed in experiments using atomic clocks, where one is on the ground, and the other in a plane flying (http://hyperphysics.phy-astr.gsu.edu/hbase/Relativ/airtim.html#c1) Einstein's Special Theory shows that measurements of space and time are ultimately linked since a measurement of space also depends on how fast you move over a period of time, and your experience of time depends on how fast you travel through space.

Throughout the creation of SR, Einstein realised that it implies that space and time are linked, birthing a new physical entity, spacetime. *Spacetime* combines the three spatial dimensions (X, Y, and Z) with the time variable (T) in a four-dimensional continuum (X, Y, Z, CT) where C represents the speed of light. With spacetime being the fundamental component of his theory of *General Relativity* (1915), which describes gravitation in relation to mass and spacetime, he envisioned gravity as a geometric property of spacetime, one like a fabric that objects possessing mass warp with their presence. A massive body will warp the multidimensional fabric of spacetime around it, creating a depression in it. The more mass, the more the fabric will warp; and with more mass, the deeper the warp, and the stronger the gravitational force. A smaller body will travel the curved spacetime, essentially "falling" into the gravitation of the larger body. In essence, "Space tells matter where and how to move, and matter tells space where and how to curve."

It wasn't long before the theory had an opportunity to be tested. Not only did it properly account for an unexplained shift in Mercury's orbit, but it was also put on full display in an experiment run in 1919. *Sir Author Eddington* used an eclipse on May 9, 1919, to test the theory of massive bodies warping spacetime. He observed the light passing by the sun during this solar eclipse. If GR held, then there should be a star of known position in a different position due to its light bending around the sun from the curved spacetime (See below).



As you can see, the star's known location was different from its observed location, proving General Relativity to be an accurate theory of gravity.

By knowing the position of a star, and observing its position in a different location close to the sun than predicted, this offered evidence that space was bent around the sun, making it look like the star was in a different position while the light actually bent around the sun. This also meant that the laws of General Relativity are true in all locations of the universe.

Einstein realized that all mass in the universe, if no counter-acting force were present, would cause a gravitational effect throughout, and over time would cause all the matter in the universe to congeal in one single area. As each massive body exerts a gravitational force on the others, the matter in the universe would eventually blob together at a single point. Isaac Newton posited an infinite amount of matter that was equally distributed throughout an infinite space to allow for this balance. But Einstein's case was vastly different because his theory posited that all matter bent space itself, so that if the universe consisted of an infinite amount of matter, massive bodies would still cause the space to curve in on itself, eventually meeting the same blob-point end. He realized that if gravity were the only force acting, then all the matter would congeal and spacetime would contract on itself, creating a "big crunch," but nothing of the like has happened.

In response to this issue, he posited an outward pushing force of expansion to account for all the space observed between galaxies (massive bodies). This physical constant was called the "Cosmological Constant".

The Static Universe

In his 1917 paper titled "*Cosmological Considerations in the General Theory of Relativity*," he introduced the cosmological constant to explain the constant active repulsive force that countered the effects of gravity from massive bodies. In it, he argued that his equations allowed for a *static universe* if some assumptions were made. (1) The Curvature of the universe was positive (meaning like the surface of a sphere), and (2) his equations include the additional cosmological constant with a specific value to perfectly balance the gravitational force, not allowing the universe to expand or contract. He assigned a value so precise to ensure that the effects of gravity and repulsion were perfectly balanced (we will see how this value is precise shortly). His choice for the value had no empirical justification; it followed from his assumption of an eternal universe. Creating the constant with a set value allowed him to keep the universe static and eternal.

Then, in 1922, the Russian physicist *Aleksandr Friedmann* solved Einstein's field equations, but with terms that enabled the radius of the universe to change with time. The field equations allow physicists to describe the differences in the spatial configuration of the universe that would be derived from different possible distributions of mass-energy from the start. His assumption followed from Einstein's theory of gravity, mainly that massive bodies cause space to contract and change over time. Although he never attempted to explain whether or not the universe was expanding, contracting, or static (only that the status of the universe was different depending on the value of the cosmological constant), he showed that practically all values except the one Einstein chose implied a dynamic universe (dynamic here means that it changes with time, or expands/contracts). This further implied that Einstein's choice of the value made his universe ultimately fine-tuned. But even with Einstein's value, his model implied a very unstable universe that was subject to even the slightest disturbance. But in an eternal universe, such disturbances are bound to happen, and if the universe is infinitely old, those disturbances had an infinitely long time in the past to occur.

Combining Evidence with Theory

Five years later (1927), Belgian priest and physicist *Georges Lemaitre* produced the same equations that Friedmann had made, but he combined his equations with observational evidence from Vesto Slipher and Edwin Hubble. He used Slipher's Doppler shift observations of distant galaxies and correlated them with Hubble's measurements of other galaxies. With this, he implied that galaxies were receding from us, and that the further away a galaxy was, the faster its recessional velocity was. Lemaitre formulated this relationship before Hubble, although Hubble later did so with more data than Lemaitre. This recessional relationship suggested a spherical expansion in all directions.

Lemaitre not only used mathematics to suggest that space changes over time, but he also cited observational evidence to show that space is changing; in fact, it's expanding! His model implied that not just galaxies were moving away from us in space, but that space itself was expanding, and that it must have started at a single point that he called the "Primeval Atom".

> “At some point in the past… the distance between neighboring galaxies must have been zero. (Hawking, *A Brief History of Time*, Pg 49)"

Einstein had a Bone to Pick

Einstein expressed disagreement with Friedmann and Lemaitre's solutions to his field equations, at first claiming them as not actually satisfy the equations. He saw Lameître's hypothesis as "inspired by the Christian dogma of creation, and totally unjustified from the physical point of view. (Luminet, Lameître’s Big Bang, P 10)." But his mind began to slowly change, and in 1927, he saw the redshift evidence from Lameître in a cab ride at the Solvay Conference. In 1930, Sir Arthur Eddington also informed him of the observational data, introducing him to Hubble's 1929 paper establishing Hubble's Constant during a visit to the University of Cambridge. Eddington also showed him how the value of the cosmological constant and the curvature of the universe needed to be extremely fine-tuned for the universe not to expand forever or result in a "big crunch."

In 1931, Einstein visited Hubble's Mt. Wilson 2.5-m telescope, where he saw first-hand the evidence of the expanding universe. After this visitation, he publicly announced his recognition of a cosmological beginning. He later admitted that his choice of a static universe was "the biggest blunder of my life."

The Steady-State Model

During the 20th century, cosmologists were creating alternative theories to the Big Bang. Most of which were made for the sole purpose of philosophical reasons that came from a materialist worldview. An infinitely old universe would completely annihilate the requirement of understanding its origins. They needed an eternal universe because the Big Bang theory implied that the universe was caused by something outside of space, time, and mass-energy, and naturalism had nothing to posit except space, time, and mass-energy. In 1948, *Fred Hoyle*, *Thomas Gold*, and *Hermann Bondi* created the Steady-State Model to explain the expansion without implying a beginning. Since red shift evidence supported universe expansion, they posited that the universe would endlessly double in size, and since doubling an infinite generates another infinite, there would be no change to the measurable dimensions of the universe (Meyer, *Return of the God Hypothesis*, Pg 98). If the universe has some field that endlessly generates new mass-energy into the expanding space, keeping matter equally distributed, it would eliminate the need for a beginning.

But where does this matter originate? Hoyle postulated a creation field (C-field) that created new matter. His justification was arbitrarily creating a new fundamental physical principle that the universe must *always* remain at a constant density. The C-field was seen as a vast reservoir of negative energy that existed alongside the eternal, self-existent universe.

Here Lies "Steady-State Model": The Cosmic Background Radiation

For the remainder of the early 60s, the Steady-state Model remained the favored theory for most physicists. Then, at the halfway mark, in 1965, *Arno Penzias* and *Robert Wilson* made a discovery that killed it. The Big Bang theory predicted a low-energy background radiation throughout the entire universe. This was due to the extremely dense mass-energy shortly after the beginning of the universe would have radiated electromagnetic energy throughout the universe at that stage, essentially leaving behind a flash from the big bang that would still be dissipating.

In 1948, *Robert Herman* and *Ralph Alpher* predicted this radiation: As the universe expanded and cooled to the point that electrons could attain stable orbits around protons and neutrons, allowing for light to freely travel without being redirected by electrons in the *Plasma State*. This would have bathed the early universe in light traveling in every direction. The continuing expansion of space would have stretched this light's wavelength to the far end of the electromagnetic spectrum, namely the microwave portion at 1mm wavelength. They also calculated that the temperature from the blackbody of the mass-energy from the plasma state based on the Big Bang model is only a few kelvin above absolute zero in the present, at 5 kelvin. They did this by dividing the temperature of the universe at that time when light could first travel, 3000, by the expansion rate of the universe at 550 times. This gave them a temperature for the cosmic background radiation today at about 5 kelvin (Myer, *Return of the God Hypothesis*, Pg 100-101).

In 1964, Penzias and Wilson were unable to get rid of some radio static in their antenna at the Bell Telephone Laboratories in New Jersey. They had this constant hum that was in every part of the night sky. They had no way to identify and avoid the low-frequency hum. A physicist proposed that they were not experiencing an antenna fault, but detecting residual background radiation from the universe's beginning. They discovered the Big Bang Model predicted Cosmic Background radiation! They won the Nobel Prize in 1978 for their discovery. There were then later confirmations of the radiation from the Cosmic Background Explorer Satellite launched in 1989 and the Planck Space Observatory launched in 2009. For many scientists, this evidence confirmed the belief in a temporal universe.

J. Warner Wallace gives us a helpful analogy for understanding the Cosmic Background Radiation:

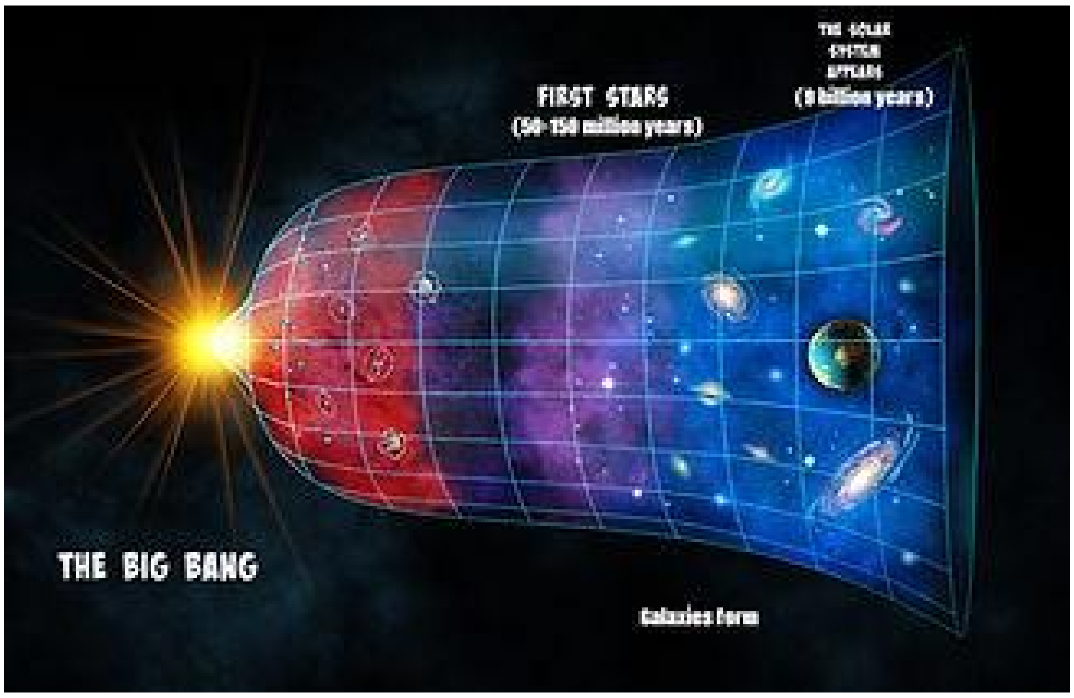
> “We employed a “flash-bang” grenade in nearly all these SWAT entries. The grenades are designed, of course, to 'flash' and 'bang'; they make a lot of noise, light, and heat. We typically threw a grenade in the room where the suspect was barricaded (usually through a window). When the grenade hit the ground, it exploded violently, lighting the room, deafening the suspect, and filling the space with debris and heat. In that instant, as the suspect was distracted, our team came in from the opposite corner. Flashbangs are excellent distraction devices because they leave a lingering impact in the space where they are deployed. (Wallace, *God’s Crime Scene*, Pg 36)"

If the universe began, expanding from an initial state of tremendous heat, density, expansion, and extreme spacetime curvature, we should expect to find evidence of the temperature that experienced expansion in the form of the low-temperature blackbody predicted by Herman and Alpher. Steady-state proponents soon admitted that their model had no prediction of this detected energy, but there were more issues. The Steady-state Model predicted that galaxies should be observed in various ages, from young to old, but no such young galaxies have ever been observed. By the 1970s, the theory was dead in the water and buried with a gravestone that reads, "Here Lies 'Steady-State Model'".

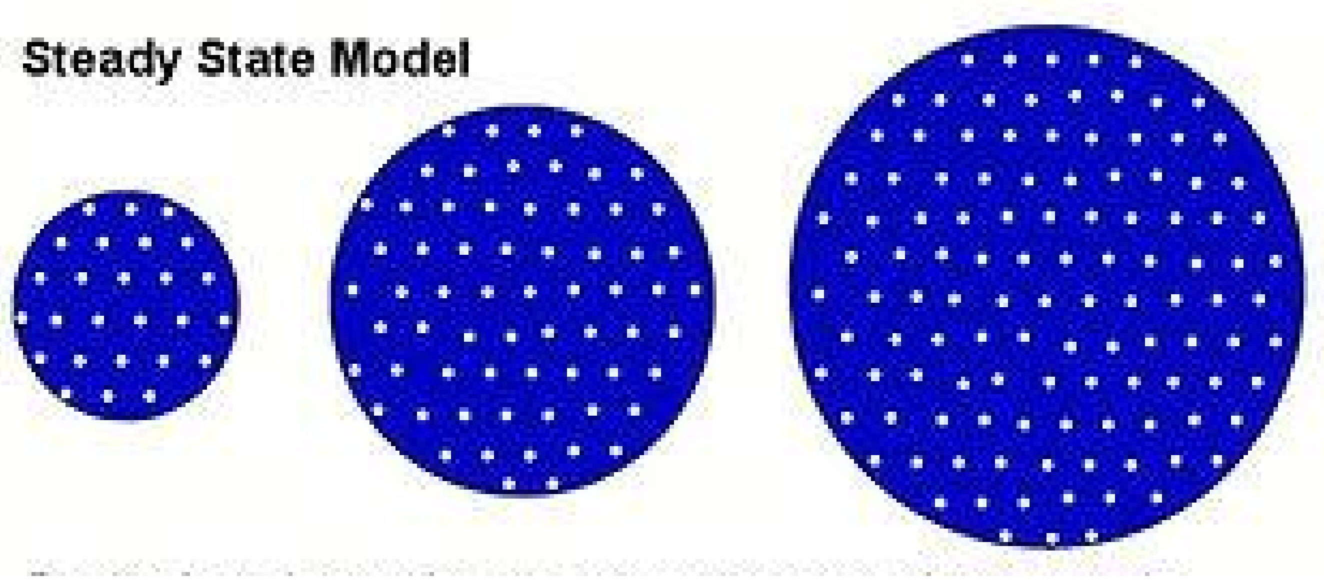
The Oscillating-Universe Model

After the demise of the Steady-state Model, physicists began proposing an Oscillating-universe Model as another alternative to the Big Bang. This theory proposed a universe that would expand, decelerate expansion, shrink under gravitational force, and then, by some unknown mechanism, begin its expansion again on repeat for eternity. Now, we have three competing models for the state of the universe.

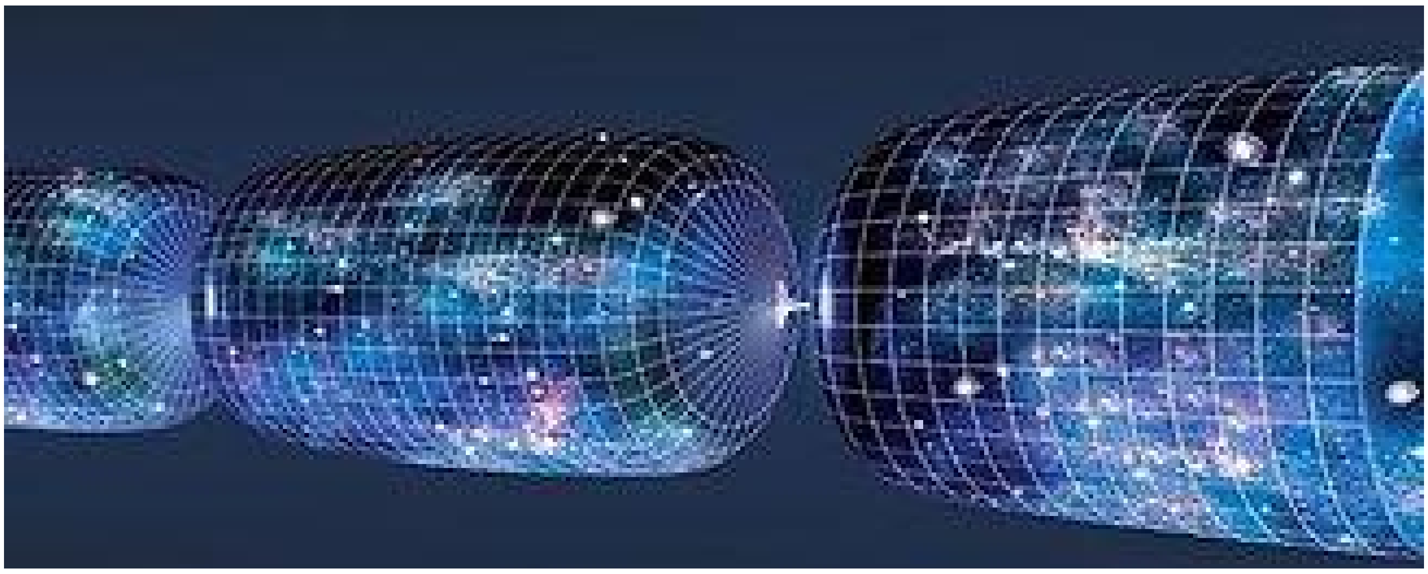
1. The Big Bang: The universe began, and it is expanding.



2. The Steady-state: The universe is expanding eternally, but also eternally creating new matter.



3. The Oscillating-Universe: The universe goes through an infinite number of cycles of expansion and contraction.



The death of the Oscillating-Universe Model

Proponents of this theory were ultimately unable to create a mechanism that would cause the expansion to restart after gravitational collapse. Nowadays, there are "bounce theories" that invoke mechanisms with absolutely no empirical or epistemic justification. They also violate the null energy condition, implying instabilities from each bounce (Diana Battefield and Patrick Peter*, A Critical Review of Classic Bouncing Cosmologies*, Physics Report (Elsevier B.V., April 1, 2015); cited in Myer, Return of the God Hypothesis, Pg 467-468 n.53). It also ran into difficulties with the 2nd Law of Thermodynamics. *Alan Guth* showed that with each cycle of oscillation, the entropy of matter and energy would increase. This results in less usable energy available to perform work with each cycle, and causes longer and longer periods of oscillation from the inhomogeneities in mass-energy distributions, affecting the efficiency of the gravitational force to cause contraction as expansion decelerates. This means each previous oscillation would be shorter and shorter in duration, and it cannot decrease *ad infinitum*. You're still left with the implications of a beginning.

To make matters worse, as the universe expands and contracts more and more for an infinite time, all the energy in the universe would reach thermodynamic equilibrium and be completely randomized, leaving only heat energy and none to perform work, known as the "Heat Death". Modern measurements have discovered that the universe's mass density is actually less than the needed density to overcome expansion and cause it to stop, laying another bullet in our buddy Osci. The expansion may also be the result of what physicists call today, *dark energy,* which seems to permeate all space and exert outward pressure on it.

One of the Last Hurdles

For the most part, the Big Bang seemed to have won the battle, coming out as the favored theory for the origin of the universe. Also, for the most part, it seemed to have one last big issue. For galaxies to begin to form, the mass-energy after the Big Bang must have had slight fluctuations in its density. This flowed from the observed space between galaxies. These fluctuations would affect the background radiation, as different densities of mass-energy would exhibit different wavelengths emitted from the different regions of the energy in the universe. This is why the Big Bang implies slight variations in the cosmic background radiation. In 1989, when NASA launched the Cosmic Background Radiation Explorer Satellite, did they measure the background radiation, suspended above the noisy atmosphere humanity dominated, and discover the predicted variations in its density that previous ground scans were unable to detect. This evidence cleared one of the last issues with the Big Bang model, solidifying it as the favored theory of a temporal universe.

The Singularity Theorems

In the 1960s, while *Stephen Hawking* was conducting his PhD research, he ran into the work of a physicist, *Roger Penrose*. Penrose was working out the physics of blackholes, areas where the mass is so densely packed by gravitational force that not even light can escape its effects. The mass of a black hole is so strong that it curves spacetime into an enclosed region of space, with such gravitational effects that not even light can escape.

Fun Fact: Depictions of black holes display a black spherical center. This black sphere is not the actual black hole itself, but a region called the *event horizon*. This is the point around the black hole where the gravitational attraction is so strong that light cannot escape, hence the entire region appears black, because no light can escape that region. For us to see the black hole itself, light would have to bounce off its surface, but if no light can escape the event horizon, then all we can see is a black area of space due to the absence of light reflection beyond that point.

Hawking began analyzing his work and realized something about the past status of the universe. At every single point in the past, the mass of the universe would become smaller and smaller. Extrapolating further back, the curvature of space would approach an infinitely tight spatial volume that corresponds to zero volume. This zero-volume area is called a *singularity,* where the laws of physics break down, and where the universe would have begun its initial expansion. In his PhD thesis, Hawking had a chapter about the implications of General relativity and the expanding universe, also providing mathematical proof for the singularity at the beginning of the universe. He showed that any time or light-like path between 2 points in the expanding universe would necessarily terminate at some finite point in the past (Hawking, *Properties of Expanding Universes*, Pg 105).

During the late 60s and 70s, Hawking, Penrose, and *George Ellis* published some papers that made implications for the beginning of the universe from General Relativity. Their solutions to Einstein's field equations implied a singularity at the beginning of the universe, where the matter density and curvature would approach an infinite value.

The Hawking-Penrose-Ellis Model

Friedmann's previous solutions for a dynamic universe also implied a singularity at the beginning of the universe, but he did so by assuming the mass-energy distribution was completely homogeneous; in other words, the distribution of mass-energy was the same in all directions, and looked the same in all directions. But for galaxies to form, the initial distribution needed slight differences in its density. Then came the big three. Hawking, Penrose, and Ellis solved Einstein's field equations without assuming perfect homogeneity of mass-energy distribution. In doing so, they showed that given General Relativity, the universe began in a spacetime singularity.

As the universe expands, space flattens, and the curvature approaches zero; but in the reverse direction of time, the curvature increases, and as the distances between any 2 points also decrease, the curvature approaches an infinite value, and the distance between any 2 points approaches zero. Hence, the infinite curvature corresponds to zero spatial volume. Also, if the curvature of space approaches an infinite value, and the volume approaches zero, time would approach a zero value too.

How Much Can We Put Where and When?

In 1978, *Paul Davies* described the spacetime singularity like this:

> “If we extrapolate this prediction to its extreme, we reach a point when all distances in the universe have shrunk to zero. An initial cosmological singularity therefore forms a past temporal extremity to the universe. We cannot continue physical reasoning, or even the concept of spacetime, through such an extremity. For this reason most cosmologists think of the initial singularity as the beginning of the universe. On this view the big bang represents the creation event; the creation not only of all the matter and energy in the universe, but also of space-time itself. (Davies, *Spacetime Singularities in Cosmology*, 78-79)"

An infinitely tight space corresponds to zero spatial volume. The singularity theorems do not allow one to posit prior mass-energy or gravitational fields as an eternal entity since neither space nor time existed beforehand. It implies that energy and matter first arose at the beginning, along with space and time, although the actual point of creation is not described by current physics.

Inflationary Cosmology

During the 1980s, Alan Guth, *Andrei Linde*, and *Paul Steinhardt* developed a theory they called *Inflationary Cosmology*. Initially created to explain the homogeneity of mass-energy in the universe. It posits that soon after the Big Bang, the universe experienced a short, rapid expansion due to negative gravitational energy from a proposed *inflaton field*. It asserted that space rapidly expanded within fractions of a second after the Big Bang for a brief period of time (Alan Guth, *Inflationary Universe*).

Due to Quantum Field theory, many thought this field would be subject to quantum fluctuations, random fluctuations in its local energy density that would necessarily produce causally separate regions of space called *bubble universes*. After an expansion of space occurs, a quantum fluctuation causes it to decay locally and create a bubble universe, but since the field itself is eternally expanding, the bubble universes will continue to expand slightly and produce other regions in the field for other universes to inhabit as the fluctuations cause other regions to decay. This form of the theory is called *Eternal Chaotic Inflation*.

Eternal Chaotic Inflationary Violations

Proponents imagined the inflaton field being effective eternally into the past as well as into the future, creating an infinite array of bubble universes. Since the space outside the universes continues to expand faster than the bubble universes, they practically never make contact with each other and are thus undetectable from within one of them. Inflationary cosmological models all affirm quantum fluctuations as the prime mechanism to produce universes, but these models also include violations of various energy conditions required for singularity theorems to hold. Some quantum fluctuations would result in negative mass-energy densities for universes, which violates the *Strong Energy Condition* of General Relativity.

But Why Inflation?

The inflationary theory was first created to explain the homogeneity of the universe. This means that the universe has roughly the same matter distribution in all locations, mainly from the uniform temperature of the cosmic background radiation, which exhibits fluctuations so faint as to 1 part in 100,000 (LAMBDA - Cosmic Background Explorer). This was only an issue for the Big Bang model unless very finely tuned initial conditions were posited. Some people are misinformed that inflationary theory is required for the Big Bang model, but it can be explained by the Big Bang by postulating that the universe had nearly perfect uniformity in temperature and mass-energy distribution in the plasma state. But inflationary cosmologists do not attempt to explain homogeneity on initial conditions, as that would beg intelligent design of the universe. Instead, it postulates an early, rapid rate of expansion that smoothes out the distribution via an exponentially fast rate and a sudden stop at just the right time. Because of this, any remnants of the beginning of the universe would have been pushed far beyond the edge of the observable universe.

This expansion explained the observed flatness of the universe. *Flatness* means that space would have no curvature, so that two parallel lines would never converge or diverge, but remain next to each other. Our universe is relatively flat because its expansion has barely overcome the gravitational attraction produced by the mass-energy density. Today, physicists believe our universe has a mass density slightly lower than the critical mass required to cause gravity to overcome expansion and stop it. Nonetheless, gravity would still cause the universe to be slightly curved, just so that any small section of it would seem relatively flat (like a small section of land on the Earth). Inflation also seemed to explain the absence of *Monopoles*, particles that would act as magnets but with only one pole instead of two. How so? By claiming inflation pushed the evidence far beyond an observable distance.

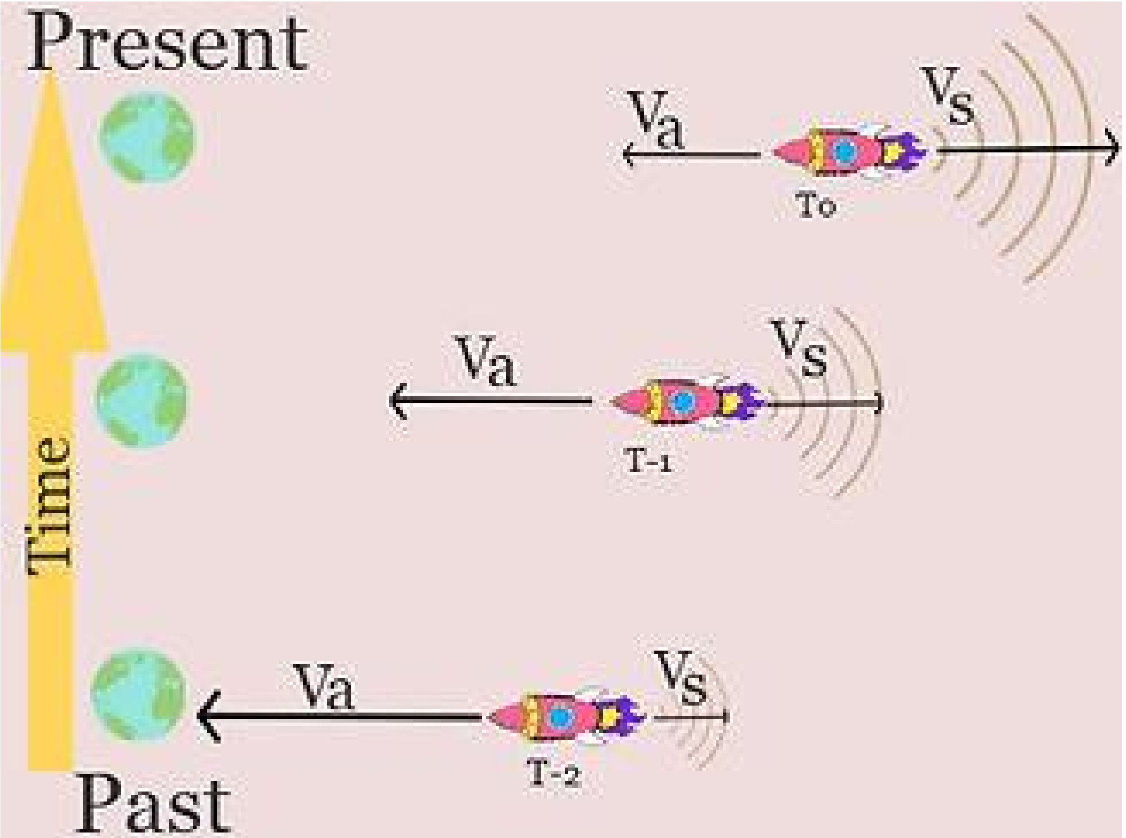
The BGV Theorem, and the Death of Eternal Inflationary Cosmology

By the 90s, Inflationary Cosmology dominated the fields. It was the best model for the origin of the universe, and nobody could make a refutation to it. But then came a group that created just that, a theory that led to another proof of the temporal universe. The best part is, it holds even if the inflationary theory is correct.

The popularity of inflationary cosmology motivated physicists *Arvind Borde* and Alexander Vilenkin to attempt to see what inflation implied about the universe. If the universe really could be "past eternal". They were later joined by Alan Guth, and soon came to a sobering conclusion. Instead of attempting based on General Relativity, they did so on the grounds of Special Relativity. In 2003, Borde, Guth, and Vilenkin created a theory for the beginning of the universe that did not lean on any energy conditions or singularities.

> “A remarkable thing about this theorem is its swapping generality. We made no assumptions about the material content of the universe. We did not even assume that gravity is described by Einstein’s equations. So, if Einstein's gravity requires some modification, our conclusion will still hold. The only assumption that we made was that the expansion rate of the universe never gets below some nonzero value, no matter how small. (Vilenkin, Many Worlds in One, Pg 175)"

The BGV Theorem states that "any universe that is on average expanding is past incomplete. Before I explain the theory, let me sum it up in simple terms for the layman. Simply, the theory states that if any universe is expanding, as time is extrapolated backward, all matter and energy within the expansion will eventually reach a velocity limit, the speed of light, marking the beginning of the expansion because it would be impossible to extrapolate back any further.



As time advances, the apparent velocity of the ship (V_a) decreases due to the velocity of the expanding space around the ship (V_s) increasing. As time decreases (T), the recessional velocity of the space around the ship (V_s) decreases; consequently, the apparent velocity of the ship (V_a) increases. If we were to continue to extrapolate backward, the apparent velocity of the ship (V_a) would eventually reach the speed of light, marking the start of the expansion and the beginning of the universe.

If a spaceship were moving towards Earth, it would appear to move more slowly than it would if the universe were not expanding. If the spaceship continues to fly at a constant velocity, the spaceship will appear to be moving slower and slower as time progresses due to the space around the spaceship expanding at a faster and faster rate, and the space between the ship and Earth expanding. For example, on an expanding balloon, as objects on its surface draw further and further apart, they recede faster and faster from each other as the surface of the balloon grows. As we extrapolate time backward, the velocity of the expansion of space will decrease around the ship, resulting in the apparent velocity from Earth observed as increasing (due to the space around and between contracting). The recessional velocity of space would have been greater in the past. This means that as time is extrapolated back, the apparent velocity of any object increases; eventually, this velocity would reach the speed of light, the universal speed limit for anything containing mass. At this point, no back extrapolations could continue, implying that the universe must have had a beginning to its expansion.

To sum it up in other words, in an expanding universe, the further one follows the path of an object back in time, the greater its apparent velocity would have been relative to an observer. But according to Special Relativity, an object in any frame of reference cannot exceed the speed of light. So if we extrapolate time back, objects relative to an observer would have reached this limit at some point in the past, at which point no further back extrapolations can be done. This would necessarily represent the beginning of the path of any matter or energy and mark the beginning of expansion.

The Eternal Burp

Borde, Guth, and Vilenkin (Who the BGV Theorem is named after) showed the world that all cosmological models featuring an expanding universe, whether that be the multiverse, inflation, steady-state, or oscillating models, are subject to the BGV theorem.

> "With the proof now in place, cosmologists can no longer hide behind the possibility of a past-eternal universe. There is no escape; they have to face the problem of a cosmic beginning. (Vilenkin, Many Worlds in One, Pg 176, Quoted in Meyer, Return of the God Hypothesis, Pg 128)"

Nowadays, cosmologists look towards quantum cosmological models to explain the eternal universe, but that is a topic for the coming articles. We shall discuss in more detail Inflationary Cosmology, String Theory, and finally Quantum theories for the origin of the universe, and whether they can claim an eternal universe.

The Big Size Limitation

Now, before we conclude, I must mention one last very important fact before we continue to other areas. All singularity models presuppose General Relativity as the most accurate theory for describing gravity.

But general Relativity poses one issue: these models can really only go backwards so far. As far as when the universe had a spacetime curvature of 10^{-12} to 10^{-33} cm in diameter. At this unimaginably small size, General Relativity breaks down, and another theory has to be used, called Quantum Physics. At this small size, quantum phenomena dominate, and cosmologists have to develop models analogous to phenomena found in quantum physics to explain the state of the universe before this period, before the singularity.

Philosophical Evidence: Infinite Regress

As mentioned briefly in the previous article, there are some philosophical issues with an eternally existent universe. From here, I refer you to the discussion of potential and actual infinites from the previous article on the Kalam Cosmological argument. Potential infinities are one thing, that being an ideal limit to a continuous set. Like a man counting from one and continuing to do so for an infinite time. He will count and approach that ideal limit of infinity, but he will never actually reach it. Now we come to actual infinites, that being infinites that actually exist. An example of an actual infinite is the number of numbers in the whole number set. There is an actually infinite number of numbers in the set, but actual infinites existing in the material, natural world is an entirely different thing. Actual infinities result in absurdities.

If I have a chest full of an infinite number of lollipops, and I have to give away one lollipop to every person on Earth, how many would I have left? An infinite number of lollipops are still in my chest. Moreover, if the candy government taxes 33% of my lollipops, how many do I have left after 1/3 is removed? Still, an infinite number remains. Here's a better example, in the set of whole numbers, which has an infinite number of numbers in it, how many odd numbers are contained in it? An infinite number of odd numbers are within the whole number set. How many prime numbers are there? An infinite number of prime numbers. J. Warner Wallace offers a useful explanation: you are about to begin a race, and before the race begins, you are told to move your starting line back a foot. Before the race starts again, you are told to move your line back a foot. If this continues forever, will you ever reach the finish line? Without a beginning, you will never have an opportunity to finish. If the universe never began, today would never terminate.

Thermodynamic Evidence of a Beginning

Not only does an infinitely old universe result in logical absurdities, but the idea also violates thermodynamics. Namely, the second law of thermodynamics. The quantity of energy in a closed, isolated system remains constant while the amount of usable energy to perform work deteriorates as time advances. The amount of entropy in a system will increase over time, or disorder. This means that if the universe were infinitely old, then the amount of usable energy would have run out an infinitely long time ago, which is an absurd thought, and has obviously not happened. Better yet, unless fed from an outside source, the energy in the universe would even out, be randomized, and reach equilibrium in temperature, energy, and disorder.

Imagine you stumble across a cabin while hiking with your friends. You guys walk up the porch steps (what remains of them) and approach the door. The door is just on its hinges, and as your buddy knocks it over, you all see an old, broken-down kitchen with a table. On the table is a cup of hot tea, and on the floor is a wind-up easter chick, still bounding and ticking about. You would almost immediately deduce that the tea was just recently made, and the toy was just wound up by another person, before you knocked the door off its hinges. The fact that the universe still contains usable energy and is not a large sludge of heat hints at the reality that the universe had a beginning. Moreover, models like the Steady-state Model violate the first law of thermodynamics, which states that mass-energy is not being created, nor annihilated, but transferring its form and usability.

Conclusion of Chapter 2

As we have seen, major developments in astronomy, cosmology, and mathematics all offered hard evidence that the universe was, in fact, not eternal, nor infinite in time or space. With the spacetime curvature of a singularity approaching an infinite value corresponding to zero spatial volume, the universe essentially did begin at this point, with matter and energy arising alongside space and time. For where can we put something if there's no space to put it? Indeed, if singularity theorems do not enable one to posit a material state prior to the singularity, then the cause of such cannot be within it. It seems, at least to me, that this cause must have been transcendent to space, time, and mass-energy. It must be a spaceless, timeless, self-existent, all-powerful, intelligent cause to be at least adequate to explain the universe in the first place! How can a material state exist before any material state? If the universe remained at this material state for an infinite age, why did it not cause a universe at any point before when it did if it existed in a material state that is causally adequate for the universe to come into existence for an infinite amount of time beforehand? Jeese! All of this infinity babble is making my brain cramp!

Moreover, the cause must also be personal, for reasons to be stated in a future article, but for now, I can say that to go from a state of non-creation to creation requires a choice to be made. And if there was a personal mind before the universe, it very well could have chosen to create this universe that we see today. Might I also say that this does not really get us to the Christian God; rather, that comes with a thorough investigation of the historical reliability of the crucifixion and resurrection of Jesus Christ. At least for now, we can confidently say, some personal cause with the attributes of the Biblical God is causally adequate to explain the universe we observe today.

"In the beginning, God created the heavens and the earth. (Genesis 1:1)"

"And when you look up to the sky and see the sun, the moon, and the stars—all the heavenly array—do not be enticed into bowing down to them and worshiping things the LORD your God has apportioned to all the nations under heaven. (Deuteronomy 4:19)"

"He sits enthroned above the circle of the earth, and its people are like grasshoppers. He stretches out the heavens like a canopy, and spreads them out like a tent to live in. (Isaiah 40:22)"

"Behold, he is coming with clouds, and every eye will see him, even they who pierced him. And all the tribes of the earth will mourn because of him. Even so, Amen. (Revelation 1:7)"

Now What?

We can now say with high confidence that the second premise of the Kalam Cosmological Argument is true. That being that the universe began. By looking at the discoveries of modern science, we see how the universe would have indeed began at a single point with no volume, a singularity.

Continuing, we will now look at an area of physics called the “fine-tuning parameters”, which are specific values found in natural laws that exhibit extreme fine-tuning, with many of them only able to change their current values a small fraction before life in the universe as we know it is impossible. In doing so, we can then begin to lay out the nature of the cause that left the effect of the universe.

Chapter 3

Is Our Universe Fine-Tuned for the Existence of Life?

Did the cause of the universe have a desire for life?

In the previous articles, we have established the various scientific, philosophical, and mathematical discoveries that confirmed the notion that the universe had a beginning. If we are going to tackle the question of whether a personal God was the cause of that beginning or not, we must look at an area of discoveries in physics called the fine-tuning parameters of the universe. Cosmologists, Physicists, and mathematicians alike have all discovered that various laws in physics exhibit fine-tuned values within their logical structure. Not only are the laws themselves fine-tuned, but their relationships to one another all lie within extremely specific and improbable values, values we would not expect if everything happened randomly. So, let's now dive into some of the history of these discoveries, and their implications regarding a transcendent intelligence.

The Fine-Tuning Required for Life's Most Essential Element

Since the 1950s, physicists have come upon the brute fact that life in the universe depends on a very improbable set of forces and mass-energy distribution. It was Fred Hoyle who researched theories attempting to describe nuclear reactions inside stars. He was specifically looking for a way that hydrogen would fuse into the elements on our periodic table. He was a stark atheist when he started his research:

> “Religion is but a desperate attempt to find an escape from the truly dreadful situation in which we find ourselves.” (Hoyle, *Our Truly Dreadful Situation*, 1948, Harper's Magazine)

It was Hoyle who coined the name "Big Bang" to the emerging theory of cosmic expansion and an absolute beginning. He did this to poke fun at the idea of a beginning to the universe, which motivated him to create his *Steady-State Theory* mentioned in the previous article, *Did the Universe Have a Beginning?* But Hoyle also played a big role in the discovery that the properties of the universe fall within improbable ranges that are necessary for the development of life. The magnitudes and strengths of various forces, along with the initial distribution of mass-energy at the beginning, seem to be balanced on a knife-edge to allow life to thrive. Each fundamental law or force has just the right strength, and all the energy was perfectly distributed in just the right arrangement to allow stable galaxies and stars to form, heavy elements to be created, and ultimately for Earth to be the outcome with life.

The Fine-Tuning Required to Produce Carbon

Carbon is the most crucial and fundamental element for the existence of life. Its atomic structure makes bonds with other elements the best out of the rest. Carbon dioxide is also a gas, making it easy to dispel as waste, and it plays a key role as the central atomic structure of many biomolecules, out of which all life is created. It can also form long, stable chain-like molecules that can store information (DNA & RNA). Hoyle knew that the universe contained an abundance of carbon (Burbidge, E. M., Burbidge, G. R., Fowler, W. A., & Hoyle, F. 1957, *Synthesis of the elements in stars*. Reviews of Modern Physics, 29(4), Pg 547–650). The theory at the time was that protons and neutrons collided inside stars to produce heavier elements, but most models predicted the expected amounts of lighter elements, and not the expected amounts of heavier elements.

Fusing elements inside stars meant they had to pass atomic structures with five protons and neutrons in the nuclei, but these structures are very unstable and would not last long enough for another collision to happen and continue the process. This block was named the

"5-nucleon crevasse." 5 nucleon atoms have half-lives of $1/10^{24}$th of a second; thus, most theorists were stumped at finding a way for elements to pass through this barrier. *George Gamow* and *Ralph Alpher* envisioned three helium atoms (2 protons and neutrons each) colliding to make carbon-12, the most common form of carbon found (6 protons and neutrons), but rejected their model due to the implausibility of this type of collision occurring inside stars. But Hoyle cooked up a method that solved the issue, though a bit trivial at first. Hoyle imagined a helium nucleus colliding with beryllium-8 to form carbon-12; (2p and 2n) + (4p and 4n) = (6p and 6n). He chose beryllium because (1) it had the right amount of nucleons, and (2), despite it also being unstable, it has a half-life just long enough to continue making collisions to produce carbon.

Then he ran into another barrier, the total energy of this carbon exceeded the total energy of the common carbon-12. This means there must be a form of carbon with this energy level for his theory to be correct. He calculated the total energy of the helium and beryllium to be more than the ground energy state of carbon-12. Later on, he would visit the *Kellogg Laboratory at Caltech* and have a physicist's experiment to see if this form of carbon existed. Though resistant and skeptical at first, *Willy Fowler* would discover a form of carbon that had the exact energy that Hoyle predicted (Meyer, *Return of the God Hypothesis*, Pg 135). But this had some implications now that it was confirmed; It meant that this form of carbon had to have this exact energy level, or heavier elements would not develop, and neither would life.

> “The resonance levels of different elements are a consequence of many factors and can be calculated using equations of quantum chromodynamics, a subdiscipline of quantum mechanics. Thus, the resonance levels of carbon would have been different if different factors had been in play. And if those resonance levels had been different, then beryllium-8 and helium-4 could not have combined to form carbon-12” (Meyer, *Return of the God Hypothesis,* Pg 135)

This means that there are specific physical parameters that, if otherwise, would prevent the heavier elements from being manufactured in stars, along with Earth and life later developing. Fred Hoyle's recognition of this motivated him to do more research on the conditions required to produce his form of carbon. He formed a theory that collapsing stars can make carbon from the lighter elements under particular conditions, once those conditions are met. But creating this theory just created more questions and dug the fine-tuning hole another foot deeper.

The Fine-Tuning Parameters

Hoyle's model for how carbon could be produced by collapsing stars revealed some fine-tuned physical laws and forces that are responsible for the energy levels of helium, carbon, and beryllium. There are four fundamental forces in nature:

1. **The Electromagnetic Force**: This force causes particles with opposite charges to be attracted to one another and repels those with the same charge.
2. **The Weak Nuclear Force (WNF)**: This force causes nuclear radiation, which is the decay of atoms, releasing energy.
3. **The Strong Nuclear Force (SNF)**: The attractive force that binds quarks into protons and neutrons into the nucleus of the atom.
4. **Gravitational Force**: This force acts on macro-scale objects to form the larger universe, with planets, stars, and galaxies.

The strength of the electromagnetic force and the SNF must be balanced with each other. Inside the nucleus of an atom, protons are about ten-trillionths of a centimeter apart, and with the electromagnetic force acting, the repulsion between the like-charged protons is about 24,000,000 dynes of force. The average man can punch about 2,400 newtons of force. 24,000,000 dynes, which only comes out to about 250 newtons, is an immense force applied to such small particles. This repulsive force packs enough punch to send both particles in opposing directions near light speed. There is something neutralizing the force of electromagnetism, overcoming it, but it must be incredibly strong to overcome the force, and it must rapidly disperse with distance, being only detectable smaller than that ten-trillionths of a centimeter. The SNF must have a precise strength to balance the electrostatic repulsion.

If the strength or magnitude of the force were changed slightly, the protons wouldn't be able to form stable atomic nuclei; moreover, the mass of the types of quarks (sub-atomic particles that make up protons and neutrons) fit together to produce protons and neutrons with just the right mass and energy. Recent calculations reveal that the SNF and electromagnetic force are specifically fine-tuned within about .5% their current values (Csoto, Oberhummer, and Schlattl, *Fine-Tuning the Basic Forces of Nature Through the Triple-Alpha Process in Red Giant Stars*).

The Fine-Tuning of the Quark

The charges of up-quarks and down-quarks are heavily fine-tuned to allow stable atomic nuclei to form. There are six types of quarks: Up, Top, Charm, Down, Strange, and Bottom. But the up and down quarks are what make up protons and neutrons, which make up the atomic nucleus. For ease of understanding, I will use the charge of an electron as a comparison to the charge of the quarks. This way makes it easier to see how perfect these charge values are. The Up quark has a charge of $+\frac{2}{3}$ of an electron, and the Down has $-\frac{1}{3}$ of an electron. Now, when up and down quarks combine to form a Neutron, one up and two Down quarks combine. This means the charge combination can be written as:

Up($+\frac{2}{3}$) + Down($-\frac{1}{3}$) + Down($-\frac{1}{3}$)

This can be simplified to:

$\frac{2}{3} - \frac{2}{3} = 0$

And this is why a neutron has a 0 charge; its charge value is 0 compared to that of an electron. Now, let's say we want to make a proton, which takes one down and two up quarks to combine. The combination can be written as:

Up($-\frac{1}{3}$) + Down($+\frac{2}{3}$) + Down($+\frac{2}{3}$)

Which may be simplified to:

$(-\frac{1}{3}) + \frac{4}{3} = 1$

This is why the proton is said to have a positive charge; it has a charge of +1 electron. If these charge values were to change, protons and neutrons could not form, and by and large, neither will atoms. Not only are the charges fine-tuned, but their masses are as well. The range for these possible mass values extends between zero and the Planck Mass, which equals about .002 milligrams. The mass of the up quark must have a mass between zero and 10^{-9} of the Planck Mass, which corresponds to a fine-tuning of 1 part in 10^{21}. The mass of the down quark is 3.9×10^{-22} of the Planck Mass, making its fine-tuning 1 part in 10^{22}. Thus, for Hoyle's form of carbon to be produced, multiple layers of fine-tuning must be met, layers that are individually implausible given their possible values. 10^{22} is a very large number, one that the human mind cannot even imagine. When scientific notation is used, the exponent represents how many zeros follow or precede the number it's applied to. For example, 10^{6} is the number 1 followed by six zeros, or 6,000,000. So 10^{22} is 10,000,000,000,000,000,000,000. If a number written in scientific notation has a negative exponent, the zeros precede the number, for example, 3×10^{-3} is .0003. Hopefully, this illuminates the sheer size and implausibility of these numbers.

For helium and beryllium to gain enough kinetic energy (a measure of particle movement) to produce carbon-12, the strength of the gravitational force must be its precise value. The kinetic energy gained enabled helium and beryllium to overcome the sheer electromagnetic repulsion they experience, and this varies with the temperature inside stars. The ability of a star to produce extreme temperatures is heavily dependent on the specific strength of gravity. If the gravitational force were weaker, stars would not burn hot enough to produce the kinetic energy required to produce carbon, and if it were stronger, stars would only be able to produce heavy elements, burning up too fast, resulting in a different ratio of elements in the universe.

Physicists have discovered that the value of the gravitational constant (G) is fine-tuned to 1 part in 10^{35} in relation to the possible values it could have had. The value of G is 10^{40} times weaker than the SNF, and assuming that the SNF represents a maximum for the possible strengths of G, it could have had a value anywhere between 0 and 10^{40} times its current value. This means if the value were to change in either direction, 1 part in 10^{35} - 10^{40}, its current value, say goodbye to the ordered large-scale universe.

Finely-Tuned Laws and Constants

It is, nowadays, rather undisputed whether the laws of physics are fine-tuned for the allowance of life on Earth. Both the laws of Physics and Chemistry are exquisitely fine-tuned, but what does that mean? The constants in the laws themselves are what are fine-tuned. In *A Fortunate Universe*, authors Lewis and Barnes list the leading physicists like John Barrow, Bernard Carr, Paul Davies, Stephen Hawking, George Ellis, Alan Guth, and more who all affirm the appearance of fine-tuning. Stephen Meyers says that the list was generally split between theists and non-theists, with the theists mainly disagreeing with multiverse models from the non-theists (Meyer, *Return of the God Hypothesis*).

Variable Quantity: A quantity that can change its value depending on the situation's context.

The laws of physics are used to relate a variable quantity to another. For example, a variable (Force) begins to increase in a car as I press the gas pedal; another variable(like velocity and acceleration) will also increase or change proportionally by some factor. In this case, applying more force to the car caused its acceleration to increase proportionally to the applied force. These relationships can be proportional (as one increases, the other increases) or inversely proportional (as one increases, the other decreases). Within these equations that describe forces and fields, resides a constant, or a physical quantity that is unchanging and discoverable through measurement and experimentation, and always remains the same in every context. For example, if the gravitational constant (G) were increased, your mass on Earth would remain the same, but the strength of gravitation would increase, and you may struggle to walk, and any large increase would make it difficult to stay alive.

These constants have values that are very unlikely given the vast range of possible values they could have. “The really amazing thing is not that life on earth is balanced on a knife-edge, but that the entire universe is balanced on a knife-edge, and would be chaos if any of the natural ‘constants’ were off even slightly” (*The Anthropic Principle*, May 18, 1987, episode 17, season 23, quoted in Meyer, *Return of the God Hypothesis*)).

> “The remarkable fact is that the values of these numbers seem to have been very finely adjusted to make possible the development of life.” (Hawking, *A Brief History of Time*, Pg 26)

Not only are the constants fine-tuned, but their ratios to each other exhibit extreme fine-tuning. The electromagnetic force constant experiences fine-tuning to 1 part in 10^{120} with some sources offering slightly different numbers, and some completely different, but still fine-tuned nonetheless. The ratio between the WNF and SNF constants cannot exceed 1 part in 10,000. If it were to deviate from its current value by that much, stars fueled by hydrogen fusion would never have the possibility to exist. The ratio between the electromagnetic force constant (K) and the gravitational force constant (G) is fine-tuned to 1 part in 10^{40}.

If G or K were stronger or weaker by $1/10^{40}$th, gravitation would be too strong in comparison, overpowering the electromagnetic force causing stars to burn too fast from rapid particle collisions, and not producing heavier elements necessary for Earth. If it were too weak, stars or any large-scale objects would not form, and the universe would be a giant soup of charged particles as gravity would be overpowered by the sheer electromagnetic repulsive forces felt between each particle. It is very obvious that the constants of the laws of physics and chemistry experience unimaginable fine-tuning in and of themselves entirely, as well as between each other.

More Fine-Tuning

The fine-tuning of the constants is but one aspect of the fine-tuning parameters of the universe. There are at least two other general aspects of fine-tuning in relation to the universe and its features: The initial conditions of mass-energy at the beginning (entropy), and the fine-tuning of some other contingent features.

1. The Fine-Tuned Initial Entropy

If you read the previous article, you may recall the mention of Einstein's field equations that allow a physicist to determine different spatial configurations of the universe derived from possible distributions of mass-energy. This initial distribution needed to exhibit small fluctuations, apart from being completely uniform and homogenous. You may also notice that I will sometimes refer to matter at this stage as mass-energy. Einstein's equations gave us the famous equation $E=MC^2$, which describes how energy and matter are different forms of the same substance. At the beginning of the universe, the energy within it was at such a dense and compact point that practically no matter was formed yet; it was all a dense ball of hot energy with mass, hence "mass-energy." So the initial distribution of mass-energy heavily affects how the large-scale universe will structure itself given time. The specific distribution of this mass-energy at the beginning accounts for the formation of stars, galaxies, clusters, etc. Physicists have unearthed the fact that if this initial distribution of mass-energy were different even by the smallest amount, the universe would result in either a clumping of all the matter, leading to a universe of only black holes, or a distribution of matter that is far too sparse and spacious for gravity to accumulate large-scale structures. Both of these alternatives prevent the formation of elements, stars, planetary systems, and galaxies.

Entropy: A measure of the amount of disorder within a system being observed.

Remember how I talked about General Relativity in the previous article, too. Einstein's theory of gravitation posited that any object with mass will bend the fabric of spacetime around it, changing the spatial trajectory of objects influenced by this warp, falling into the curvature that we call gravity. Since all objects with mass bend spacetime and exert gravitational effects, the initial distribution of energy (that would cool into matter as the universe expands) at the beginning of the universe would determine the structure in the future, as all mass would exert gravity, driving physical change over time. This initial distribution is fine-tuned to 1 part in 10^{55} of its current value, meaning if it were to change by $1/10^{55}$th, the above-mentioned circumstances would result. Physicists refer to this distribution of mass-energy as the universe's initial entropy.

A universe with high initial entropy would result in black holes, and one with low entropy would result in ordered large-scale structures. The universe, with ordered structures in its later development, exhibited a low initial entropy (highly specific) of the distribution of mass-energy. To evaluate the amount of entropy required, the number of alternative configurations that align with a specifc circumstance must be determined first; in this case, our circumstance is a life-permitting universe. So if we were to calculate the total entropy of the universe, we must know how many alternate configurations there are that result in a life-permitting universe. This, in turn, will offer us an assessment of whether this entropy experiences unexplained fine-tuning.

A black hole represents the highest possible entropy a system can have, as the extreme gravitational force ensures that the matter and energy within its event horizon exhibit many chaotic forms and configurations while not really affecting the black hole's structure in toto. A galaxy, on the other hand, represents a low-entropy system, as there are few ways to arrange the matter within to result in the ordered spiral structure. So when we examine our universe and find very few black holes in comparison to stars and galaxies, we can confidently say it exhibits a low-entropy state in its present form. This implies that the universe had to have a lower entropy in the past, as entropy increases in a system as time moves in the forward direction.

Finding Entropy

Baryon: Protons and Neutrons

The mathematical giant, *Roger Penrose*, was the one who tackled the task of determining the number of different initial mass-energy configurations that would cause a life-permitting universe. He started by assuming that no possible universe could have more entropy than that of a black hole. This meant he needed to find the total entropy of the universe if it were a single blackhole. To do this, he used an equation known as the *Bekenstein-Hawking* equation, based upon General Relativity and Quantum Mechanics, which would calculate a reasonable maximum entropy for the universe. Using the Bekenstein-Hawking equation, he calculated the value for every possible entropy per baryon to be about 10^{43}/baryon. He then multiplied this (the number of configurations per proton and neutron) by the number of total baryons in the observable universe (10^{80}), which came out to a total entropy value of 10^{123}. This entropy value represented the maximum for any universe, that of a black hole universe.

Penrose then calculated the total entropy of the present universe. To do this, he assumed that every galaxy had a black hole at its center with an average mass of one million solar masses, which yielded an entropy of 10^{21}/galaxy. He then took this number multiplied by the total baryons, which came to a total entropy for our universe of 10^{101}. The universe at the beginning of its existence would exhibit an entropy no greater than this value. He concluded that our universe has an entropy value that is very improbable compared to the possible configurations of mass-energy it could have had. This is because 10^{101} is a small fraction of 10^{123}; subtracting 10^{123} by 10^{101} just results in 10^{123}. Also, 10^{123} is more than the total observable baryons in the universe at 10^{80}. We can confidently conclude that our universe has an extremely improbable initial entropy that resulted in a life-permitting universe as opposed to the common possible values it could have had.

2. Universe Expansion

A life-permitting universe does not solely rely on its initial distribution; it also relies on many other features that could have been otherwise, and if they were, would not result in intelligent life thriving on Earth. For starters, the expansion rate of the universe is highly determinative of whether a universe would be life-friendly or not. *Stephen Hawking* calculated the expansion rate of the universe to be fine-tuned to 1 part in 10^{17}. This implies that if the expansion rate were smaller by $1/10^{17}$th of its current value, gravity would have overcome expansion, causing the universe to collapse under its own curvature. But the rate of expansion is dependent on other factors that are individually fine-tuned. The density of mass-energy would have been about 10^{24} kg, and if it were to change by a single kilogram per meter^3, galaxies would never have formed. This means the expansion rate is fine-tuned itself to 1 part in 10^{17}, but also has underlying fine-tuning of 1 part in 10^{24} in its mass-energy density per meter^3.

But there is more, the cosmological constant (Λ), which represents the mass-energy density in the equations for the expansion rate, exhibits fine-tuning to 1 part in 10^{90}. This means that the expansion rate exhibits fine-tuning on multiple layers.

3. The Size, Shape, and Position of the Milky Way Galaxy

If our home spiral galaxy, the Milky Way, were not the structure it is, such as an elliptical or irregular galaxy, its center would emit radiation that is harmful to the existence of life. If it were a dwarf galaxy, it would exhibit a low amount of heavy metals.

Moreover, if our galaxy were not separated from other galaxies, we wouldn't have such a stable gravitational field, thus being influenced by other galaxies, further preventing the thriving of life. Our galaxy is also large enough not to have common solar collisions, giving life enough of a time window to develop.

4. Our Planet's Location

The last piece of fine-tuning I will mention in this article is what astronomers call the "Goldilocks Zone," a location for a planet that ensures the conditions are perfect for the thriving of life. Our Planet is just far enough from our sun as not to be bombarded with more or less radiation and heat. Our Planet has:

A. Liquid Water: Earth has an abundance of liquid water on its surface, a crucial condition for life to thrive, and chemical reactions necessary for life to occur. This relies on the distance the Earth is from the sun, as well as the shape of its orbit. But this relies on physical factors such as the strength of gravity.

B. Stellar Energy: The Earth's location prevents it from receiving too much radiation, so the water does not boil.

C. The Stage of Our Star: Our star is at the perfect stage in its lifespan to allow life. If it were larger, its habitat zone would be moved further away from where it is now, too small, and it moves closer. If it were older, in its red giant phase, our orbital distance would actually be inside of the star.

D. Perfect Atmosphere: Our atmosphere is not thick enough to rapidly trap greenhouse gases, which would result in uninhabitable temperatures. And if we have a thinner atmosphere, we wouldn't be able to trap enough greenhouse gases to keep the temperature right.

To our current knowledge, there have been no exoplanets found that exist in the Goldilocks zone, with all the correct features for the thriving of life. For more information on why this does not mean life can originate, follow this link to my Abiogenesis Series: https://www.ptequestionstoeden.com/services-9.

Can Chance Explain Fine-Tuning?

The claim to chance is far beyond an adequate explanation at this point, as there are simply not enough particles in the observable universe to account for some of the fine-tuning features. This explanation also discourages any further discovery and research. If it all happened by chance, then there's no real rhyme or reason to think there's a law that caused it, since laws operate in regularity, and chance by definition is not regular. Going along with this explanation just ignores the improbabilities mentioned above, and it is grasping at thin air at this point.

Is Fine-Tuning the Result of Necessity?

As our discussion about Roger Penrose calculating the total entropy of the universe compared to the possible entropy already dismantles this explanation, because there is no reason to assume they are not contingent values. "The universe is life-permitting specifically because the laws of physics are fixed, and this must have happened." This explanation lacks empirical support, as the fact that other universe models with different mass-energy configurations are logically possible, there is no reason to think it *must have* happened that way. This also ignores the mass-energy distribution fine-tuning, as the laws of physics can not explain why it is as it is, either.

Could the Laws of Physics be Responsible?

The Physical constants are the variables that determine, for example, the strength of the electromagnetic force attraction of oppositely charged particles, or the strength of gravity upon an object. But these constants cannot be explained by the laws of physics because they are a foundational part of the laws themselves. No law has been discovered that can be responsible for the initial distribution of mass-energy at the beginning of the universe; the laws describe how forces and fields interact and govern the behaviour of material states, once specific material conditions are met. In other words, the laws *presuppose* the initial conditions; they do not *explain* them.

What About the Hostility of Our Universe?

Some say that the universe cannot be fine-tuned for life because 99.99% of the rest of the universe seems unsuitable for it. This ignores the fact that the universe itself *must* have a total size, mass, and density that it currently has to achieve the single goal of a planet suitable for life. It also ignores the possibility that God may have had more than one reason for making the universe as it is. Like making the heavens diverse and beautiful, driven and governed by laws describable in a simplistic, comprehensible, linguistic, and mathematical fashion with symbols. This would enable His creation to observe the heavens and conclude that a God had made it solely for them (Psalm 33:6; Colossians 1:16; Nehemiah 9:6; Isaiah 40:26). God also warned us not to worship the heavens, or mistake them for living beings (Deuteronomy 4:19), unlike some people nowadays who see the stars as having magical powers to determine their futures, or that the universe itself is somehow alive and a divine mind (whatever that means, because matter is not mind) that solely exists to serve their pleasures.

The hostility of other locations of the universe is actually not surprising to the Christian, who doesn't necessarily expect there to be anywhere else exactly like Earth, since God has His special attention on it. The atheists, on the other hand, believing in some form of chance or necessity originations, would expect at least some habitable zones for life to originate.

Naturalistic Interpretations: WAP and SAP

In 1974, Australian-born theoretical physicist Brandon Carter introduced a naturalistic interpretation of the fine-tuning evidence. He tried to offer an explanation that dwarfed the need to explain the fine-tuning. He stated,

> "What we can expect to observe must be restricted by the conditions necessary for our presence as observers" (Carter, *Large Number Coincidences and the Anthropic Principle in Cosmology*)

The Weak Anthropic Principle

This interpretation was called the *Weak Anthropic Principle* (WAP), and proponents of it argue that we shouldn't be surprised to observe a fine-tuned universe because if the universe were not fine-tuned for life, we wouldn't be here to observe it. They argued that because observers would have the potential to exist in an observer-friendly universe, there is no need to explain why there is fine-tuning. This is faulty logic;

it is confusing *Observation* for *Explanation*. Imagine you were blindfolded and had a bunch of marksmen ready to execute you. Once the shots are fired, you take off your blindfold and observe that all the shots didn't hit you; they missed. The fact that the marksman missed does not explain why they missed. So the fact that we can observe the universe in an observer-friendly universe only explains the fact that we can observe the universe that is consistent with the thriving of life. It does not in any way explain *why* we live in such a universe with the incomprehensibly improbable conditions necessary for life to thrive.

The Strong Anthropic Principle

This interpretation, also proposed by Carter, says that "the Universe must have those properties which allow life to develop within it at some stage in its history" (John D. Barrow and Frank J. Tipler, The Anthropic Cosmological Principle, Pg 21). Proponents of this interpretation never explained what causes the fine-tuning parameters to exist. They posit that any universe must, at some point, form life to observe it. But this is simply arbitrarily assuming that, and ignoring the plethora of evidence against it.

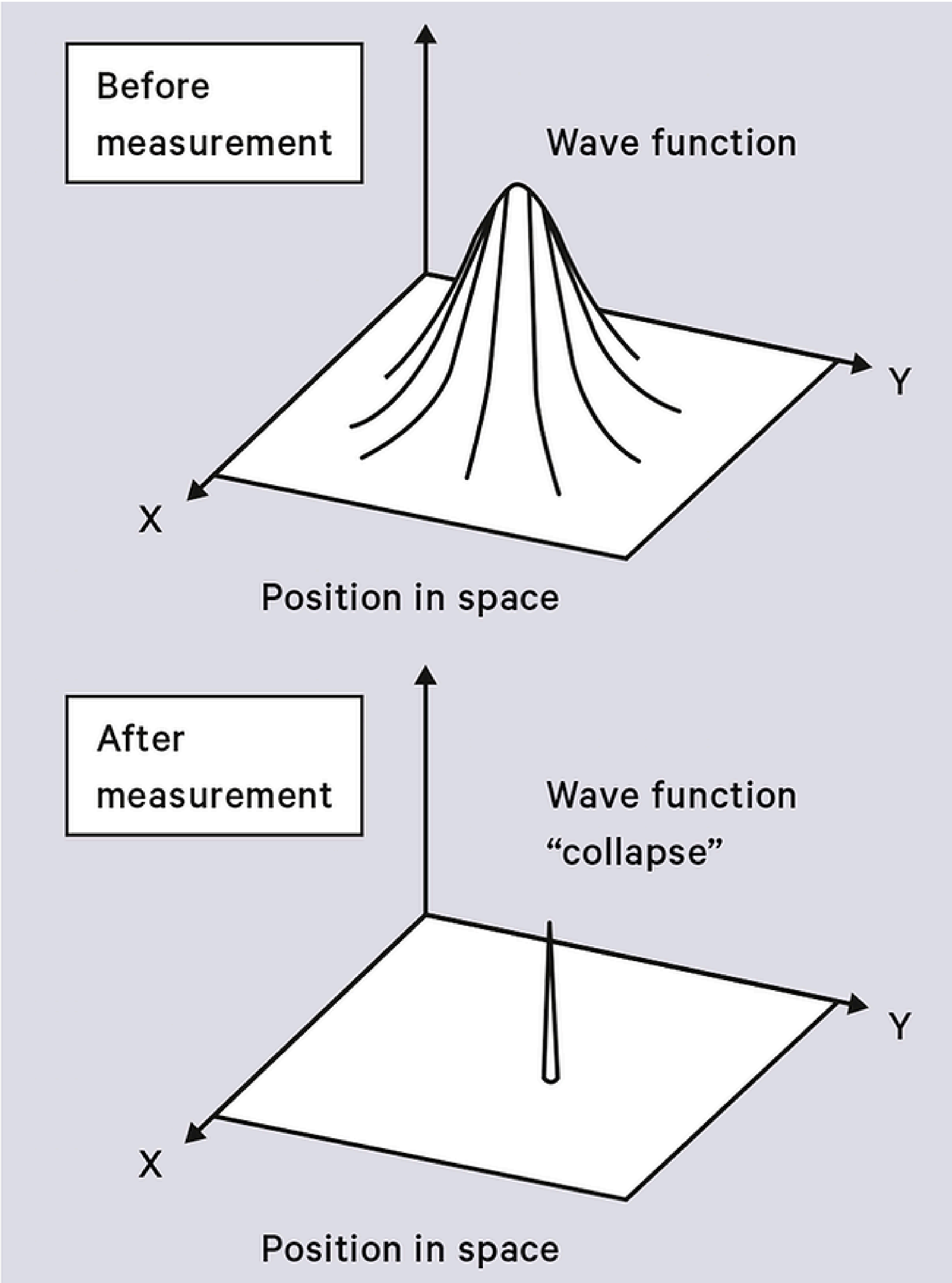
SAP 2.0

There is another version of the *Strong Anthropic Principle* that claims:

> "The need for observers to confer reality upon the universe means that the universe had to be fine-tuned to produce human observers to observe it" (Meyer, *Return of the God Hypothesis*, Pg 155)

This version was created analogous to the *collapse of the wave function* in Quantum Physics.

In Quantum physics, there exists something called the wave function, which can be derived from a previous equation, whose solutions represent different positions that a particle may manifest within a wave of energy. For example, I have a wave of light approaching a photographic plate. Whenever I do my calculations, I come to many different locations for a photon of light to be detected across that wave of light. Until I make a measurement, I will not know what possible location the particle is in. Only once I make an observation, will I know which possibility the particle is located at. Electrons and photons exist in multiple possible positions along a wave of energy. When an observer measures the wave of energy, a particle is detected.



Depiction of the collapse of the wave function. Under the Copenhagen Interpretation, an observer causes the collapse to occur and a particle to be measured.

An interpretation of Quantum Physics, called the *Copenhagen Interpretation,* claims that the observation causes the particles to manifest along the wave, thus they claim that the universe itself may depend on a observer to observe it for its very existence. So the universe is fine-tuned for life because life observes it. But this has a major issue. Our concept of time and cause implies that an event that produces an effect precedes the effect in chronological sequence. Thus, the observers in this case, who cause fine-tuning, make their observations well after the effect they caused happens. Even in Quantum Physics, the collapse of the wave function happens *after* the observation has occurred. Thus, this interpretation was so bad that Scientific American writer *Martin Gardner* called it the CRAP, "the Completely Ridiculous Anthropic Principle" (Gardner, "*WAP, SAP, FAP & PAP*").

Conclusion of Chapter 3

Was the universe fine-tuned from the get-go? Absolutely. The sheer impossible chances of these features finding the values they do, the initial distribution of the mass-energy, the expansion rate of the universe, the strength of the four forces, the features of the Milky Way, the location of our Planet, and many more contingent features all point straight in the direction that the universe was fine-tuned for the thriving of life.

If the universe were fine-tuned, with extremely interdependent laws and features, and it also had a termination point of time in the past, then what are we to think of the cause? We can confidently list the characteristics of the nature of the first cause from what we have examined thus far. the cause of the universe must be space-less, as before the effect, space was non existent; time-less, as time arose with space; immaterial, being transcendent to matter because non existed beforehand; all-powerful, to causally adequate to produce the vast amount of total energy in the cosmos; all-knowing to be able to create everything we know to exist; omnipresent, because if it is immaterial, then it is not confined to a physical body or space; personal, to be able to choose to create from a state of non-creation; intelligent, to know to create the initial conditions so finely tuned to produce a life-permitting universe, and to obviously have a goal of observers in mind; to some degree loving (even all-loving, being, as of now, the cause of the love we experience), as it put so much into just creating a single planet with human beings equipped with mids able to make sense of it; and it must exhibit a mind, because only minds make decisions, and only minds comprehend things as complex as physical laws and the universe.

All of these characteristics align with the nature of God as revealed in the Bible. But so far in our investigation, we cannot really say which God it could be. We also haven't gone over alternative models or a deep dive into the total implications. Stay tuned in, because all of this is coming soon. May Jesus Christ bless you with an awesome respect and reverence for the majesty and glory He displays in the creation He has left us with.

"For by him all things were created, in heaven and on earth, visible and invisible, whether thrones or dominions or rulers or authorities—all things were created through him and for him". (Colossians 1:16)

"All things were made through him, and without him was not any thing made that was made". (John 1:3)

Chapter 4

Does the Multiverse Explain Cosmological Fine-Tuning?

Responding to alternate models and refuting their proponents claims

In the first three articles, we have covered the idea that the universe had an absolute beginning some time in the past. We covered the philosophical issues that arise from accepting the idea of a past-eternal universe, as well as the Kalam Cosmological Argument, which posits three premises that, if proven true, will confirm the idea of a cosmic beginning. We then examined the scientific and mathematical developments that led to the most accepted cosmological origins model, the Big Bang. This theory posits that the universe has been expanding, and extrapolating back in time results in the universe converging on one single point of infinite density, corresponding to zero volume, implying a beginning. We also looked at the BGV Theorem, which states that any expanding universe will have a temporal beginning and must be past incomplete. For further discussion about the BGV Theorem, see *Did the Universe have a Beginning*. We also examined an area of physics called the fine-tuning parameters of the universe.

We discovered that our universe exhibits extremely low and ordered entropy in the present, and must have been even more ordered at the beginning. The universe has a very specific initial arrangement of mass-energy, as well as containing physical laws that, in themselves, are fine-tuned, and the constants within them are exquisitely fine-tuned with improbable values. We looked at a few naturalistic interpretations, such as the Strong and Weak Anthropic Principles, and how they fail to explain the existence of rare fine-tuning without invoking a transcendent intelligence. Indeed, naturalism posits that the only thing that exists, from which everything comes, is solely matter and energy. Proponents of this worldview presuppose that nothing outside of the natural world can exist, and many hold forms of naturalism that try to expand its explanatory power by postulating an infinite array of other separated universes.

Thus, the Multiverse Theories were created in order to explain the fine-tuning problem that is posed to naturalists. This fine-tuning they attempt to explain away was present from the very beginning, which suggests more of a fine-tuner external to the universe, rather than an internal one. X cannot cause X; something like Y must act to cause X. Even though the interpretations of the SAP and WAP were thrown out the door, nonetheless, some still tried to explain away the fine-tuning issue by increasing the likelihood of a life-permitting universe being created by chance; by positing an infinite amount of universes, by which a life-permitting one is bound to emerge at some point.

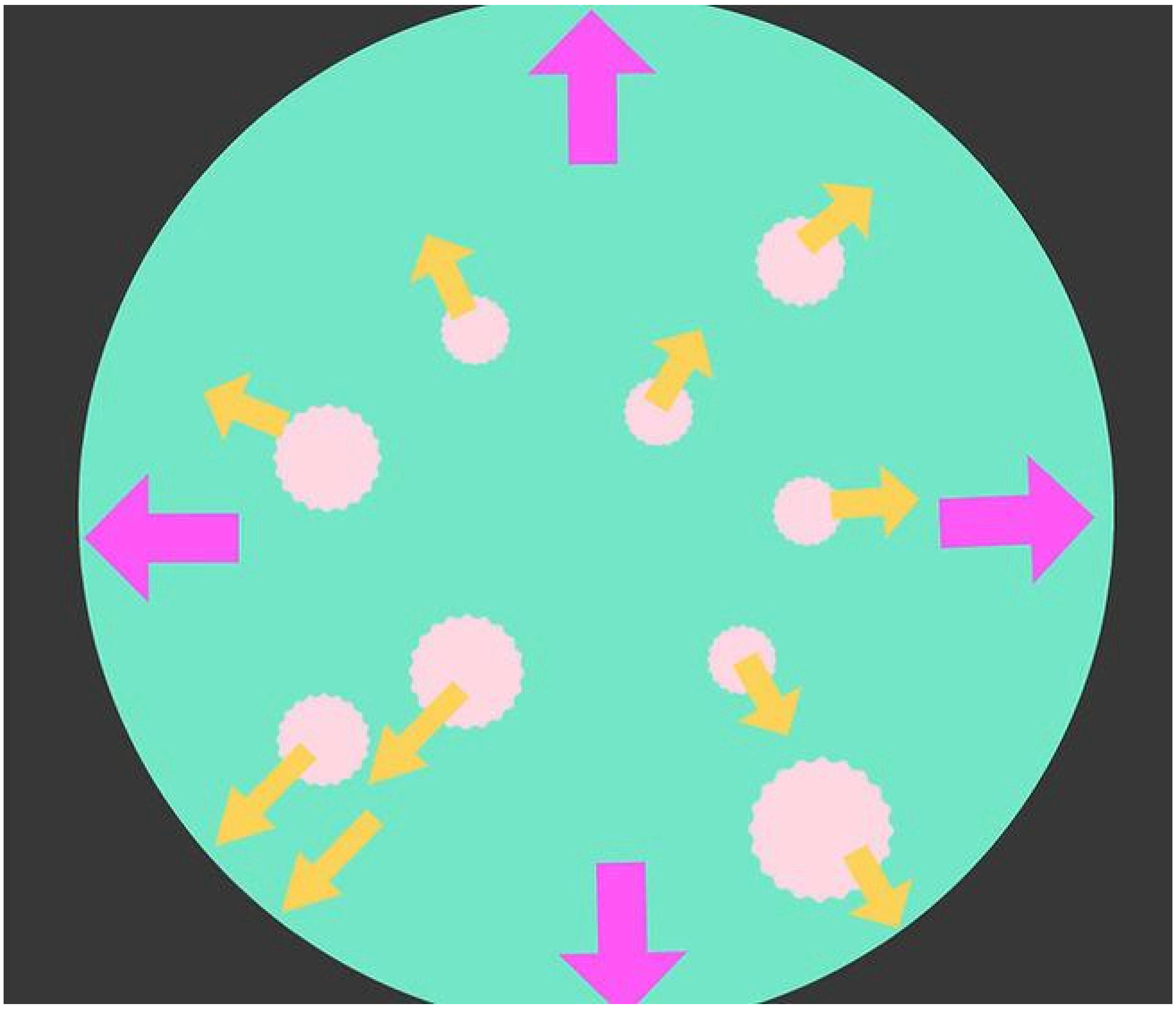
The Inflationary Multiverse

When the fine-tuning features of our universe were discovered, many naturalists were introduced to a massive problem: a cosmic beginning, one with implications of an eternal fine-tuner, some may even call God. To get around the bush of an intelligent fine-tuner, theorists postulated an infinite number of causally separated universes existing within a further expansion of space, no matter how unlikely or irrational it may be. And unlike popular belief, these theories did not only posit multiple universes, but an entire ensemble of mechanisms and agents that make this infinite array possible. Proponents of these theories envision our universe as the winner of a cosmic lottery game with an endless number of players, which is rather convenient when explaining fine-tuning.

Vacuum Energy: The energy of space, caused by the minimal energy level a quantum system can exhibit due to fluctuations, derived from the Heisenberg uncertainty Principle.

But the other universes in these theories are causally separated from one another; in other words, one event in one universe cannot affect events in another. Thus, positing a universe-generating mechanism lowers the rarity of a life-permitting universe and shifts the fine-tuning issue to the result of random chance; moreover, there would need to be a mechanism, otherwise, from where would these universes be coming from? Thus, we come to the first type of Multiverse Theory, the *Eternal Chaotic Inflationary Model*. This model posits an outward pushing, expanding field that has vacuum energy, causing further expansion of space in which universes can be born. This expanding field is called the *Inflaton Field*.

Created by *Adrei Linde*, *Aland Guth*, and *Paul Steinhardt* to explain a few issues found in the universe. It was created to explain the universe's relative homogeneity of temperature in the Cosmic Background Radiation, the flatness of the universe, as well as the absence of predicted monopoles, all mentioned in *Did the Universe have a Beginning*. Proponents posit that shortly after the beginning of the universe, space experienced a sudden, rapid expansion that smoothed out the mass-energy and stopped a fraction of a second later to a more modest expansion rate. The most accepted version of this theory is the above-mentioned *Eternal Chaotic Inflation model*.



The inflaton field (light blue) is continuously expanding while quantum fluctuations cause bubble universes (light pink) to form. As the field continues to expand (dark pink arrows), so too do the bubble universes (yellow arrows) move away from one another along with it.

As the inflaton field continues to expand, it decays in random locations due to quantum fluctuations in its vacuum energy, causing low-energy pockets to form, called bubble universes. The continuous expansion of the field causes bubble universes to slowly expand with it, away from each other, practically never making causal contact. This model's mathematics explained away the fine-tuning of initial conditions only, not even touching the laws of physics, as the universes generated exhibit the same laws as the field is subject to. Inflationary proponents claim that since there is an infinite array of other universes, every single event that has occurred, and will occur in this universe, is bound to happen in another universe, an infinite number of times. This, in turn, makes the extremely implausible features probable.

String-Theory Multiverse

Since Inflationary Cosmology wasn't adequate to explain both the initial conditions and laws of physics, theorists looked for another theory. This motivation led to the creation of *String Theory*. This theory, originally made to describe the Strong Nuclear Force, posits that the fundamental units of matter are not particles, but one-dimensional strings of energy. Each string exhibits a different vibration pattern that can be either in an open or closed string form. All elementary particles are simply manifestations of these vibrations. The theory found its roots in the 1960s and was made for the sole purpose of describing the Strong Nuclear Force. Despite another method, Quantum Chromodynamics, proving to be more reliable for this purpose, *John Schwartz* revisited the theory in the 70s in an attempt to unify General Relativity and Quantum Physics (Meyer, *Return of the God Hypothesis*, Pg 501, note 11).

Boson: Particles that transmit and carry their corresponding force, for example, the Gluon is the boson that carries the Strong Nuclear Force.

Fermion: Material Elementary Particles, such as nucleons and electrons.

The first version of String Theory described particles called bosons, thought to carry the Strong Nuclear Force, and required a 26-dimensional spacetime, 22 of which were unobservable. More modern versions have found that about seven dimensions are enough to include both fermions and bosons. Remember that dimensions here do not refer to separate worlds or universes, but a physical quantity that describes space, matter, or time.

Where Are these Dimensions?

But where do these extra, unobservable dimensions reside? They are curled up into many different structures on an infinitesimally small degree, smaller than 10^{-35}m, which physicists call the *Planck Length*. These incredibly tiny compactifications of spacetime dimensions are called *Vacua*, and theorists envision these vacua containing the vibrating strings, where the 22 or 7 extra dimensions manifest the particles we observe on the macro-scale universe. As the strings in the vacua vibrate, lines of flux form around them that hold the spatial dimensions in a specific shape. These lines of flux can be imagined to be similar to the lines of flux drawn in magnet diagrams (the lines that extend from one pole to another). This theory is a particle-based theory of gravity, rather than a fabric-like warping theory of General Relativity.

It posits the existence of particles called *Gravitons*: massless, closed strings that transmit gravitational attraction. Since General Relativity is a theory of gravity, and String Theory posits a gravity particle, it was highly expected that the theory would reduce all forces to gravity, and unify General Relativity with Quantum Physics, creating a *Grand Unification Theory*, or a theory of everything! Specific vibrations of gravitons produce observable gravitational attraction, with other vibrations generating material particles, called *Fermions*.

String Theory Revised...

Early models only produced universes that contained only bosons, with no fermions. In order to explain the existence of fermions, string theorists posited an arbitrary principle called *Supersymmetry*. Supersymmetry states that for every bosonic particle, there exists a complementary fermionic particle, and every fermionic particle has a bosonic counterpart. This principle reduced the first proposed 26-dimensional spacetime to just 10 dimensions. Thus, they proclaimed the existence of not only gravitons, but also their supersymmetric counterpart particle, the *Gravitino*, which gives rise to different fermionic particles. String theorists hoped that by postulating this new form of physics, they would be able to create a single unified theory, one that reduced all four fundamental forces into one mathematical structure (Dimopoulos, *Splitting Supersymmetry in String Theory*) that accurately described everything.

But... the mathematical structure of the theory didn't produce any solution corresponding to the physics of our universe. This is because the equations for string theory had an infinite number of solutions (different vacua compactifications) that each described different physical laws. It wasn't long before the light of finding a solution that matched our universe began to dim. The number of solutions that have a positive value for their cosmological constant represents anywhere between 10^{500} and $10^{1,000}$ different vacua. String Theorists called this vast number of vacua solutions the *String Landscape*.

Finally Explaining Fine-Tuning... or so it Seems

Despite the extremely large number of solutions, the vast majority not corresponding to our universe, some theorists still attempted to use this to their advantage. They claimed that each solution to the equations represented a different universe with different laws and constants. They postulated that the different shapes of vacua determined the physical laws that manifest in the macro-scale universe, as well as the lines of flux determining the constants within those laws. They then applied this interpretation to the beginning of the universe.

They imagined each universe first as an initially high-energy compactification of space exhibiting one single quantum gravitational field (a quantum field responsible for gravity, stemming from Quantum Field Theory). Then the lines of flux around the universe begin decaying and losing energy, allowing new spatial compactifications of dimensions and strings to occur in the vacua, corresponding to a different universe with different laws. These new shapes would determine the laws of physics, and the size of them (determined by the strength of the line of flux) determines the constants. As this decay continues, a universe would change from one form to another, as each universe cascades down the landscape of possible vacua compactifications represented by the many possible solutions to the equations.

> “But this postulation is highly debatable, since there is no way of knowing how much of the string landscape will get explored by such a means.” (Meyer, *Return of the God Hypothesis*, Pg 501, note 18)

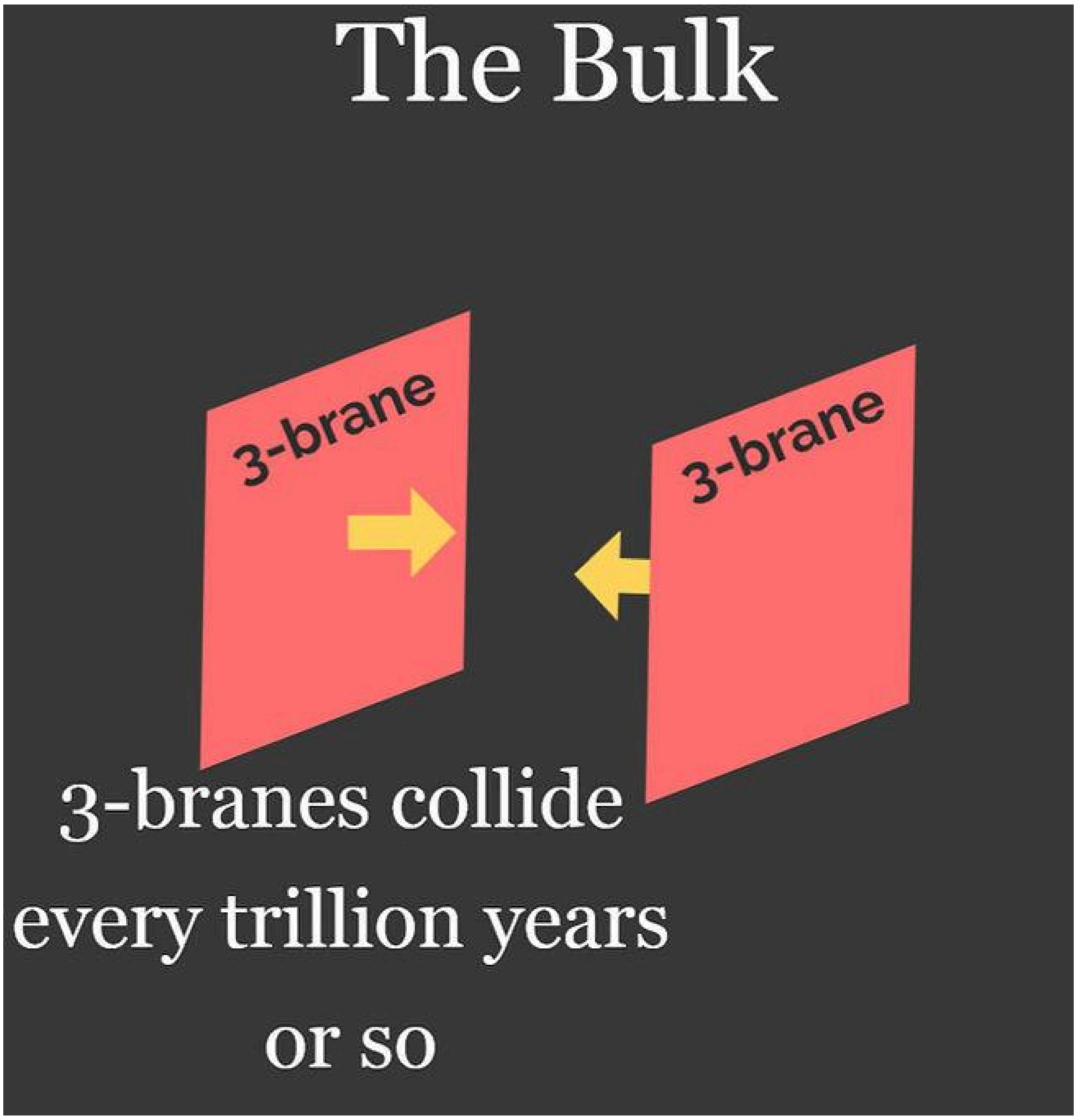
There is no reason whatsoever to expect that the entire landscape will be explored by a cascading universe. If the cascade doesn't cover all possible solutions, there is zero guarantee that the decay of flux would eventually result in a life-permitting universe. Thus, though this theory does explain some fine-tuning, it does so by sacrificing observable entities in favor of purely theoretical ones.

Multi-versal Teamwork that Makes the Confusion Worse

Does String and Inflationary Cosmology provide adequate explanations for the fine-tuning of the laws & constants of physics, and the initial mass-energy distribution at the beginning of the universe? Oxford Philosopher *Richard Swinburne* applies the principle of Ockham's Razor (read more about the history of Ockham's Razor here: https://www.ptequestionstoeden.com/post/return-of-the-god-hypothesis-part-1-the-judaeo-christian-origins-of-modern-science), which states that when explaining specific phenomena, we should avoid multiplying unobservable, theoretical explanatory entities as much as possible. Positing a transcendent intelligent designer offers only one single explanatory entity: an intelligent, powerful, personal, transcendent causal agent, rather than infinite unobservable universes and multiple theoretical mechanisms.

Accepting the naturalistic multiverse requires the acceptance of two separate universe-generating mechanisms, not just one. Inflationary

Multiverse explains the fine-tuning of the initial conditions, but not the laws and constants of physics. This is because the entire inflaton field operates according to the laws of physics of our universe, and each bubble universe thus contains the same laws and constants as the field they are born into; only the mass-energy distributions of these universes are different. On the other hand, String Theory explains the fine-tuning of the laws and constants, but in most models, it never touches the initial distribution. The only String model that explains both is called the *Cyclic Ekpyrotic String Theory Model*. The only issue is that this theory posits many unobservable entities. It proposes that our universe exists as a thin membrane-like fabric of three-dimensional spacetime called a 3-brane that resides in a higher, 11-dimensional spacetime called the "bulk". Some models only posit two 3-branes, while others incorporate other brane pairs.



Cyclic Ekpyrotic models posit multiple pairs of 3-branes that reside in a larger space called the Bulk. Branes collide every trillion years to produce new expansions or "Big-Bangs" within them, resulting in "new universes".

The different 3-branes collide within the bulk every trillion years to generate new universes. The breaking of Ockham's razor here renders it beyond dull. The unreasonably multiplied entities of this theory include: the 3-branes of spacetime; multiple universes that exist in the bulk; eleven extra dimensions of spacetime, including seven unobservable ones; an eleven-dimensional gravitational field containing other 3-branes; and a process of collisions every trillion years that produces 10^{500} new universes. Another theory, called M-theory, posits vibrating membranes of energy and unobservable compactifications of extra spacetime dimensions; and lines of flux. As you can see, the extrapolation of the imagination is astonishing.

This means that to create a cosmological theorem that explains both the initial conditions and physical laws and constants would require both an inflationary mechanism operating in conjunction with String Theory vacua. This need for teamwork led to the formulation of a new hybrid theory, *the Inflationary String Landscape Model*.

The Inflationary String Landscape Model

The theory of the Inflationary String Landscape was coined in the early 2000s by the American Physicist *Leonard Susskind*, and was later pushed by other physicists like *Raphael Bousso* and *Joseph Polchinski* (Meyer, *Return of the God Hypothesis*, Pg 336). They proposed the decay of lines of flux around an initial vacua universe, just like Standard String Theory, but added the occurrence that in each vacua, inflation would happen. As these vacua begin to expand from their inflaton fields, the fields decay in the local regions from fluctuations to produce bubble universes, each exhibiting different laws and initial conditions. While this theory did seem to explain the fine-tuning based on chance, it sacrificed observability for a massive ontology of causal entities.

Inflationary Absurdities

Now, Inflationary String Theory does explain fine-tuning, but "at the cost of what philosophers of science call a ‘bloated ontology’" (Meyer, *Return of the God Hypothesis*, Pg 336). A bloated Ontology occurs when a model or theory is unnecessarily complex and contains more entities, categories, or relationships than are required to explain a given phenomenon. The Inflationary String Model does so by positing a very large number of purely theoretical and hypothetical explanatory entities, for which there is no evidence of their existence. The combination of the unobservable mechanisms of inflationary and String Theory affirms the existence of many entities that we cannot observe. This list includes the following:

1. An Inflaton Field.
2. The decay of the field creates bubble universes.
3. Each universe produced has different initial conditions.
4. The inflaton field will continue to expand forever, and has been doing so eternally into the past. Basically, that actual infinities can exist.
5. Particles are actually the vibrations of one-dimensional strings.
6. As these strings vibrate, lines of flux form around them,
7. The initial universe (vacua) had lines of flux that determined a positive cosmological constant out of the near infinite ones that don't.
8. The validity of Supersymmetry.
9. Gravitons and Gravitinos exist that manifest as bosons and fermions.
10. Each solution to the equations represents a possible universe.

11. An inflaton field and string landscape universe generating mechanism can produce a cascade that includes enough universes to reach a life-permitting one.

The main issue with these theories is their violation of Ockham's Razor, which is not a law, but a very good and proven method for finding what's responsible for something. The constant speculation about unobservable entities just bashes the edge of the razor. So much so that it seems as if there are almost no observable entities within them, except for those observed in our universe (those things on which the theory is built). Not only do these theories multiply unnecessary explanatory bodies, making one accept obvious absurdities, but they also just push the fine-tuning issue back another layer.

Inflationary/String Theory Fine-Tuning

The universe-generating mechanisms themselves seem to require prior fine-tuning to produce a universe like ours, trampling right over the exact issue they were designed to solve.

Inflationary Fine-Tuning

To explain the homogeneity of the Cosmic Background Radiation, the inflaton field must have a specific energy level at the start of the expansion of the universe, as well as a specific decay rate to allow a life-permitting universe to result. This precise halt of expansion requires its own fine-tuning to one part in 10^{53}, all the way to 10^{123}. Not only is the halt fine-tuned, but the amount of time that expansion occurs is too. Inflation begins around 10^{-37} seconds after the beginning and stops exactly at 10^{-35} seconds, with a size growth of 10^{26} times the universe's original size.

Moreover, recent research has revealed that the majority of universes that experience inflation will not inflate to a life-permitting universe.

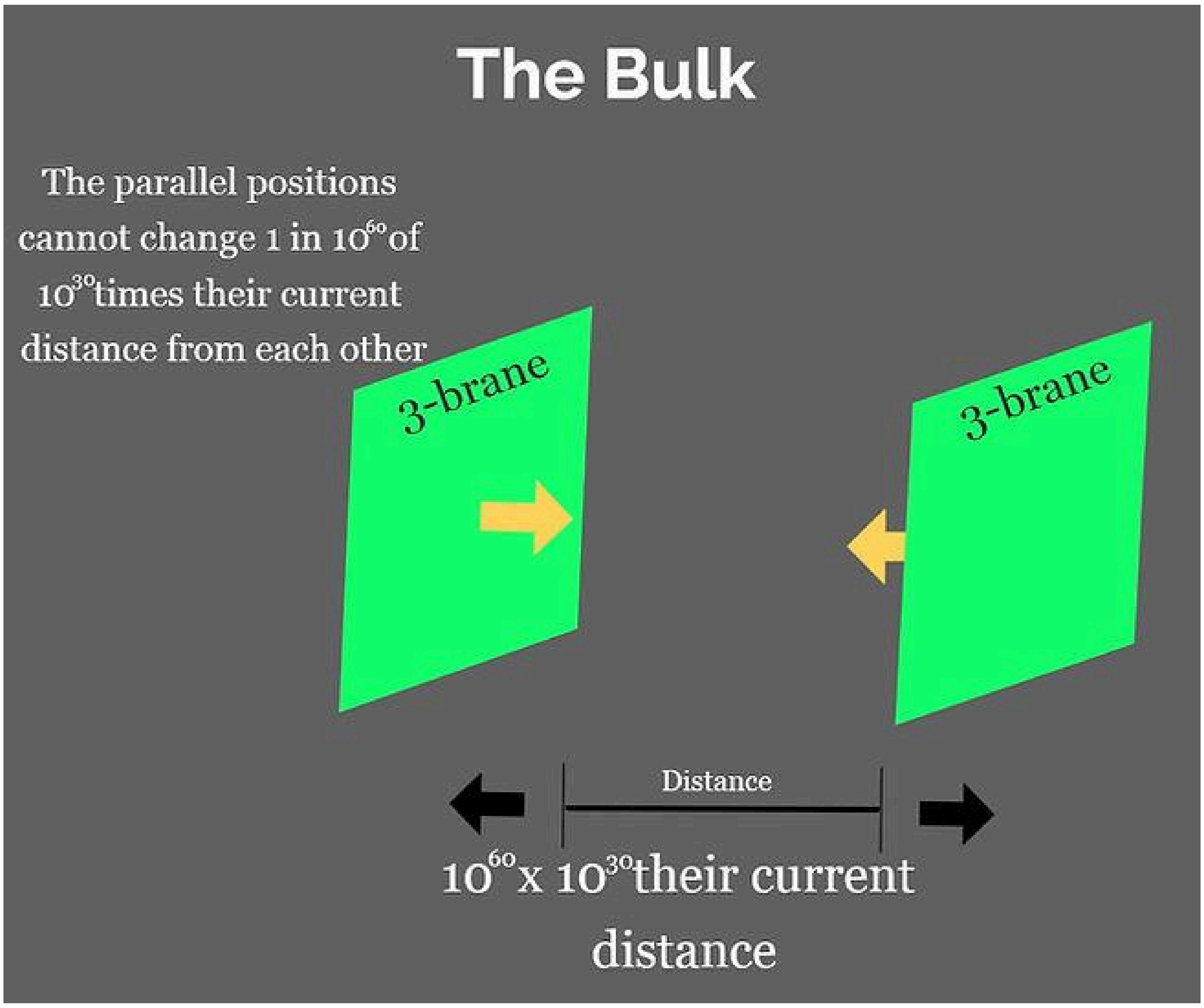
The inflaton field generates more universes not suitable for life than those that are, this is because the field is subject to random quantum fluctuations, with no goal for life. The estimated chances of generating a universe compatible with life are no less than 1 part in $10^{66,000,000}$ (ten followed by 66 million zeroes), a number that trumps the amount of elementary particles in the observable universe at 10^{80}, multiple times over. This implies that the inflation itself requires prior fine-tuning, begging a cosmic fine-tuner even more than standard Big-Bang models (Sean M. Carroll and Heywood Tam, *Unitary Evolution and Cosmological Fine-tuning*, referenced in Meyer, *Return of the God Hypothesis*). But wait! There's more! The massive energy from expansion during the inflation period would increase the total entropy of the universe far more than the normal expansion of the Big Bang. In other words, the surge of expansion energy would increase the disorder of the mass-energy distribution (like dropping a bowling ball on top of a tower of cards, or slamming a heavy object on a table with dominoes standing up on it; the surge of energy from the ball or heavy object would cause the ordered dominoes or cards to decrease in the order they had before and fall over); thus, the distribution before expansion must have exhibited an even finer arrangement to account for the massive increase in disorder caused by inflation to retain the entropy it exhibits today, which is rather highly ordered (for a discussion on the universe's entropy, see here: https://www.ptequestionstoeden.com/post/is-our-universe-fine-tuned-for-the-existence-of-life). Thus, inflation begs for an even lower entropy of the initial homogeneity in the mass-energy distribution to account for the low entropy, ordered structures we observe in our universe today.

Thus, there are multiple layers added onto the already existing multi-layered fine-tuning issue, if inflationary models are entertained. This makes theism a simpler hypothesis than Inflationary Cosmologies.

Them Fine-Tuned Strings

String cosmologists envision a compactification of space that represents a universe that contains a high-energy quantum gravitational field, which begins the process of "exploring the landscape". As the lines of flux decay, different configurations of spacetime arise along with new laws of physics. A universe may experience a phenomenon called *Quantum Tunneling*, allowing a universe to jump into a new, higher-energy state that produces other bubble universes, but the chances of tunneling occurring are statistically low. This, too, requires prior fine-tuning. Remember that the solutions to String Theory equations that represent a universe with a positive cosmological constant are around 10^{500} to $10^{1,000}$ solutions. But there are far, far more solutions that don't meet this single requirement; thus, to ensure a cascade down the landscape through as many low-energy solutions as possible, the universe must have begun at possibly the highest energy level. Think of this like the game of high striker, or ring the bell: where a person must smack a target with a hammer with the goal of transferring enough kinetic energy to make a metal puck slide up a vertical tower to ring a bell. If a person doesn't wack the target with enough energy, the puck will never scale the tower. Similarly, a universe would have to start at the highest energy level possible to ensure a life-permitting universe is within the exploration of the landscape, just like if a person wants the puck to scale the entire tower to reach the bell.

But the BGV Theorem also applies to Standard String Theory models; exploring the string landscape would also require a beginning, along with fine-tuning, the same issue they attempted to kick out of the river. This, in turn, implies the need for exquisite initial conditions because of the rarity of the highest-energy solutions compared to all other solutions at 1 part in 10^{500} at the least. But there is no guarantee that the entire landscape will be explored, which further implies some sort of fine-tuned mechanism that can guide the process to explore those solutions that are compatible with life. Not only do the standard models invoke fine-tuning, but other models do as well.



The position of the 3-branes cannot change, lest there be a non-life friendly universe that results.

The Cyclic Ekpyrotic model that introduces the many 3-branes of spacetime that collide every trillion years requires the 3-branes themselves to be specifically positioned to guarantee the correct collision occurs. The branes of spacetime must be parallel to prevent large inhomogeneities in the resulting universe. The two universes must remain parallel in the multidimensional spacetime they inhabit to 1 part in 1060 across not just their current distance from each other, but a distance 1030 times greater than the distance between them to generate a life-permitting universe, which is fine-tuning on an entirely different level. The energy potential of the colliding branes is also fine-tuned to 1 part in 1050 (Renata Kallosh, Lev Kofman, and Andrei Linde, *Pyrotechnic Universe*).

The process of attempting to explain one area of fine-tuning seems only to push the issue to a new location, the location intended to explain the very fine-tuning issue it further bloats!

Where's Waldo...

These theories do not just have fine-tuning reasons to doubt them, they also lack a lot of empirical confirmation too. Neither are they the best explanations for what they aim to explain. The Standard Big-Bang Model is able to explain the homogeneity with simple fine-tuning parameters, and physicists can easily account for the relatively uniform temperature of the Cosmic Background Radiation purely on mathematical grounds, without invoking inflation (Meyer, *Return of the God Hypothesis*, Pg 505, note 41).

> “The homogeneity and flatness problems are only considered problems by those who regard the existence of fine tuning as a problem” (Meyers, *Return of the God Hypothesis*, Page 343).

The other issue these theories attempt to explain, the absence of magnetic monopoles (predicted particles that only exhibit a single magnetic pole), can also be explained by concluding they do not actually exist, and the unification models that predict them, for other reasons as well, are not true.

Failed Inflationary Predictions

Not only have inflationary Models taken hits in prior fine-tuning, as well as other absurdities, they have all experienced their fair share of failed predictions, a red flag that a scientific theory or model is not correct. The first failed predictions are the variations in the wavelengths of the Cosmic Background Radiation, mainly that these theories predicted variations far larger than what has been observed. Inflationary models predict larger variations in the temperature; due to fluctuations in the inflaton field, and once the period of inflation ends, the energy of the inflaton field is converted to standard mass-energy, thus causing the previous variations to enlarge themselves as hot and cold spots in the CMBR. but the *Planck Satellite* has not detected the predicted variations of most models.

The second failed prediction is the absence of detectable gravity waves from quantum fluctuations in the gravitational field. These models predict that the gravitational quantum field experiences random fluctuations that should be detectable as random warps of space, as the fluctuations would cause gravity to randomly curve in various locations. They predict that when photons interact with these warps, they will polarize in a distinctive, detectable way. To this day, no random warps of space have been found, and no photon has been either.

Scale Invariance: When the scale at which the patterns of an image are observed, I.e. how much the observer zooms in on the image, doesn't affect how the patterns look. Another easier definition are objects that do not change their fundamental properties, no matter how much its scale or size is increased.

The last major failed predictions in the phenomenon known as scale invariance in the imaging of the CMBR variations. Inflationary models predicted a moderate invariance of the variations of the CMBR, but recent imaging of the CMBR shows an almost near perfect scale invariance, more than the theories predicted.

Failed String-Theory Predictions

String theory has, as well, bore some heavy blows when it comes to failed predictions. The prediction of gravitons and gravitinos said they were not going to be detectable, but other supersymmetrical elementary particles should. *The Large Hadron Collider* in Switzerland has never detected these predicted particles. String theory states that these particles should be detectable under specific high-energy conditions, those of which can be met in the Collider. To date, no supersymmetric particle has ever been detected, despite repeated attempts to do so.

Moreover, the idea of a particle responsible for gravity does not really jive with me personally. This is because, for a graviton to travel and transmit the gravitational force, it would have to move through spacetime. But our most accurate models for gravity are interpreted as the curvature of spacetime itself, and that the curvature is gravity. Thus, how can a particle that travels through spacetime cause spacetime itself to curve? It just doesn't really make sense, unless spacetime and gravity are two distinct and separate entities.

Conclusion for Chapter 4

As we have seen in this overview of Inflation and String theories, they do not really offer a simpler and more plausible explanation for fine-tuning. Inflationary theory posits an underlying inflaton field that is eternally expanding with bubble universes, but requires even more exquisite fine-tuning in order to produce a universe that is life-permitting, as well as the sheer probability of one spawning at 1 part in $10^{66,000,000}$. String theory posits that the universe began as a tight compacification of spacetime (vacua) that was held together by lines of flux, that when decayed, allowed different spacetimes to arise, and thus different universes; but failed to predict the very thing the theory is grounded upon, as well as prior fine-tuning to guarantee a cascade includes ours. The failed predictions of both theories lowers their credibility as actually being true models.

Moreover, positing a single intelligence offers a simpler explanation to the fine-tuning than does offering a whole host of individually fine-tuned mechanisms that still require a beginning. Richard Swinburne, Oxford philosopher affirms the principle of Ockham's razor, which states that when explaining phenomena we should avoid multiplying theoretical entities as much as possible. The God Hypothesis offers one explanatory entity, an intelligent, powerful, transcendent agent rather than multiple unobserved mechanisms like an infinite array of separated universes and universe generating mechanisms. Thus, we can soberly conclude that the Multiverse just pushed the fine-tuning problem to the very location that is meant to explain it. Theism stands as the best explanation for the beginning, and the fine-tuning parameters of the universe. God bless you, Amen.

Chapter 5

Does Quantum Cosmology Explain a Universe from Nothing?

Have Stephen Hawking and Alexander Vilenkin truly created universes from nothing?

Thus far, we have reviewed the Kalam Cosmological Argument for the implausibility of an infinitely old universe; the scientific discoveries leading up to the modern consensus that the universe originated from a single point of zero volume a finite time ago; the evidence that our universe exhibits extreme fine-tuned initial conditions and physical laws; along with refuting some naturalistic interpretations and multiverse models. Now we are led to the last big enemy, Quantum Cosmology. Many claim that these theories have proven that our universe originated from absolutely nothing, while others claim that they explain how our universe is somehow eternal in age. So let's dive into what these models posit, and see if angry internet atheists are correct in these claims, or if they have fallen for blown-out-of-proportion article titles and slogans.

Quantum Cosmology has its beginnings in Stephen Hawking's book titled *A Brief History of Time: From the Big Bang to Black Holes* in 1988. If you remember from previous discussions, Stephen Hawking aided in the confirmation of the singularity theorems, but he found the implications of a temporal beginning to be unsatisfying. Thus, he formed a theory of cosmology that was analogous to Quantum Physics, a model that described the universe before it was the size of the Planck Length. This theory of particle physics describes the behaviour and relationships of subatomic particles that exhibit wave-like properties. At some point in the universe's past, it would have been smaller than 10^{-35}m in diameter, a size physicists would have to take into consideration. At this incredibly small size, the laws of General

Relativity break down, and Quantum Mechanics must be applied, which is a probability-based theory, as you will shortly see.

> "Einstein's general theory of relativity fails to take into account the quantum fluctuations which must be present in any physical process involving gravity; therefore general relativity cannot be extrapolated in an unmodified form to predict what will happen at or below the Planck length" *(Has Hawking Explained God Away?*, quoted in Meyer, *Return of the God Hypothesis*, Pg 349)

Imaginary Time

When Stephen Hawking was working out this new model, he discovered that in order to make calculations about the early universe, he needed to introduce a new concept called *Imaginary Time*. He then smudged it into Einstein's spacetime metric, sometimes called the *metric tensor*, which describes the geometry of spacetime (C. Allan Boyles, *God and Quantum Physics*, Pgs 94-99). He simply equated the ordinary time variable with this new imaginary time variable to calculate the possible states of the early universe, which he named the Wick Rotation (Wiltshire, *An Introduction to Quantum Cosmology*, Pg 488). When he performed the wick rotation, the result depicted a universe with spatial dimensions, but no preferred direction of time, imagine the universe as a cone with a point representing the beginning. Hawking essentially made the point of the cone a curve, eliminating the pointed temporal beginning. His math treated time as another dimension of space, but eliminated the need for a temporal beginning, only if he continued to use the imaginary time variable.

He claimed to have overcome the challenge of a beginning in the past in A Brief History of Time: "So long as the universe had a beginning, we would 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 simply would be." (Hawking, *A Brief History of Time*, Pgs 140-141). A few years after Hawking produced his Quantum Cosmological model, Alexander Vilenkin also created another theory, one that attempts to explain how the universe originated from a singularity that came from nothing.

Lack of Physical Meaning and Arbitrary Value

When Hawking first released his work, many pointed out that his decision to equate time with imaginary time had no physical justification. It seemed that his only reason for doing so was that it enabled him to make the calculations he desired to make about the early universe. When imaginary time replaced ordinary time in the metric tensor, the resulting mathematical structure has no correspondence to anything in the physical universe.

> "Instead, time, when confined to the imaginary axis of the complex plane... has no physical meaning. Hawking himself acknowledged as much. As he explained, imaginary numbers are a mathematical construct; they don't need a physical realisation; one can't have an imaginary number of oranges or an imaginary credit card bill." (Meyer, *Return of the God Hypothesis*, Pg 352)

Moreover, Hawking's justification was that science does not tell us anything objective about the universe; it only creates models to explain what we see at that time, thus it is acceptable to make a model using mathematics that do not correspond to the physical. But if we strong-man this position and impose its logic upon itself, we see that his own theory also tells us nothing objective about the universe either! Therefore, Hawking's method of treating time as another spacetime dimension does not result in a mathematical expression with any physical meaning; there was no sense of a universe changing over time. You see, in General Relativity, time and space are linked (X, Y, Z, and CT), but they are treated fundamentally differently. Events happen in space in a temporal, chronological sequence, but Hawking collapses time into a dimension of space; thus, his math does not offer a description of spacetime that applies to the universe we inhabit.

Stephen Meyer informs us in *"Return of the God Hypothesis"* that Hawking discusses the lack of realism in his mathematics, but then draws metaphysical and scientific implications, primarily his claim of eliminating the need for a temporal beginning. Also, whenever his mathematical construction of spacetime is transformed back into the real domain, with an ordinary time variable, singularities reappear:

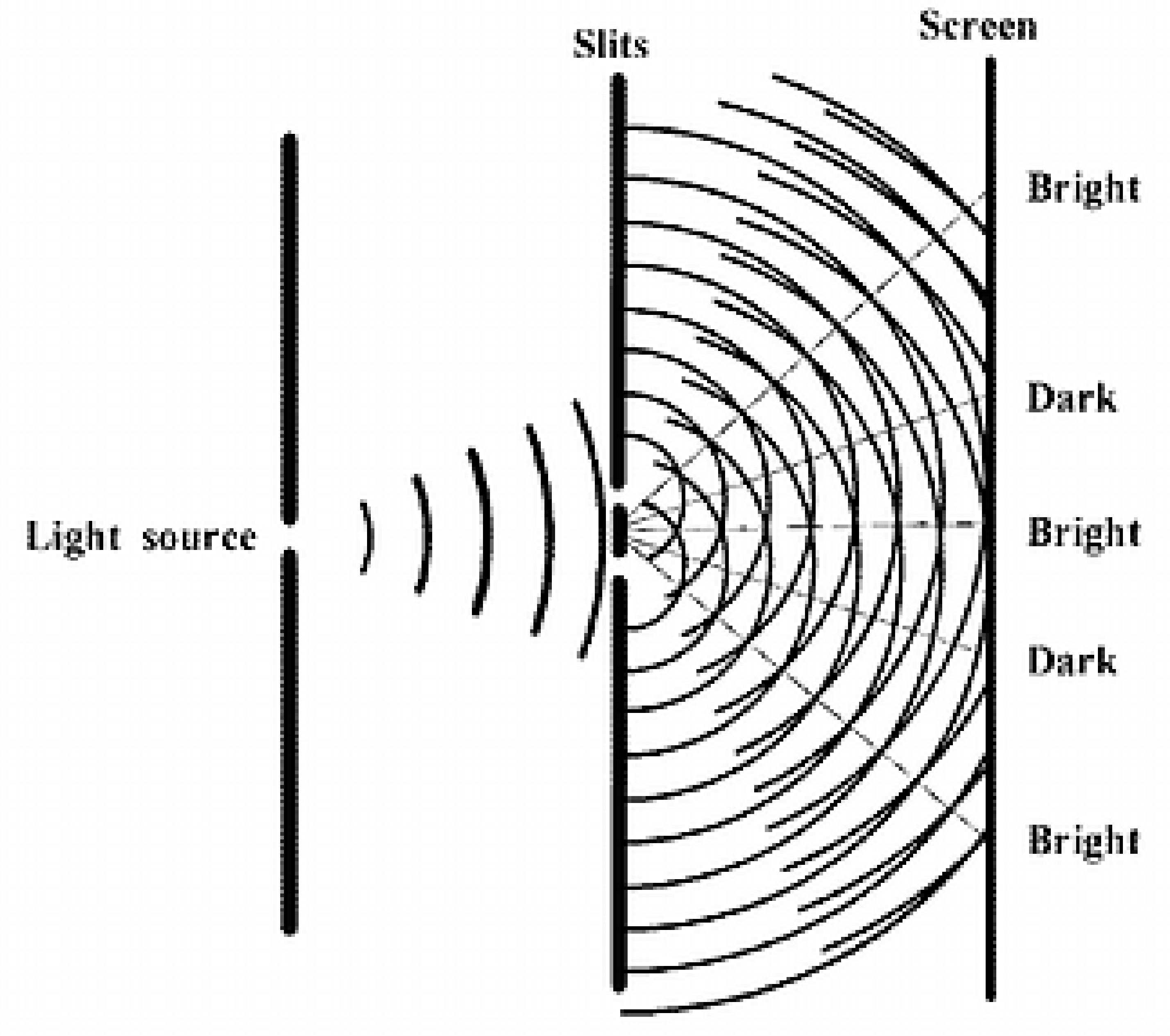
> "Only if [we] lived in imaginary time would [we] encounter no singularities… In real time, the universe had a beginning and an end at singularities." (Hawking, *A Brief History of Time*, Pg 136)

Analogous to Quantum Physics

When developing quantum cosmology, cosmologists sought to apply phenomena from standard quantum physics to the early universe. Quantum physics was created to describe the nature of wave-like particles (photons, electrons, and other subatomic particles). So, to understand quantum cosmology, you must understand the formation of quantum physics.

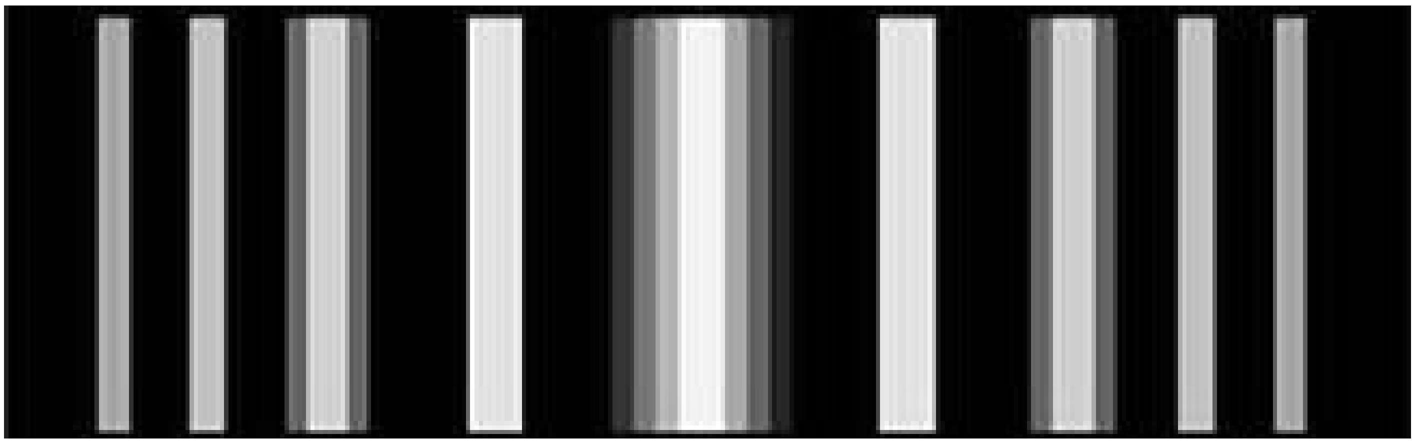
The Development of Quantum Physics

Before the year A.D. 1801, the opinion on the nature of light was split. Some believed light was a particle, like Newton, who described light as a particle, claiming it better explained optical reflection; and some who believed it was a wave, because it could be split into different wavelength colors by passing it through a prism. In 1801, *Thomas Young* performed the famous double-slit experiment. He passed a single wave of light through a slit in a divider; he also passed the light through the first divider, into a second one with two slits, and then finally terminating on a detection plate. Whenever he passed light through the second divider with two slits, the detection plate exhibited a wave-interference pattern characteristic of waves.



Waves of light passing through two slits create two smaller waves that interfere with each other, leaving dark and light spots on a detection plate.

When two waves overlap, they create points of increased height where their peaks line up (constructive interference), and areas where their peaks do not align, they cancel out (destructive interference). Where waves interfere constructively appear as light stripes on the plate, while the areas where the peaks cancel out exhibit dark stripes (shown below).



The lighter stripes are where the waves interfered constructively, the dark stripes are where they interfered destructively.

This seemed to confirm that light behaves like a wave, but there was another particle confirming phenomenon, known as the *Photoelectric Effect*. In 1887, *Heinrich Hertz* conducted an experiment where he bombarded a piece of metal with light, causing the metal to emit electrons from its surface. Many predicted that since light was a wave, the amplitude (height of the wave) of the light determined the kinetic energy of the electrons, but it was actually the discrete frequency that determined the kinetic energy, characteristic of particles. Albert Einstein suggested that light energy propagated through space in concentrated packets of energy called photons. This is because photons would not cause electron emission unless they reached a specific minimum energy; thus, Einstein proposed that light traveled in small discrete packets of energy called "quanta".

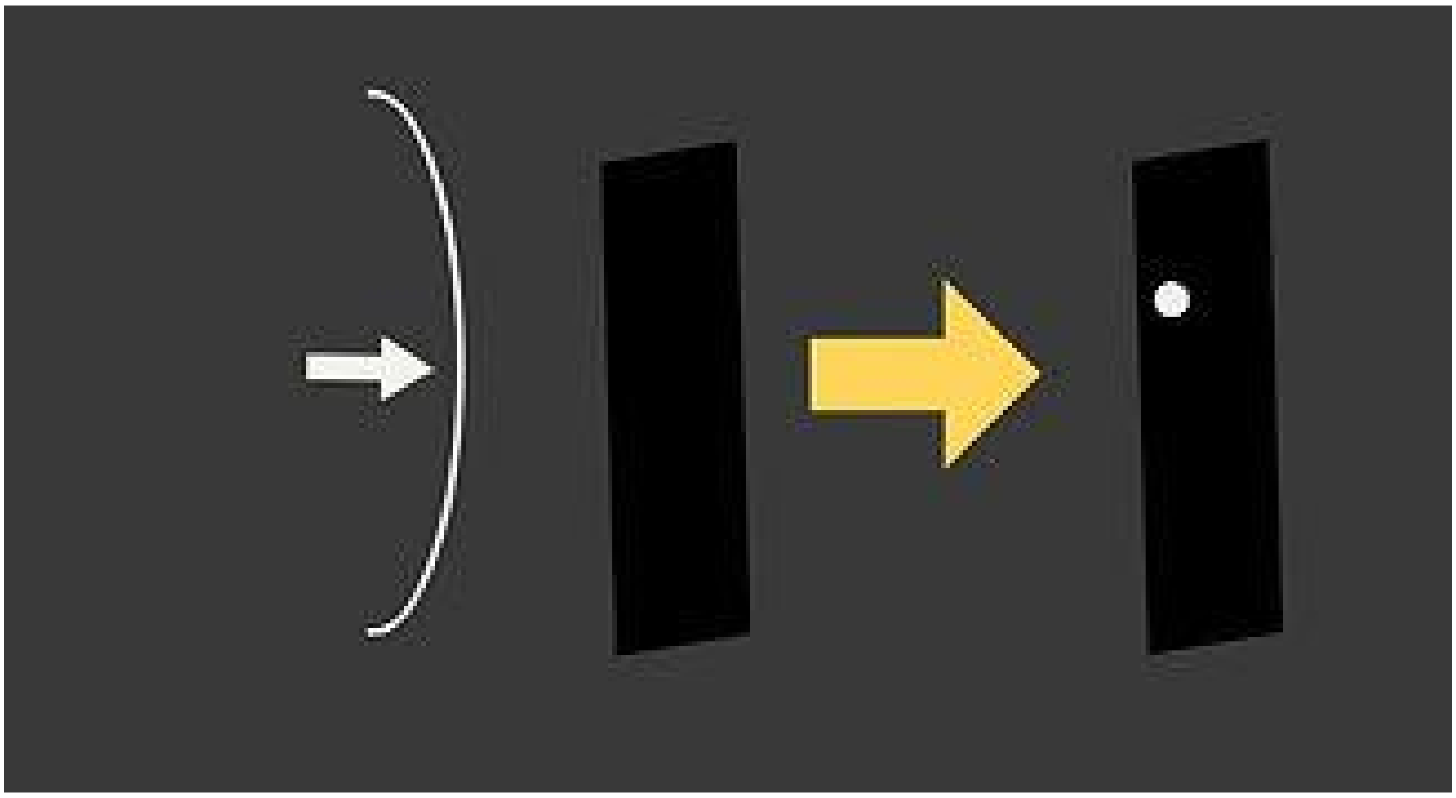
Light was then seen as obviously behaving like a wave, but also like a discrete particle of energy. Then, another experiment came along that further confirmed the particle-like nature of light, also using the double slit apparatus. In 1909, *Geoffrey Taylor* performed the double-slit experiment, but lowered the light intensity so that the photons were separated enough to practically pass through the divider one at a time. In theory, this would guarantee there would be no interaction between photons, and thus no wave interference pattern should emerge. His method did result in small dots of particle-like packets of energy hitting the detection plate, but as more and more arrived, the same wave-like interference pattern emerged. This suggested that the photons were passing through the slits as single waves, creating two smaller waves via the two slits, but as they made contact with the plate, they collapsed into a specific position along the spread of the waves.

Later experiments confirmed the wave-particle dual nature of light and other subatomic particles, and by the 1920s, a mathematical theory was being developed that was able to describe the wave-particle nature. What resulted from this endeavor was the Schrodinger equation, named after *Edwin Schrodinger*. This equation allows physicists to calculate the probability that a specific particle will manifest at any given location across the spread of a wave of energy. Before a particle makes contact with a detector, film, or plate, physicists do not know where the exact location of the particle is; they only know where it may manifest upon observation.

How Does the Schrodinger Equation Work?

The Schrodinger equation is a *differential equation*, which is an equation that generally describes the behaviour of objects in a physical system or apparatus. Their solutions do not represent specific numbers, but rather entire functions. Differential equations also generally have a near infinite number of possible solutions when left alone. But these solutions are functions in themselves, all having specified constants, and must be defined after a mathematician fixes these values by providing what are called boundary and initial conditions. For example, an equation describes how much damage a car may experience during a collision, but to predict how much damage will be done, a physicist must know the mass and material of the car, and the initial conditions of the vehicle must be known, like the initial velocity and forward momentum. A physicist must also know how fast the car is moving and what it may collide with (boundary conditions). Before this information was put in, the amount of damage could have manifested many possible values, but once these conditions were applied, it limited the possibilities to a fixed value that would occur if a car of (x) mass traveled at (y) mph into a wall made out of (z) material. Similarly, the Schrodinger equation must have boundary conditions specific to the system being observed to be solved.

When the Schrodinger equation is solved, it produces a wave function that is represented with the symbol, Ψ. The wave function can only be produced once a physicist fixes boundary conditions in accordance with the experimental apparatus she is using. Since the wave function allows a physicist to calculate the possibility that a particle will manifest in a specific location along a wave, the wave function represents the wave before observation, and the *collapse of the wave function* is when the wave collapses into a manifested particle with a position. This concept also introduced the idea of *superposition*: before an observation is made on a wave of energy, particles exist as mathematical possibilities in multiple undetermined states at one single time, only manifesting a location in space after an observation.



A wave of light (to the left) makes contact with a detection plate. When this happens, a particle will manifest at some point along that wave (on the right).

This is why quantum physics is fundamentally a probability-based theory; there is no 100% prediction of where or how a particle will behave, only predictions of possibilities. When this was discovered, that particles existing in the Planck length exhibited a probability behaviour, cosmologists sought to apply this to the early universe, when it was at a size smaller than 10^{-35}m; therefore, quantum cosmology is analogous to quantum physics.

Quantum Cosmology

Since the universe is presently expanding, reversing that expansion back in time would result in a smaller universe. Eventually, you would reach a size on the scale of quantum phenomena, where gravity as described by General Relativity does not apply. To date, there have been no successful models for a theory of quantum gravity. Thus, quantum cosmologists sought to develop a theory of quantum cosmology mathematically analogous to ordinary quantum physics.

The Wheeler-DeWitt Equation and the Universal Wave Function

Recall how the Schrodinger equation is a differential equation that allows a wave function to be derived, which offers possible locations for a particle to manifest along a wave. In quantum cosmology, the Schrodinger equation is replaced by the *Wheeler-DeWitt equation*. This differential equation allows cosmologists to develop a wave function for an entire universe, a universal wave function. The universal wave function describes different universes with different possible spacetime curvatures and mass-energy distributions that affect their overall gravitational field. The universal wave function then describes different possible spatial geometries and configurations of matter and energy that a universe may manifest.

Superspace

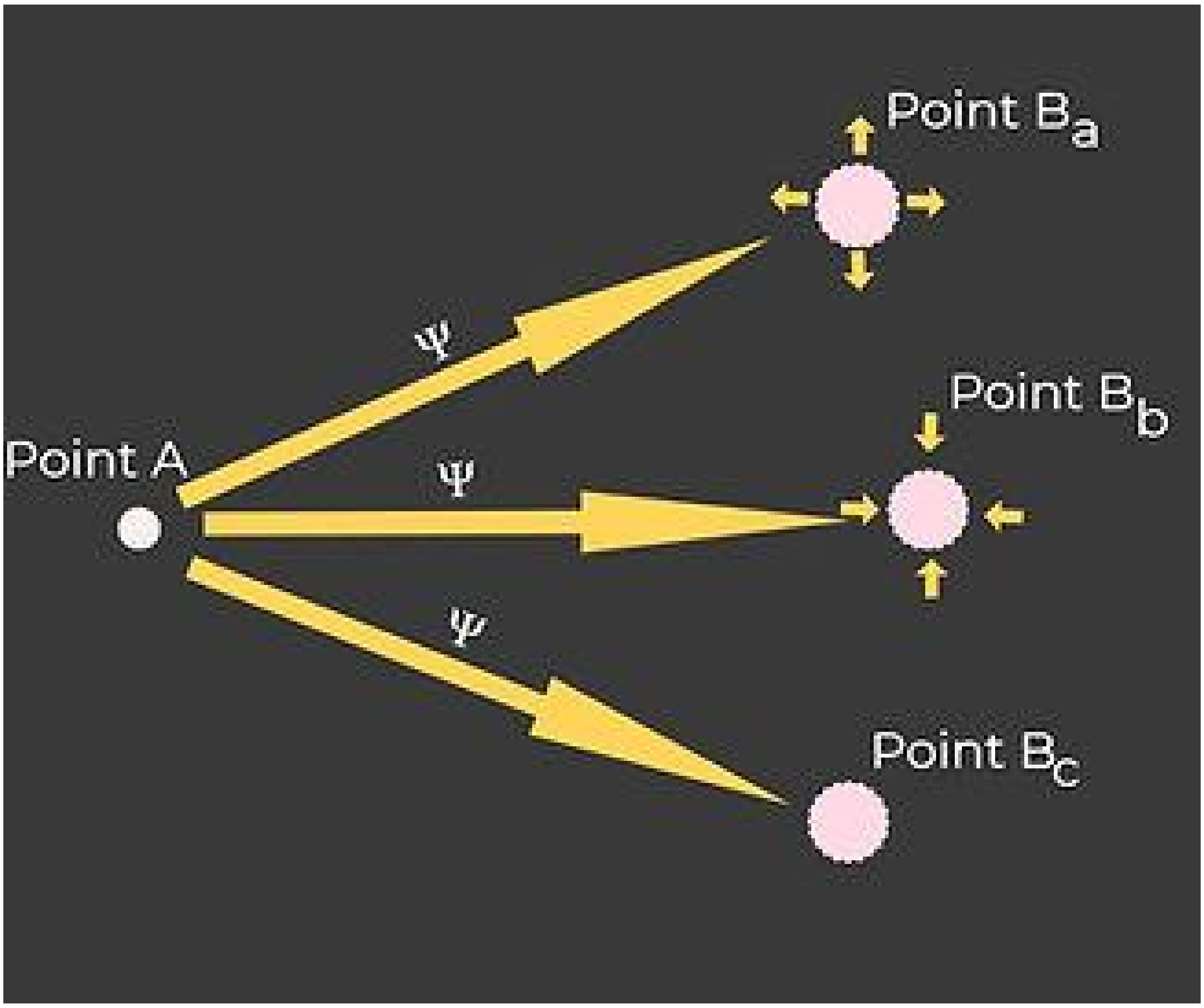
In quantum physics, before a wave is observed, a particle exists in many different indeterminate locations along the wave, and this is called superposition. In quantum cosmology, this concept is taken into consideration as well. The mass-energy distributions within space that affect the curvature of spacetime determine what kind of gravitational field a universe may have. The universal wave function describes different pairings of spatial geometries and mass-energy distributions, represented as ordered pairs that exist in an abstract space of pure mathematical possibilities called *Superspace*. The ordered pairs, representing different universes, are written as: Ψ(*Spacetime Curvature*, *Mass-energy Distribution*). This idea of superspace was analogous to the concept that there are many possible locations a particle may manifest along the spread of a wave of energy in superposition (Meyer, *Return of the God Hypothesis*, Pg 362).

Thus, physicists can create a universal wave function that describes the entire universe from the Wheeler-DeWitt equation and then calculate the probability that any specific universe will emerge from a singularity (Wiltshire, *An Introduction to Quantum Cosmology*, Pgs 496-498).

The Quantum Cause

For quantum cosmology to offer an adequate explanation for the origin of the universe, the Wheeler-DeWitt equation must produce a universal wave function that includes our universe as a reasonably probable outcome. Stephen Myers says, "Understanding how physicists use quantum cosmology as an origins theory requires keeping just three main elements in view: first, the origin of the universe… **the thing to be explained**; second, the universal wave function, the mathematical entity **that does the explaining**; and, third, the Wheeler-DeWitt equation and the mathematical procedure for solving it, and **the alleged justifications** for treating the universal wave function as an explanation fo the origin of the universe." (Meyer, *Return of the God Hypothesis*, Pg 363).

Stephen Hawking developed his model with *James Hartle* based on the previously mentioned Wheeler-DeWitt equation. They were attempting to remove the need for a singularity by explaining the beginning of the universe on purely naturalistic terms. In doing so, they used a method called *sum-over-histories*. In ordinary quantum physics, the sum-over-histories method is used to sum up all the mathematical expressions that describe the possible paths a particle may take in an experimental apparatus, allowing them to construct a wave function. Hawking and Hartle wanted to apply this method to sum up the expressions that describe possible paths from the presupposed singularity, through superspace, to possible universes with different gravitational fields.



The universe came from the singularity Point A, and travels through superspace to many possible universes Point B_{a-z}. In this diagram, Point B_a represents a universe with a positive cosmological constant (C) and distribution that allows expansion, Point B_b represents one with a negative C and a distribution that overcomes gravity causing collapse, and Point B_c represents a static universe for easier understanding. The yellow arrows represent different paths through superspace.

They assumed the universe originated from a singularity they called Point A, with many different trajectories to possible Point B's, or other universes. This trajectory travels through superspace and into a possible gravitational field. If Hawking and Hartle summed up all the possible paths, just like in quantum physics, they could construct a universal wave function. When this universal wave function is made, it produces a probability distribution that allows them to calculate the probability of any universe (Point B) emerging from Point A. If the wave function includes a universe like ours as a probable outcome, then they could claim to have explained the beginning of the universe in quantum terms.

But, they could only solve the Wheeler-DeWitt equation by replacing ordinary time with imaginary time. When Hawking and Hartle performed the Wick rotation, the resulting mathematical expression temporarily described a universe with no temporal singularity. They were also able to make a universal wave function that included our universe. They began by calculating a ground-state function for the universe. In quantum physics, a ground-state function describes an electron in its lowest energy state, allowing physicists to determine the probable position of said electron in its lowest orbital. By analogy, a ground-state universal wave function allows cosmologists to calculate the possibility of any given universe emerging from superspace. But Hawking and Hartle's function only described closed universes, ones that do not continue to expand, but recollapse into a singularity (our universe is an open universe). To explain this problem, they postulated that some closed universes can undergo quantum tunneling into an open state with continuous expansion. In doing so, they still never removed the singularity; they continued to assume it (Meyer, *Return of the God Hypothesis*, Pgs 508-509, notes 47-49).

First-Glance Problems

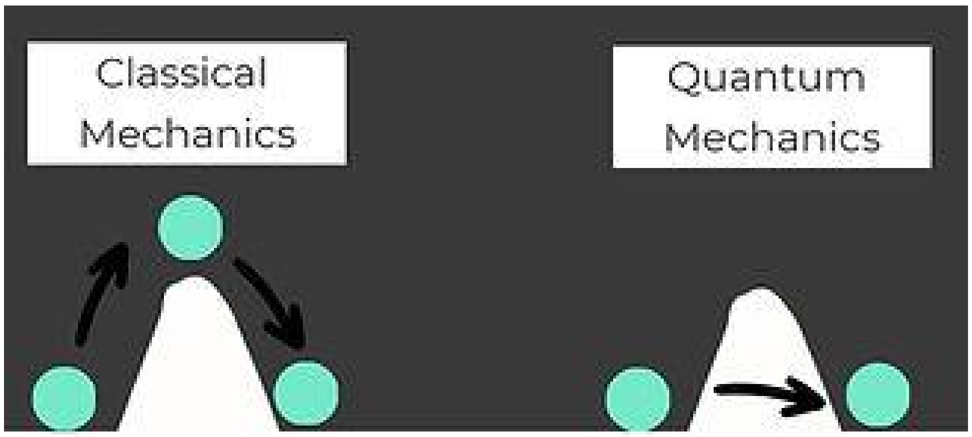
But their model had some first-glance issues. First, they did not eliminate the singularity that they presuppose many universes could emerge from in superspace. Their interpretation of a non-temporal beginning was from a mathematical expression with zero physical meaning. Second, Hawking and Hartle had to limit the number of possible paths through superspace in order to create a universal wave function that includes our universe. They only chose certain paths, ones that met criteria they made up. They only included universes that were isotropic, closed, spatially homogenous, and with a positive cosmological constant. In other words, they had to arbitrarily restrict the mathematical freedom of the Wheeler-DeWitt equation, as well as positing a rare quantum event of tunneling into a higher energy state of continuous expansion.

Redefining Nothing

Apart from Hawking and Hartle's model, there was another person who attempted to create a quantum theory of the origin of the universe. This model was created by Alexander Vilenkin, as he lays out in *Creation of Universes from Nothing*. In his book, he proposed that the universe began from a singularity of zero volume, but experienced the previously mentioned quantum tunneling into a space able to experience continued expansion. The probability of this tunneling occurring was determined by the universal wave function Vilenkin used. *Lawrence Krauss* further popularized this model in his book *A Universe from Nothing*, where he claims that the laws of physics explain how the universe came from nothing. This implies that a mathematical equation created in the human mind causes the universe to come into being, a position that has some startlingly theistic implications.

Quantum Tunneling

In order for the universe to reach a state of continuous expansion, the singularity must have experienced some sort of quantum tunneling phenomenon. In quantum physics, tunneling refers to a process where a particle can overcome an energy barrier, despite lacking sufficient kinetic energy to do so. The wave function not only allows a particle to manifest along the spread of a wave, but also the slight chance that a particle may manifest on the other side of a barrier.



Depiction of Quantum Tunneling, where a particle can overcome an energy barrier even though it lacks the kinetic energy to do so.

Vilenkin applied this idea to the development of the expanding universe. He first assumed the universe began as a singularity, which begins to expand slightly but recollapses under the gravitational energy barrier of the mass-energy within it.

He posited that such a closed universe could randomly undergo tunneling and overcome the gravitational barrier and continue to expand. In the standard Big Bang model, fine-tuned initial conditions account for the continued expansion of space, but in these models, the universe tunnels through the gravity barrier into continued expansion.

Hawking and Hartle posited that tunneling occurs to transition their closed universes into open ones that can expand indefinitely, but this doesn't account for the beginning of the universe, only the development of it. Their model made a solution that described a universe that was initially closed; they then envisioned this already existing closed universe tunneling into an open state of expansion.

Can Quantum Tunneling Explain a Universe from Nothing?

So then, does quantum tunneling offer an explanation/physical mechanism for explaining how the universe originated from nothing? Vilenkin assumed an already existing universe before it tunnels through its gravitational energy barrier; likewise, Hawking and Hartle assume an already existing closed universe that tunnels into an open state of expansion. In both cases, an already existing universe is presupposed that is able to undergo tunneling. But does this explain the origin of the universe? It does not. It only explains the universe's later development to be suitable for life.

How then could the process of tunneling preexist the universe, when it is the universe that is experiencing the tunneling? Moreover, for the wave function to be solved, an experimental system must already exist so that it can describe the possible paths of a particle. It logically follows, then, that a universe must already exist for cosmologists to create a universal wave function that describes its possible properties within superspace. The system and particle logically precede the Schrodinger equation in quantum physics; thus, a universe with possible features must also precede the Wheeler-DeWitt equation. Quantum Tunneling cannot explain the origin of the singularity because it presupposes it in order to function.

Can Physical Laws Cause Universes?

Some people, including Lawrence Krauss, claim that the laws of physics explain the origin of the universe. When they do this, they are referring to the mathematical structure of the equations within quantum cosmology. They envision these laws causing a physical event to occur, but this logic is making a category mistake.

When a cue ball hits an 8-ball on a pool table, the law of conservation of momentum allows one to predict the movement of the 8-ball after being hit by the cue ball. But the law itself is not what causes the 8-ball to travel into one of the pockets; the cue ball colliding with it is what causes the event to happen. The physical law simply described what happened. Similarly, the law of gravity is not what causes objects to fall to the ground on Earth; it only describes the interaction of material objects with each other after they are inside space. The laws of physics describe the interaction of matter and energy that already exist.

Causes are events that precede other events in time that meet specific material conditions to produce said effect. Since laws describe relationships between events and variables in nature, and descriptions of nature do not cause events in nature, the laws of physics do not cause events. The universal wave function only describes the superposition of the universes that could exist without ever specifying anything that can cause one path through superspace to be favored over another. Also, in both main models, universes arise from an already existing singularity with zero volume. Quantum cosmology presupposes a singularity while never providing a cause for the origin of the universe in the wave function or the superspace that may come out of it.

According to proponents of these models, before the universal wave function, there was no space, no time, and no energy to describe possible gravitational fields. There is nothing physical prior to the wave function, and superspace represents an immaterial, timeless, spaceless, and infinite realm of purely mathematical possibilities with no necessary physical existence. Thus, no material condition preceded the beginning, and it cannot be by definition, not even in quantum cosmology.

Prior Information and the Problem of the Mind

With the fact that the laws of physics cannot cause the universe, and mathematical equations do not cause events, what is it that does anything at all with these equations? Alexander Vilenkin acknowledged that his process of quantum tunneling is subject to laws that should be there prior to the universe itself: “Does this mean that the laws are not mere descriptions of reality and can have an independent existence of their own? In the absence of space, time, and matter, what tablets could they be written upon? The laws are expressed in the form of mathematical equations. If the medium of mathematics is the mind, does this mean that mind should predate the universe?" (Vilenkin, *Many Worlds in One*, Pg 205). If the laws of physics predate the universe, then what caused the universe, if equations, again, cannot cause anything alone?

> "What is it that breathes fire into the equations and makes a universe to describe?" (Hawking, *A Brief History of Time*, Pg 174)

This left them with two options to explain this problem. They could either claim that the laws only exist in the minds of humans, and thus have no causal power, or they could claim the laws exist separately from the human mind, and through an unknown mechanism produce universes, like the SAP seems to claim. But there was another option, if they were willing to entertain it, namely, that these laws exist inside of and originate from a preexisting transcendent mind. But math has no material causal powers apart from minds that can use it to understand nature. To deny that is to treat math like an actual material entity, which is logically fallacious. We have zero unified experience of mathematical equations creating a material state. Thus, if mathematical entities preexist the universe, they alone would have no causal adequacy to produce a universe, themselves only describing possible ones existing at once in superspace. It seems like a mind must act upon these laws, and from our experience, these laws must originate from a mind as well.

These models also presuppose existing universes before the very mechanisms they claim explain how they originated can act. But not only do cosmologists presuppose a universe, they also smudge information into the equations before a universal wave function is derived. An act that reflects a transcendent intelligence. The Wheeler-DeWitt equation allows for an infinite number of possible solutions. To calculate a specific solution, a physicist must choose boundary conditions and impose them on the equation before solving it. But this raises an issue: how will they impose boundary conditions when they claim there is no system to derive them from in existence yet?

Differential equations describe the behavior of systems, and without specific boundary conditions of a particular system, they will have an infinite number of possible solutions. Once the conditions of the system being observed are derived through observation, differential equations allow one to predict and describe the future behaviour of objects in the system. The Wheeler-DeWitt equation also has an infinite number of solutions, but physicists need information about specific boundary conditions to solve it. "In ordinary quantum mechanics, the boundary conditions for the wave function are determined by the physical setup external to the system under consideration. In quantum cosmology, there is nothing external to the universe, and a boundary condition should be added to the Wheeler-DeWitt equation" (Vilenkin, *Quantum Cosmology*, Pg 7, quoted in Meyer, *Return of the God Hypothesi*s, Pg 378).

Thus, physicists themselves must arbitrarily limit the mathematical freedom of the Wheeler-DeWitt equation in order to solve it and produce a wave function that includes our universe. They do this by applying boundary conditions that limit the values of superspace, creating what they call *mini-superspace*. Furthermore, Vilenkin decided to make arbitrary assumptions about the nature of the possible universes to emerge, namely, ones that were isotropic, homogeneous, and closed. Therefore, the wave function they produce is the result of very arbitrary limitations they themselves apply to the equations.

On the other hand, Hawking and Hartle also committed the same act by only choosing certain kinds of universes with specific geometries to be included in their sum-over-histories approach. They only chose paths through superspace that included universes that were isotropic, homogeneous, and had a positive cosmological constant. They further restricted the equations' freedom by only choosing paths that exhibited an imaginary time variable, none that had ordinary time. (Hawking and Hartle, Wave Function of the Universe, Pg 2967). Stephen Meyer claims that these models that restrict superspace "constitute *ad hoc* constraints on the process of constructing the universal wave function. In a recent interview, James Hartle acknowledged as much. 'I have to tell you in confidence,' he explained, 'that whenever we do one of those calculations, we have to use very simple models in which lots of degrees of freedom are just eliminated. It's called mini-superspace.... It's how we make our daily bread, so to speak.'" (RGH, Pg 381, referenced from https://www.closertotruth.com/series/what-quantum-cosmology).

Someone commits the *ad hoc fallacy* when they provide a new, unsupported, or untestable explanation to support their argument. Often seeming to be too unrealistic or of a "storytelling" nature in a debate or discussion. In this scenario, claiming to explain the universe from nothing, while obviously not explaining the beginning and origin from nothing and redefining nothing to be something, exhibits an unrealistic and untestable, doubtful response to these criticisms mentioned above.

Conclusion of Chapter 5

As we have seen in this article, the famous quantum cosmological models that claim to create the universe from true nothingness all fall short of actually explaining origins from nothing. The mathematics that "produce" a universe require prior information that simply wouldn't exist if nothing were beforehand. No model determined specific boundary conditions imposed on the equations; the one doing the math arbitrarily decides them. This implies information being acted upon prior to the universe leaving superspace; in simpler terms, a mind must have created a mini-superspace that guaranteed our universe. The Copenhagen interpretation of the collapse of the wave function also supports this. By positing that an observer causes the collapse of a wave to a particle position, an observer must have observed the universal wave function in order for it to collapse into a possible universe, because on their own, equations do not cause material events. There are no mathematical equations that have ever caused or created a material state; only when a mind uses them to understand nature can they act upon them and cause things. Minds have causal adequacy, but math does not. Therefore, if equations precede the universe, they would have to exist within the confines of a transcendent mind that can use and act upon them.

Quantum Cosmology does not explain the universe; it actually supports theistic design. May God give you the discernment to decide what is true and what is false. through a sober and logical mind. So come, and let us reason (Isaiah 1:18), and decide on the nature of what caused the universe... our LORD Jesus Christ. Amen.

"For his invisible attributes, namely, his eternal power and divine nature, have been clearly perceived, ever since the creation of the world, in the things that have been made. So they are without excuse" (Romans 1:20)

"Yet for us there is one God, the Father, from whom are all things and for whom we exist, and one Lord, Jesus Christ, through whom are all things and through whom we exist." (1 Corinthians 8:6)

"In the beginning was the Word, and the Word was with God, and the Word was God. He was in the beginning with God. All things were made through him, and without him was not any thing made that was made." (John 1:1-3)

What Now?

After reviewing each naturalistic model in detail, and revealing their faults and shortcomings for being adequate explanations for the origin of the universe; I think we can state with high confidence that the second premise of the Kalam Cosmological Argument is true. The universe did indeed have an absolute beginning some time in the finite past. Before which there was no space, no energy, and no time to do any sort of causing.

We can now look towards determining the nature of this cause, and whether a God may be the best explanation for the beginning of the universe.