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The Logical Impossibility of a Beginning to the Universe

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One of the common modes of failure in the application of the scientific method is failure to check if a hypothesis is a logical possibility. The hypothesis that there is a beginning to the universe is one of those cases. When we examine the definition of the word "universe" and require that the universe comply with the principles of causality and conservation of energy, we find that a beginning is a logical impossibility. The universe must have always existed. In particular, under standard quantum field theory, space is filled with a tremendous amount of energy that must be conserved. It can also be shown that mass-energy of matter is conserved based on its equivalence to the zero-point energy. Physicists and others who hypothesize a beginning to the universe are in general misusing the word or otherwise applying a non-standard definition to the word "universe."

1. Introduction

Before the scientific method became the commonly accepted mode of rational thought, thinking about the universe was dominated by religion. Most religions have or had a creation myth where its god or gods created the universe and everything in it. As the scientific method became the accepted structure underlying rational thought, scientists often failed to question this historical pro-beginning bias.

In simple terms, the scientific method starts with a question, which is based on observations of some phenomenon. Then a hypothesis is formed to answer the question and explain the observations. Next that hypothesis is tested against further observations and experimental results when available. And lastly, other scientists review the hypothesis and related evidence to determine if it should become generally accepted as a theory.

What is usually left out of the basic description of the scientific method is that we must also consider whether a hypothesis is a logical possibility or otherwise known to be fictional. If it is logically impossible, the hypothesis fails without needing to be tested. Hypotheses that are logical impossibilities fall into a larger class of hypotheses that are otherwise fictional or mythological in nature.

The idea that the universe has a beginning is one of those hypotheses. It fails the logic check. Consequently, hypotheses about a beginning to the universe are more broadly mythology and fiction, even when they are conceived by scientists and could be called science fiction.

The idea that there is a beginning to the universe logically fails due to three main problems:

a. It violates the principle of conservation of energy.
b. It violates the literary definition of the word "universe."
c. It violates the principle of causality.

By examining each of these problems, we find that the idea that the universe has a beginning is fallacious. Scientists and others confuse the definition of "universe" by redefining it based on various theories of a beginning, or matter production, or to solve similarly broad problems.

2. Conservation of Energy

The principle of conservation of energy is one of the most widely accepted theories in science and every hypothesis and theory must comply with it. This principle is usually summarized in short that energy can neither be created nor destroyed, but can only be converted from one form into another.

Consequently, in order for universe's total energy to be conserved, the energy must have existed for an infinite time into the past, and must exist for an infinite time into the future. Therefore, the universe has existed for an infinite amount of time into the past and will exist for an infinite time into the future.

The total amount of energy in the universe not only includes all of the energy that is visible or otherwise directly observable, but includes all forms of energy present in the universe, including forms that are not directly observable.

Importantly, we have convincing evidence, by way of the Casimir effect and other phenomena, that space is not empty. Based on standard model quantum field theory space is filled with energy often called zero-point energy. As such, the zero-point energy of the universe must be conserved as well. Some physicists have been known, however, to irrationally exempt zero-point energy from the principal of conservation of energy requirement, without any rational reason.

The zero-point field is estimated to have the mass equivalent energy of 10^{94} grams per cubic centimeter if we neglect vacuum fluctuations smaller than the Planck length.[1] If we do not use the Planck length or other cut-off wavelength, the energy of space in any unit volume is infinite.

Any hypothetical idea about the universe having a beginning must account for all the energy in normal space including the zero-point energy. Presently the only place we know where the amount of zero-point energy in normal space can be stored is in normal space itself. Therefore, the only place we know where the total energy of the universe can be stored is in the universe with its expanse of space.

All existing hypotheses that claim a beginning to the universe fail the principle of conservation of energy test. There is no alternative physical structure or place where the total energy of the space that fills the universe can be stored. A beginning to the universe is a logical impossibility.

3. Violation of the Definition

Physicists and non-physicists that talk about the universe have a tendency to redefine it as they want, ignoring the literary or dictionary definition. This leads to much confusion. They commonly try to confuse the definition in order to support their hypothetical idea of a beginning, or support their idea of how matter was produced. To understand the problem with these ad hoc definitions, we need to look at real definitions of the word "universe."

> *Universe: All existing matter and space considered as a whole.*

In essence the universe concept begins as a boundless container that contains all space and all physically real matter within that space. Some people add energy to the definition. But if all energy is a form a matter, adding energy to the definition is redundant. That said, we could use the word energy instead of matter, except, one could argue, we have better understanding of what we mean by matter than what we mean by energy.

In another dictionary the definition is "the whole body of things and phenomena observed or postulated." This definition unfortunately adds postulated things which may be fictional things which makes it a poorer definition. The universe does not contain fictional things.

Then to dig deeper we need to know the definition of "space."

> *Space: a boundless three-dimensional extent in which objects and events occur and have relative position and direction.*

This dictionary definition, from the same one as the poorly worded example of universe, also has problems. "Bare" space does not come with dimensional lines or a coordinate system etched into it. Those are things humans overlay on top of space. A better definition of space would just be a boundless extent in which objects and events occur. But, the word "occur" implies time which is something else that we overlay on space. "Bare" space does not contain clocks. An even better definition of space is then a boundless extent containing matter.

The later definition is essentially the same as the definition for universe, so by any scientifically valid definition they are indistinguishable. Except, in the definition of universe we can think of it containing multiple bounded regions of space. Both the universe and space are non-physical boundless containers that contain all matter.

The thing about conceptual non-physical boundless containers is that they always exist. They cannot be created nor destroyed. They are not physical, except by virtue of the physical matter they contain.

So, by their literary definitions the universe and space have always existed and always will exist. It is a logical impossibility for them to not have existed at some point in the past. That does leave the questions about how matter arises and how mass-energy is conserved, so they will be addressed in a later section.

We must also note that since the universe contains all space and matter by definition there can be nothing outside the universe. There cannot be multiple universes since the universe contains everything which would necessarily including multiple universes, which must be individually bounded. Some hypothetical universes in physics are fictional and not worth consideration. A hypothetical bounded universe—actually a bounded region of space, not a universe—within the universe may be thought to have a beginning, but the universe does not.

4. Violation of Causality

Perhaps the strongest argument that a beginning to the universe is a logical impossibility is that it is a violation of the principle of causality. The principle of causality refers to the cause and effect relationship. Causes lead to effects and effects have causes. So, in order for a universe to be produced, something had to be present to produce it.

And, if that something that produced the universe was also produced, then something would have had to produce it, ad infinitum. So, logically speak something had to exist for an infinite time into the past in order to satisfy causality. And that something would have to be able to store all the energy in space as noted previously.

This is where religions step in and say, it is their god or gods that existed forever and magically created the universe, and in the process, violated every accepted theory in physics including the principle of conservation of energy. While, at the same time, the religious never bothering explaining how a god accomplished this feat of godly magic with anything approaching a scientifically and logically rigorous explanation.

In real science, the energy of space must have existed for infinity. All matter must also have been present for infinity or there must be a real physical mechanism that allows matter to form from the energy of space without violating conservation principles. Matter and energy must be present in some real physical way, not as some non-physical abstraction that is ultimately fictional as well as non-physical. As noted above, the universe and space as containers, in the abstract sense, must already exist.

The only way for principles of conservation of matter and energy to hold, in addition to the principle of causality, is for the universe to exist for an infinite time into the past. There is no place other than space itself where the total zero-point energy of space can be stored.

It is a logical impossible for the universe to have a beginning without a cause, and the only viable "cause" is that the universe has existed for an infinite amount of time and there was no cause.

5. The Origin of Matter Problem

Based on the definition of the word "universe" and the principles of causality and conservation of energy, the universe must necessarily have existed for an infinite time into the past. It must necessarily contain all the energy of space including the quantum field energy. That leaves the problem of the origin of stable matter.

The two logical possibilities are that either stable matter has always been present or it was somehow produced from the energy of space such that the total energy is conserved. Note that quantum fluctuations can still be thought of as matter, but are individually unstable.

To understand matter and energy we must first return to Planck's theory of quantum harmonic oscillators as it applies to space. The theory tells us space cannot have a zero-energy state. It always has some non-zero energy that takes the form of a Planckian resonators. There is no such thing as "bare" space or empty space. Space is always filled with zero-point energy. So, that tells us the following:

1. The universe as a boundless container exists by default and it contains all space.
2. Space as a boundless container exists by default.
3. Space contains all the zero-point energy of space by default.

This puts us in a great position as the universe and space necessarily exist unbounded with respect to time or physical dimensions and necessarily contain an infinite amount of zero-point energy. So, the next step is to figure out the stable matter-energy conservation problem.

It turns out that this problem is easily solved based on an idea originally put forward by Paul Dirac.[2] While Dirac was interpreting the equation that bears his name he was puzzled that there was a negative energy solution that became known as the positron. One of the problems he considered was how both his positive (electron) and negative (positron) solutions would both have positive mass-energy.

He considered that space is filled with a sea of electrons and positrons in what is known as a Dirac sea. This is similar to modern quantum field theory except that we now more commonly describe it as quantum particle pairs, such as electron-positron pairs. What he proposed was that a stable particle must push on this sea in order for it to exist. We can think of an analogy of a body in water being pushed on by the water and having to push back in order to maintain equilibrium. The body displaces the water. A particle in space similarly displaces quantum fluctuations and their energy.

If we consider the quantum energy displaced by a spherical shell the size of the proton's charge radius, it is equal to the mass-energy of the proton. Consequently, a proton does not change the total energy in local space. The mass-energy of protons plus the local zero-point energy is constant and equal to the energy in an equivalent sized bounded space that contains no matter.

The same is true for an electron if we assume it displaces quantum field energy equivalent to that displaced by a Compton sized spherical shell. This is not surprising as the Compton radius of the electron has long been associated with electron mass. The proton and electron mass relationships are discussed in greater detail in another paper.[3]

This does not mean that either particle or neutrons, which are similarly proton sized, are actually spherical shells. It only means that they somehow displace quantum fluctuation wavelengths of that size. This displacement is evident in scattering experiments.

The presence of protons, neutrons, and electrons in space, which represents all stable matter, does not change the local energy of space. As such, the existence or possible production of matter does not violate the principle of conservation of energy. That still leaves open the questions of if the particles have existed for infinity or if they have been produced in some fashion along the way. That is a long discussion beyond the scope of this paper and one that requires additional investigation.

It is also important to note that since Planck resonators have frequencies and wavelengths. They have properties of time and distance. It is the quantum field of Planck resonators that gives space its spatial dimensionality as well as its property of time. So, while the fictitious "bare" space does not have these properties, real space that contains vacuum fluctuations does. Space still does not come with a pre-installed coordinate system.

6. Conclusion

It is easily seen through these three primary arguments that the idea that the universe could have a beginning is a logical impossibility. A universe with a beginning violates the principle of conservation of energy. It violates the definition of the word universe. And, it violates the principle of causality, the cause and effect relationship.

The energy of space arises from space as it is impossible for space to not contain zero-point energy. Additionally, no matter how stable matter arises within the universe, it does not change the total energy of the universe, and therefore, there is no violation of the principle of conservation of energy related to the existence of matter.

What we do find is ongoing misuse of the terms "universe" and "space" in science and popular science literature and media. People use non-standard definitions of those words in order to argue that the universe and space could have a beginning even though that idea is fallacious.

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References

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