

A Possible Solution to the Mystery of the Imbalance between Matter and Antimatter of the Universe

(Draft Version)

Some people think the Universe was created with equal amounts of matter and antimatter. However today's observations indicate that there is not enough antimatter to match the amount of matter observed. Thus, it seems that matter has, for some reason, taken over. Putting together an idea from two lead physicists: John Wheeler and Richard Feynman, the theory of the Pre-universe that I developed in 2012, and Everett's theory of the many-worlds, I found not only the possible cause of the imbalance but also that the imbalance began at the very beginning of time (normal time). Because matter and antimatter were created by a gradual and relatively very fast process (known as Meta-transformation), it is possible that most of the imbalance took place during the first instants after the Big Bang.

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1. Introduction

Both cosmological studies and a number of particle physics formulations indicate the same amount of matter and antimatter were created at the very beginning of *normal time* (see Appendix 1: Glossary). If this was so, then, why is antimatter so rare today? The observed imbalance between matter and antimatter was, until recently, a mystery. Our Universe would certainly have run out of matter very quickly because matter-antimatter *annihilation* would have converted most of the stuff that now surround us in gamma rays (part of the electromagnetic spectrum). Without this imbalance we, probably, wouldn't have been here. The aim of this paper is to explain the fundamental cause or primary cause of this imbalance and thus to solve one of the puzzles in modern physics.

At the first glance we might think that particles and antiparticles are very different physical entities. However, according to the American physicists J. A. Wheeler and R. Feynman, antiparticles

are negative energy particles moving backward in time. If this interpretation of negative energy states is correct then antiparticles are just an illusion created by our inability to travel backward in time along with them. In other words, because we are made of positive energy (normal energy) and because positive energy moves forward in time, we are forced to move forward in time as well. So particles are able to do things we, so far, cannot do: they can travel not only forward in time but also backwards, depending on the type of energy they possess. Does this mean that all properties of particles and antiparticles are identical? No, it doesn't. There are subtle known and certainly unknown differences between particles and antiparticles caused by the opposite direction of time travel. These differences include, among other things, the type of energy they possess (particles have a different type of energy than that of the corresponding antiparticles), the asymmetry in decay times, the electric charge (if the particles are electrically charged), etc. Our knowledge in this regard is very limited. However this might soon change as physicists from CERN are putting antimatter under the microscope to discover these differences. The following are some of the facts we know about matter and antimatter:

(1) the mass of particles and the corresponding antiparticles are thought to be identical. Despite the fact that the masses of particles and the corresponding antiparticles are thought to be identical, the energy content of them doesn't have to be identical. This is a consequence of Einstein's formula of equivalence of mass and energy:

$$E = \pm \sqrt{(pc)^2 + (m_0 c^2)^2}$$

This equation shows that, for a given positive mass, the energy of a particle can be either positive or negative. For example, when the relativistic mass, m (through $p = mv$), and the rest mass, m_0 , are both positive we get two different values of energy: one positive and one negative. The positive energy corresponds to a particle (e.g. electron) while the negative energy corresponds to its antiparticle (e.g. positron). It is a misconception to think that the energy of a particle and its antiparticle are of the same type. If particles and antiparticles were made of an identical type of energy, then they would not annihilate when they come in contact. So there must be some difference between the energy of a particle and the energy of the corresponding antiparticle (also for particles and antiparticles time runs in opposite direction so, when they come in contact, time stops "ticking" for both particles. Then their masses are converted into pure energy, in the form of gamma ray photons. This effect is called: *time cancellation* – see Glossary). Thus we draw the conclusion that the type of rest energy and relativistic energy that particles and antiparticles possess is somehow different. To make thing even more confusing, when a particle and an antiparticle annihilate, these two types of energies add up as if they were both made of the same type of energy. To explain all the differences between the type of energy particles and antiparticles possess is a major challenge of modern physics. So the negative sign of energy in the above equation is much more than a simple arithmetic sign, is telling us that there is another type of energy in the Universe whose properties (except for the properties mentioned above: particle-antiparticle annihilation, backward time travel, asymmetry, etc.) are unknown to man.

(2) the electric charge, direction of time travel of particles and antiparticles are different or, if you like, opposite.

(3) Matter and antimatter are not perfectly symmetrical with respect to the weak force. Even though equals amount of matter and antimatter are produced in 1:1 correspondence, and due to an unknown phenomenon they do not decay in a symmetrical manner. Also some antimatter spontaneously

decays into matter. This unknown process, which I shall call: secondary mechanism of antimatter creation, will always create more matter than antimatter. However this is not the primary cause of the imbalance between matter and antimatter we observe today in the Universe.

It is well known that high energy collisions produce equal numbers of particles (quarks) and antiparticles (antiquarks). And yet, our Universe has an extraordinary extra amount of matter, of which all things are made of, including ourselves. How did this imbalance between matter and antimatter happen? To be able to answer this question we need to understand a sixties' interpretation on negative energy states (antimatter) and the fundamentals of a new cosmological theory.

2. The Postulates

The formulation presented in this paper is based on the following postulates: (a) the quantum mechanical interpretation of negative energy states proposed by Wheeler and Feynman, and (b) on the theory of the Pre-universe. I shall dedicate the remainder of this section to briefly discuss these two points.

2a. The Wheeler-Feynman Interpretation of Negative Energy States

The American physicists J. A. Wheeler and R. P. Feynman proposed the following interpretation of negative energy [1], which, if true, would be one of the most important discoveries of all time: *“The fundamental idea is that the “negative energy” states represent the states of electrons moving backward in time...reversing the direction of proper time amounts to the same as reversing the sign of the charge so that the electron moving backward in time would look like a positron moving forward in time.”*

I shall refer to this process of backward time travel as the *Feynman time travel effect* (see **Glossary**).

2b. The Postulates of the Theory of the Pre-Universe

The new cosmological theory I developed in 2012 and that I published last year: *the theory of the pre-universe* [2] is based on the following 5 postulates:

- (POSTULATE 1) Nothingness does not exist.
- (POSTULATE 2) There exists a Pre-universe or Meta-universe which had no beginning.
- (POSTULATE 3) The fundamental properties or elements of this Meta-universe are: Meta-time, Meta-energy and Meta-space. These properties did not have a beginning either.
- (POSTULATE 4) Matter/Antimatter were created during the Big Bang and there was no matter/antimatter before that time.
- (POSTULATE 5) Meta-space has, at least, 4 (spatial) dimensions (our Universe has 3 spatial dimensions).

The Pre-universe or Meta-universe, preceded by an eternity of Meta-time, existed before the *creation* (see Glossary) of normal space and matter which occurred 13,823 million years [3, 4] ago in a meta-transformation known as the *Big Bang* (see Glossary). This means that energy, time and space didn't have a beginning. On the contrary, matter (all of it) was created from Meta-energy

13,823 million years ago. Consequently, the famous Einstein's equation $E = mc^2$ is not applicable to the Pre-universe.

3. Forbidden Survival

Let us assume that equals amount of matter and antimatter were created in the first instants of the Universe. Because the newborn antiparticles, according to Feynman, travel back in time, and because time existed before the Big Bang (*Postulate 3*), they would have travelled back to a time prior to the Big Bang. However, according to *Postulate 4* of the previous section, the Pre-universe does not contain and cannot contain any matter or antimatter. Consequently, these time travellers or antiparticles must have been converted into pure energy before arriving to their destination. The destination of this time journey was the Pre-universe. As a result of this time journey, all the antimatter created during the Big Bang (primary mechanism) should have disappeared, perhaps, almost as fast as it was created. I shall call this process of creation and disappearance: *Forbidden Survival* (see Glossary). Thus any hypothetical asymmetrical decay of matter with respect to antimatter could have had nothing to do with the extraordinarily large asymmetry between these two material worlds in the initial stages of “creation” (see Glossary). As a result of time travel, the Universe was forced to possess only matter (see **Figure 1**). For simplicity the figure shows the initial matter with blue bubbles (blue circles) and the initial antimatter with orange bubbles (orange circles). In the real Universe, matter and antimatter would have been unevenly spread throughout the entire volume and could have taken any shape. Thus, I have assumed that large quantities of antimatter, which I shall call antimatter bubbles (which don't need to be spherical) or antimatter “islands”, would have been isolated from matter. These extraordinarily large bubbles avoided annihilation with matter and would travelled back in time into either one of the infinite number of parallel universes or into the Pre-universe. The existence of these large antimatter bubbles were the primary reason of the imbalance between matter and antimatter at the beginning of normal time. Of course some matter-antimatter annihilation could have taken place on the surface of these antimatter bubbles (depicted as a red area of **Figure 1**) before they disappear through the Feynman time travel effect mentioned before. It is worthwhile to observe that our Universe did not begin as a single point of infinite mass. The Universe must have started with a size of a sphere of radius equal to the Planck length and with a mass equal to the Planck mass over 2. Then the Universe grew gradually as more matter and antimatter “islands” were “created” over time in the first instants after the Big Bang. But while the Universe expanded, more antimatter “islands” and matter “islands” were created. These new antimatter islands travelled back in time and vanished from our Universe.

We also have to consider a secondary mechanism of antimatter creation through high-energy particle collisions. But the quantities of antimatter produced through this mechanism was (and still is) negligible with respect to the primary mechanism explained above (initial antimatter, see orange circle in **Figure 1**).

In summary, from the beginning of normal time equal amounts of matter (medium blue bubbles) and antimatter (orange bubbles) were “created” through a Meta-transformation known as the Big Bang. The big dark blue circle with white circumference represents the Universe. It is worthwhile to note that some matter and antimatter could have annihilated before the disappearance of all initial antimatter due to collisions with matter. The result of this annihilation was the loss of a relatively small fraction of the amount of matter present in the beginning. In order to make the figures simpler I have made two simplifications: (a) the result of this annihilation is shown, in red, for one bubble only, and (b) dark matter and empty space are shown both in dark blue. The Pre-universe is shown in light blue. Both figure 1 and figure 2 are not to scale. Matter took over after all antimatter (orange bubbles) disappeared into the Pre-universe due to the Feynman time travel effect (See **Figure 2**). This process continued for a relatively long amount of time. However a new question

arises: why didn't the antimatter that travelled back in time did not come back into the Universe to form part of it again? This appears to be a new unsolved mystery. However, if the theory of the many-worlds¹ proposed in 1957 by Hugh Everett III is correct, then the initial antimatter could have travelled back in time to a different universe: a parallel universe². This way the time-travelling antimatter would have an extremely low probability of returning to our Universe. Another possibility is that, perhaps, Meta-time is different to the normal time of our Universe in some fundamental aspect we do not understand, so that the energy that came from the Universe into the Pre-universe through time travel cannot return to our Universe again.

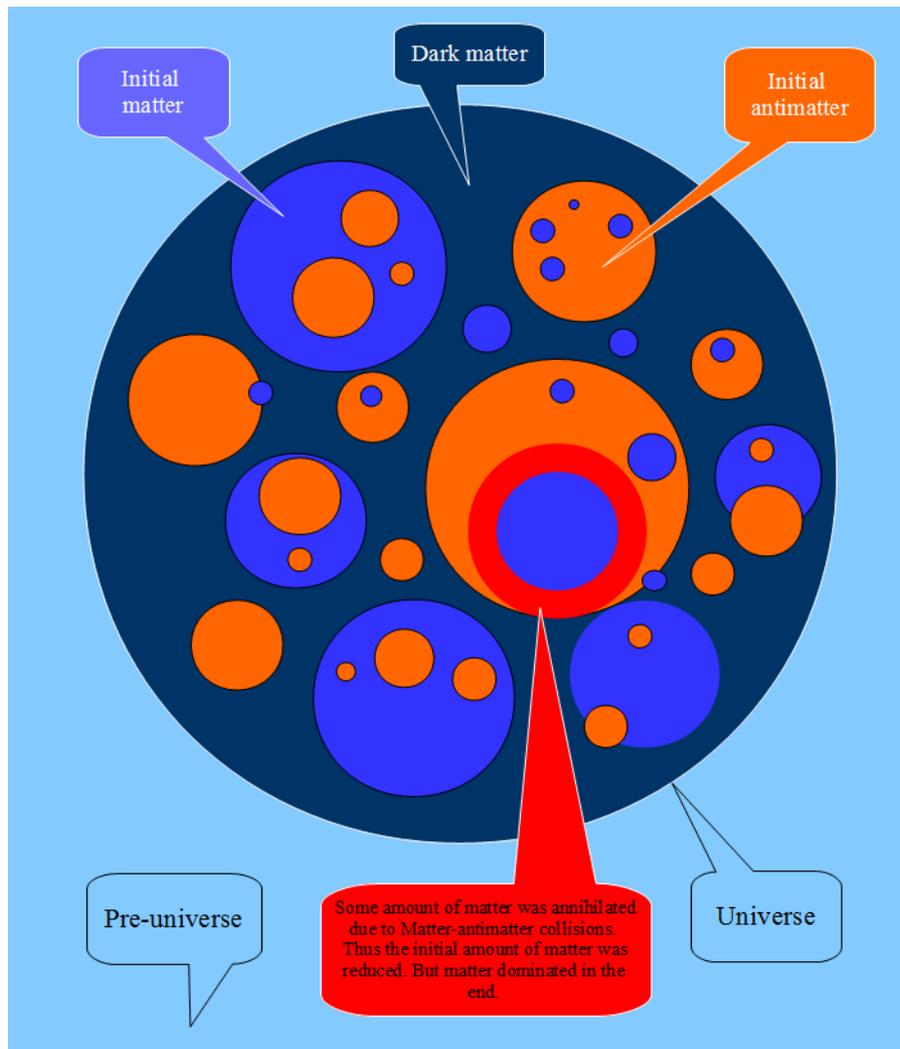


Figure 1: This simplified diagram shows how the imbalance between matter (medium blue circles) and antimatter (orange circles) could have originated at the beginning of (normal) time. Matter took over after all the initial antimatter disappeared into a parallel universe due to the Feynman time travel effect. Antimatter continued being created at smaller scales due to high energy collisions (secondary mechanism). However this secondary mechanism cannot explain the observed imbalance. I have assumed that the initial volumes of matter and antimatter were equal. In order to simplify the diagram, dark matter and empty space are shown in dark blue, while the Pre-universe is shown in light blue.

(1) also known as the relative-state formulation of quantum mechanics, the theory of the universal wavefunction, the many-worlds interpretation of quantum mechanics, the theory of the many-histories, etc. The name “many-worlds” is due to Bryce DeWitt.

(2) In general, a parallel universe is one of the many worlds of Everett's relative-state formulation.

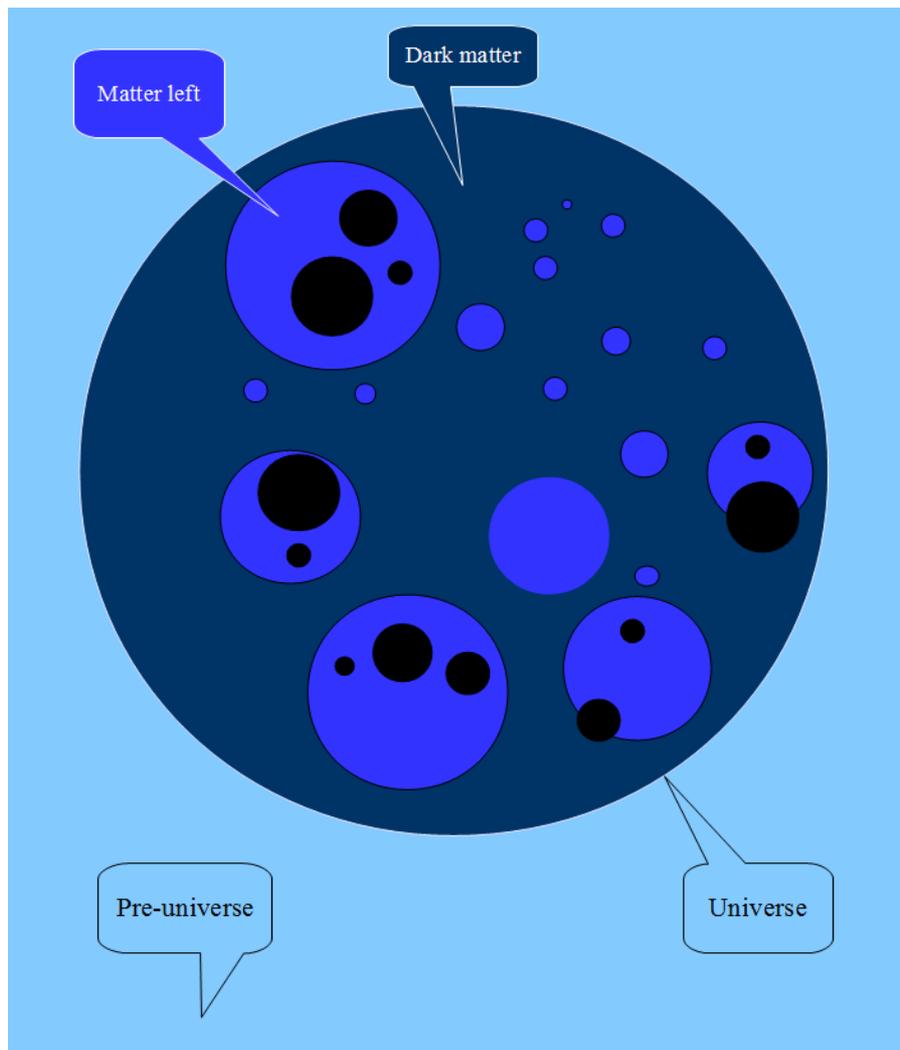


Figure 2: After all the initial antimatter disappeared from our Universe due to backward time travel (probably to a parallel universe), only a material world is left. The black circles inside the medium blue bubbles represent the volume that was occupied by the initial antimatter before the Feynman effect took place (backward time travel). Thus the Universe was left with an enormous imbalance between matter and antimatter.

4. Conclusions

If negative energy states indeed represent particles moving backward in time, as proposed by Wheeler and Feynman, then, the direction of time travel (of antimatter) should have been the primary reason of the overwhelming abundance of matter over antimatter we observe today. The initial antimatter could have travelled back in time to one of the infinite number of parallel universes there exist, and thus would have an infinitesimally low probability of coming back to our universe. This would explain the observed imbalance.

The other less likely cause of the observed imbalance could have been a process that I call: *spontaneous large scale antimatter-matter transformation* (see Glossary). This transformation could have been triggered by an unknown asymmetry between matter and antimatter. In summary, there are at least two processes that can explain the large imbalance between matter and antimatter:

- (1) Forbidden survival
- (2) Spontaneous large scale antimatter-matter transformation

As the result of any of these two possible mechanisms, or a combination of both, our world is overwhelmingly made of normal matter.

Notes

This article was first published online on 4th July 2015 and withdrawn on 5th July 2015. Since then the articles was modified. The spontaneous large scale antimatter transformation did not appear on the original paper.

Appendix 1 Glossary

Annihilation

Process by which matter and antimatter disintegrate when they come in contact. The masses of the particle/antiparticle pair are converted into pure energy (gamma rays).

Antimatter

Matter, made of negative energy. According to Wheeler and Feynman, antimatter is matter travelling backward in time.

Big Bang

Meta-transformation from a high entropy Meta-state to low entropy state. During this Meta-transformation all types of matter (matter, antimatter, dark matter, and any other unknown “matter” types) were created from only three “ingredients”: Meta-time, Meta-energy and Meta-space.

Cosmology

The study of the Universe as a whole.

Creation or “Creation”

Another name for the Big Bang or Meta-transformation. Strictly speaking there was no creation. Matter is a result of a transformation of Meta-energy into mass.

Forbidden Survival

Possible solution to the mystery of the observed imbalance between matter and antimatter based on the fact that all (or most of) the antimatter created at the beginning of normal time (13.823 billion years ago) and afterwards (possibly in the first seconds or minutes) would have been converted into energy and then travelled backward in time to a time before the beginning of normal time. There are two possibilities:

(a) antimatter could have travelled from our universe to the pre-universe. But because the pre-universe cannot contain any matter or antimatter, all time travelling antimatter (created during the beginning of normal time and afterwards) would have been converted into pure energy before or while crossing the temporal “border” between our universe and the pre-universe. Note that the Universe did not start as a point of infinite density as proposed by some cosmologists, simply because infinite density does not make any sense. The mass of the Universe was “created” by a

gradual and very fast process. Most of the mass of the Universe was created in the first 1,000 million years or so after the Big Bang or even earlier.

(b) According to Everett's many world interpretation, antimatter could have travelled from our universe to one of the infinite number of parallel universes there exist. Thus, antimatter could have never returned to our universe (because the probability of returning through multiple time travel would be negligible).

Imbalance between matter and antimatter

Extra amount of matter over antimatter observed in our Universe.

Matter

The stuff the solar system, the Milky Way (our galaxy), and the rest of normal galaxies are made of. Matter is made of positive energy or normal energy. Particles made of normal energy travel forward in time like us. Matter does not include the so called dark matter or any other body made of negative energy.

Meta-energy

A kind of energy that existed before the Big Bang.

Meta-space

Space of some kind that always existed before the Big Bang and which has, at least, one extra dimension in comparison to the three-dimensional space we are familiar with.

Meta-time [2]

A kind of time that existed before the Big Bang.

Negative energy

Type of energy antiparticles are made of or state they acquire due to backward time travel. Normal matter or particles, on the other hand are made of the normal energy (positive energy) we are all familiar with.

Normal time [3, 4]

The time that started at the beginning of the Universe (13.823 billion years ago). In other words the time that started when the Universe was "created". Normal time is the same as universal time. However, we have to keep in mind that time existed before the Big Bang. This "earlier" time is called Meta-time.

Planck time

Smallest time interval, with physical meaning, between any two given events.

Positive energy (also normal energy)

The type of energy the solar system and most known galaxies are made of. We are made of positive energy. Antiparticles, on the other hand, are made of a different type of energy (negative energy).

Pre-universe/Meta-universe

The "mother" Universe from where our Universe came from.

Singularity

A point of spacetime in which the curvature of space is infinite.

Spontaneous large scale antimatter-matter transformation

Transformation process by which a particular kind of antimatter (antiparticle/s) transformed into matter spontaneously on extraordinarily large scales at the beginning of time and afterwards. The cause of this transformation would be due to an unknown asymmetry between the material particles and the anti-material counterparts.

Standard Model

The Standard Model of particle physics is a formulation which describes and considers only three of the four known fundamental forces in the Universe. The formulation assumes that the forces between any two particles are due to the exchange of unobserved intermediary particles known as "messengers" or force carriers. One of the limitations of this formulation is that it does not include Gravity, the weakest and the most familiar force in people's everyday life. Another limitation of the Standard Model is that is unable to explain the observed imbalance between matter and antimatter I have just explained in this paper. Despite the above mentioned limitations the theory has successfully explained an impressive number of experiments and predicted a large number of phenomena.

The Theory of the Pre-Universe

Theory proposed by the author which affirms the existence of a hypothetical immaterial Pre-universe which had no beginning. The Pre-universe or Meta-universe would be made of Meta-energy, Meta-time and Mate-space.

Time cancellation

Phenomenon that occurs when a particle and its corresponding antiparticle come in contact. Because for particles and antiparticles time runs in opposite direction [time runs forward for particles with positive energy while time runs backward for particles with negative energy (antiparticles)], when they come in contact, time stops lapsing for both of them. Thus their rest masses/energies (and kinetic energies if they were in motion before annihilation) are converted into pure energy, in the form of gamma ray photons. In other words, two particles that travel in opposite directions in time produce time cancellation because:

- (1) The normal particle travels forward in time, therefore time increases.
- (2) The antiparticle is a particle travelling backward in time. Therefore time decreases.

Because time cannot increase and decrease in the same place, time must cancel out. In other words time must stop lapsing. This is exactly one of the properties of photons. Photons are timeless, meaning that photons do not experience time.

Time Traveller or Tiny Time Traveller or Time Travelling Antimatter

Particle with negative energy, or in a negative energy state, that travels backwards in time.

Universal Time [3, 4]

See normal time.

Universe

All there is except the Meta-universe. The Universe contains all the stuff that was "created" during and after the Big Bang. The Meta-universe is not included into the Universe definition to avoid confusion.

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