A Possible Solution To The Mystery Of The Imbalance Between Matter And Antimatter Of The Universe

(Draft Version)

Some scientists 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 in the universe. Thus, it seems that matter has, for some reason, taken over. Putting together an idea from two lead physicists: John Wheeler and Richard Feynman, Hugh Everett's theory of the many-worlds, and the theory of the Pre-universe that I developed in 2012, I found that the possible cause of the imbalance is time travel. I also found that the imbalance must have began at the very beginning of 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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February 2016 (v6)

Keywords: *Matter, antimatter, matter antimatter imbalance, matter/antimatter imbalance, annihilation, matter-antimatter annihilation, Pre-universe, Meta-universe, gamma rays, electromagnetic spectrum*, *Standard Model of particle physics, positive energy, negative energy, negative energy states, equivalence of mass and energy, electric charge, time travel, normal time*, *the theory of the pre-universe, Planck time, Feynman time travel effect, Forbidden Survival, the many-worlds interpretation of quantum mechanics, Everett's relative-state formulation.*

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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. Feyman, 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 the rate of decay, 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 new 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:

$$E^2 = p^2 c^2 + m_0^2 c^4 \qquad (1.1)$$

$$E = \pm\sqrt{p^2 c^2 + m_0^2 c^4} \qquad (1.2)$$

This equation shows that, for a given positive mass (mass is, as far as we know, always a positive quantity), the energy of a particle can be either positive or negative. Because the relativistic mass, m (through $p = mv$), and the rest mass, m_0 , are both positive quantities, we get two different values of energy: one positive and one negative. In quantum mechanics we cannot neglect the negative energy solutions. 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

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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. 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 point of space, time must "cancel out". This time "cancellation" is experimentally observed as an annihilation. The result of annihilation is the creation of two gamma ray photons. Photons, which are massless particles, are produced because they are timeless. They do not experience time. The only particles that do not experience time are photons and probably gravitons if they exist. However gravitons cannot satisfy the energy requirements. It is important to bear in mind that the only way for a particle to be able to travel back in time is that the particle has negative energy. A particle with positive energy cannot travel backwards in time.

Thus we draw the conclusion that the type of rest energy and relativistic energy that particles and antiparticles possess is somehow different. You can stop a ball with your hands but if you try to stop an anti-ball the same way your hand will be annihilated instantly. So the anti-ball must be made of negative energy even if it moves through space like a normal ball. To make the matter of *matter and antimatter* 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. This has confused many people over the years (including me). 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.

(4) There are other differences (such as strangeness, charmness, bottomness, topness, etc.) that I shall not discuss here because we already have all we need to move on.

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), the Everett's Many-Worlds Theory and the fundamentals of a new cosmological theory. A brief overview of these theories is discussed in the next section.

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2. The Postulates

The formulation presented in this paper is based on the following formulations: (a) the quantum mechanical interpretation of negative energy states proposed by Wheeler and Feynman, (b) the Many-Worlds Theory proposed by Hugh Everett III, and (c) on the theory of the pre-universe proposed by the author. I shall dedicate the remainder of this section to briefly discuss these theories.

2.1. 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 s 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).

2.2. The "Postulates" Of The Many-Wolds Theory

(POSTULATE 1) There exist an infinite number of parallel universes.
(POSTULATE 2) Any universe (or world), including our own universe can "send" antimatter to any other parallel universe during and after the Big Bang through time travel.
(POSTULATE 3) Antimatter arriving into a parallel universe could be transformed during the trip, or at arrival, into another type of exotic matter such as dark matter.

2.3. 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), antimatter, dark matter, etc. were 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.

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3. The Mechanisms Of Antimatter Creation

There are two mechanisms of antimatter creation: a) a primary mechanism and b) a secondary mechanism. This section analysis these two mechanisms.

3.1 The Primary Mechanism Of Antimatter Creation

I shall assume that the primary mechanism of antimatter creation was the Big Bang. Thus, in the beginning of normal time equal amounts of matter and antimatter were created simultaneously. But what was the Big Bang? The Big Bang is a meta-transformation that brought into existence our universe. Our universe was not created from nothingness, as some people have claimed, simply because nothingness does not exist. Before the Big Bang there was the pre-universe (or meta-universe) and that's it. Thus all the stuff in the universe, including matter, antimatter, dark matter, etc. came into existence because of the pre-universe. The pre-universe is the source of everything there is.

3.2 The Secondary Mechanism Of Antimatter Creation

We also have to consider the secondary mechanism of antimatter creation. This mecahnism is due to high-energy particle collisions. However, the quantities of antimatter produced through this machanism was (and still is) negligeble in comparison with the primary mechanism explained above. Therefore this mechanism will not be discussed here.

4. The Causes Of The Imbalance

There are two causes of the imbalance between matter and antimatter of the universe. The most important cause is time travel. The least important cause may be an unknown asymmetry between matter and antimatter. In this section we shall briefly explore the role of each of these causes in the observed imbalance.

4.1 The Primary Cause Of The Imbalance: Time Travel

Time travel is the first, and by far, the most important cause of the imbalance between matter and antimatter. This theory, which is based on time travel, suggests two possible solutions to the imbalance. These solutions, as we shall see, are two different destinies. Because before the Big Bang there existed the pre-universe and because, according to Everett's Many-Worlds Theory, there are an infinite number of parallel universes, there are two possibles destinies for our tiny time travellers (antimatter):

Possible Destiny 1: a parallel universe. 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 for several reasons. Some possible reasons are:
(a) Antimatter arrives into a parallel universe as another form of matter, perhaps as dark matter or another form of exotic matter or energy.
(b) Not all parallel universes receive antimatter due to reasons such as “time distance” and other unknown reasons.

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(c) Some universes may receive antimatter from other universes, but they have not received it yet because is too early in terms of many-worlds history.
(d) Unknown reasons.
Because of these and other unknown reasons, the probability for antimatter of returning to our universe would be either negligible or impossible (or perhaps it did not happened yet). In this scenario most of the antimatter created during the Big Bang left our universe in an "epic" time journey and arrived in another universe (known as a parallel universe), perhaps under a different form of matter.

Possible Destiny 2: the pre-universe. 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 (such as photons and gravitons, at least they are the simplest energy carriers) 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 people. This is so because infinite density does not make any sense [5]. 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 [5].

4.2 The Secondary Cause Of The Imbalance: Assymetry Between Matter And Antimatter

The secondary cause of the imbalance between matter and antimatter in the universe is one which I I call: **spontaneous large scale antimatter-matter transformation**. The spontaneous large scale antimatter-matter transformation is a 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. Because this transformation is not known to exist I shall not analyse it.

5. Analysis Of The Primary Cause Of The Imbalance

Just 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 travelling back in time 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 Wheeler-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 [5]. Then the universe grew

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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.

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-worlds[1] 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 universe[2].

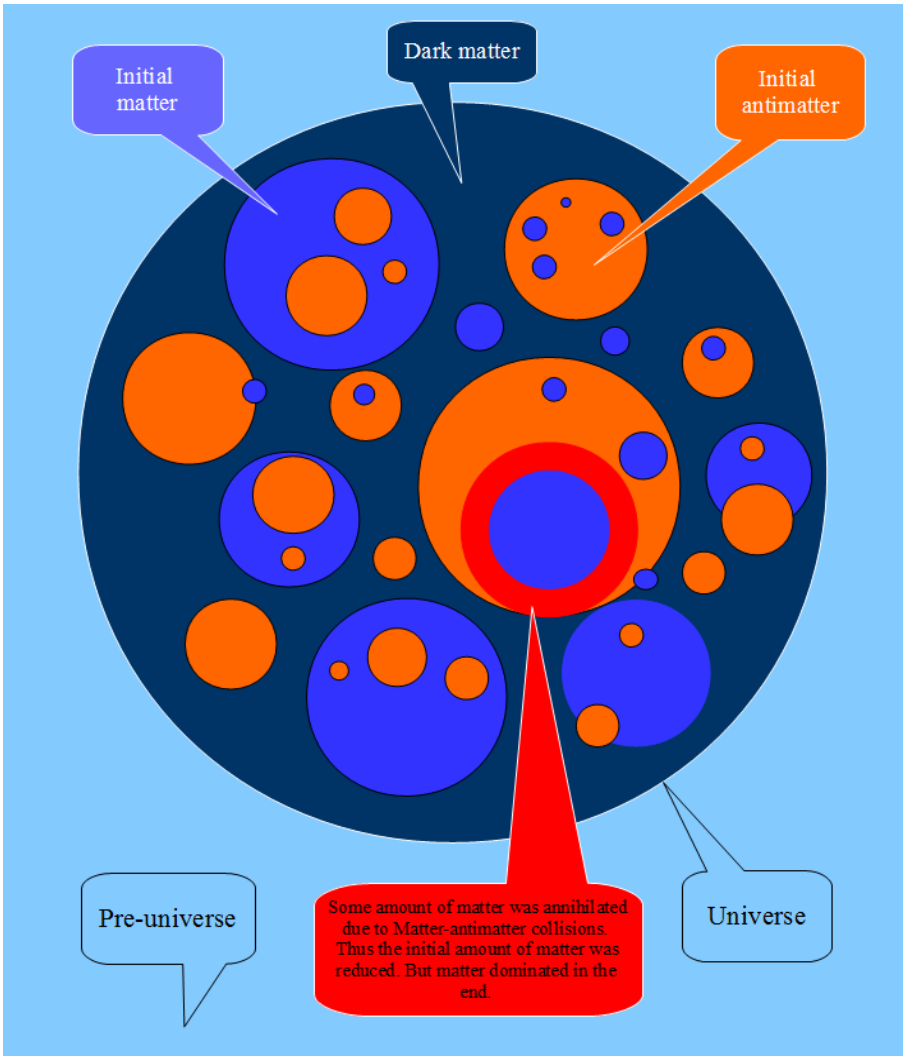

Figure 1: *This simplified diagram shows how the imbalance between matter (medium blue circles) and antimatter (orange circles) could have originated at the beginning of*

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(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.

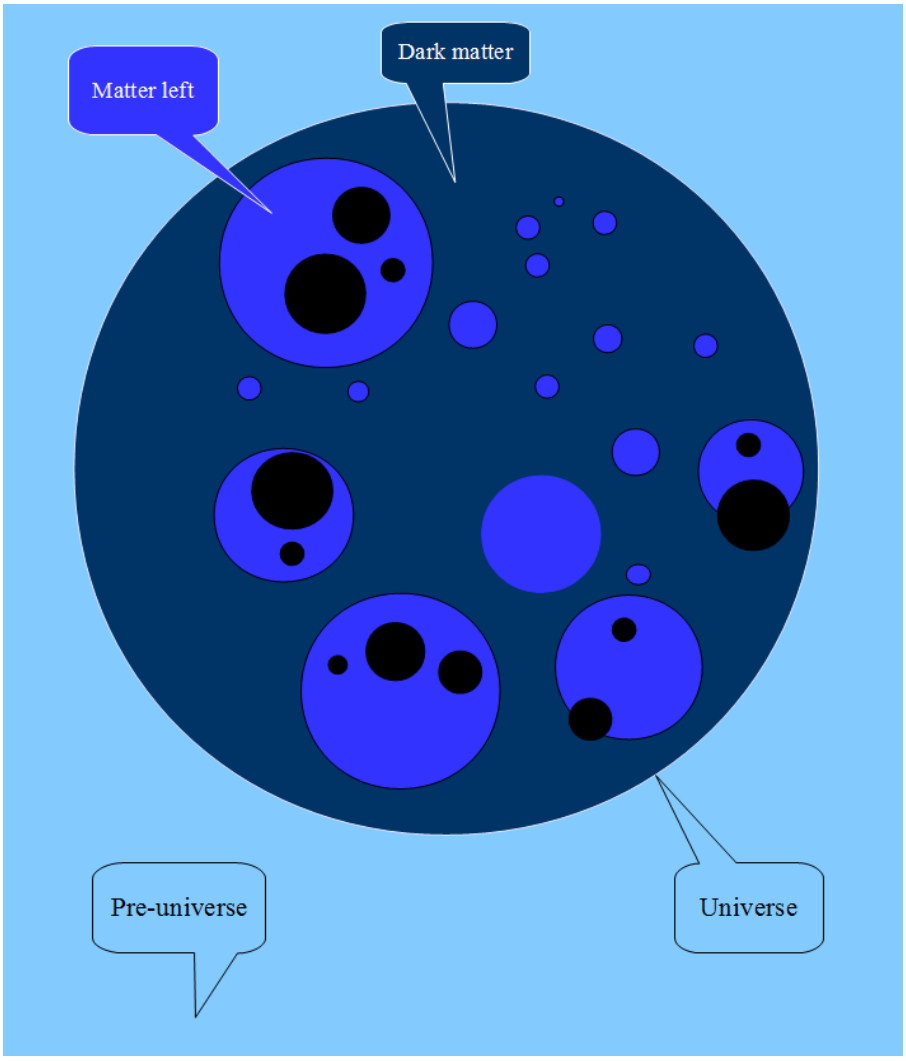

Figure 2: *After all the initial antimatter disappeared from our universe due to backward time travel (probably to a parallel universe), only a material world is left. The black circles inside the medium blue bubbles represent the volume that was occupied by the initial antimatter before the Feynman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

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6. 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 antiparticles (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. This would explain the observed imbalance. The fact that we do not observed antimatter form another world (parallel universe) was explained in this paper postulating a number of hypothetical reasons. I believe that the other cause of the observed imbalance: the spontaneous large scale antimatter-matter transformation (due to asymmetry) is less likely to have occurred. 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) Time travel
(2) Asymmetry between matter and antimatter.

In summary, as the result of any of these two possible mechanisms, or as a result of a combination of both, our world is overwhelmingly made of normal matter. However, I believe that time travel is the main cause of the imbalance.

Notes

(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.

(3) 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-

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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

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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

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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 point of space, time must "cancel out". This time "cancellation" is experimentally observed as an annihilation. The result of annihilation is the creation of two gamma ray photons. Photons, which are massless particles, are produced because they are timeless. They do not experience time. The only particles that do not experience time are photons and probably gravitons if they exist. However gravitons cannot satisfy the energy requirements. It is important to bear in mind that the only way for a particle to be able to travel back in time is that the particle has negative energy. A particle with positive energy cannot travel backwards in 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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