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DARK ENERGY CAN BE REVEALED USING THE 3-COSMIC FRAMEWORK OF A UNIVERSE WITH STRING THEORY

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Abstract

Based on the original string theory, the universe's constitution is nine-dimensional space and one-dimensional time and apply "Anthropic Principle" and "Causality" to deal with space and time, and the universe can be divided into triple cosmoses, which means a 3-cosmic framework of the universe. Between any two cosmoses, except gravitational force, there is no other fundament force that implying dark matter in cosmoses other than ours. Exploring dark matter from the interior of Earth, we found a dark planet inside the Earth but in another cosmos than ours. Based on the data of cosmological parameters from the 1-year WMAP results to Planck Satellite 2018 results, the dark energy gradually decreasing, but the total matter gradually increased at the same value. This phenomenon agrees with the theory of the Big Bang; therefore, we should consider the current dark energy as the residual energy of the universe after the Big Ban. According to the data, the cold dark-matter density gradually increases by approximately 4.3%, which implies that it exists in high-energy-density cosmoses, whereas the baryon density gradually increases by approximately 0.5%, which implies that it exists in our low-energy-density cosmos. Because the high-energy-density cosmoses expands rapidly, their dark matter should subject to a "drag" by gravity on the stars of our cosmos, causing the pulling effect of our cosmos' expansion to accelerate. The results of this study suggest that the problem of dark energy in astrophysics can be roughly solved.

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1. Introduction

In 1922, Jacobus Kapteyn, the first astronomer to address the possible existence of invisible matter in the Milky Way Galaxy, used stellar velocities [Kapteyn, 1922], subsequently, some scientists, Oort (1932), Zwicky (1937), Bartusiak (1988), Stsrobinskii and Zel'dovich (1988), found unobservable matter, which was called "dark matter", amounted to more than 90 % of the mass of the entire universe. Dark matter is real and can only be detected by its gravitational influence on visible matter. Although almost all astronomers agree on the existence of dark matter; however, after more than one hundred years of search, nothing has been gained.

In 1998, the High-Z Supernova Search Team published observations of type 1a supernova as standard candles [Riess et al., 1998], and in 1999, the Supernova Cosmology Project was launched [Perlmutter et al., 1999]. Two independent projects simultaneously reached the same conclusion: a completely unexpected acceleration of the expansion of the universe. Their discovery led to the idea of an expansion force, dubbed "dark energy". Scientists believe that dark energy is the force that tears the universe apart, but dark matter condenses all things, and that the interaction of these two forces forms the structure of the universe, as we know it today.

After the Planck Satellite observed the cosmic microwave background radiation, scientists deduced the cosmological parameters of Planck 2018 results VI were taken as the current situation of the universe, that the universe is composed of approximately 4.94% of normal matter, such as planets, stars, asteroids, and gases, etc., the remaining 95.06% is dark matter and dark energy, of which dark matter that does not radiate or absorb light accounts for approximately 26.64%, and dark energy accounts for approximately 68.42% [Afghanis et al., 2020]. Dark energy is a current scientific hypothesis, being neither matter nor radiation, its physical properties have no clue, and we do not know how it works, and dark matter is also no solution, so now all astrophysicists take them as the major Conundrums. Because the names of dark matter and dark energy come from astrophysics, we use the string theory of theoretical physics to address the major problems associated with astrophysics.

2. Multiverse Research

2.1 Based on original string theory 10-dimensional spacetime exists in the universe

To address these questions of astrophysics, string theory was introduced in the 1970s. String theory begins with the notion that point-like particles in particle physics can also be modeled as one-dimensional objects called strings. The characteristic length scale of strings is assumed to be on the order of Planck length (10^{-35} meters) that looks just like an ordinary particle, with its mass, charge, and other properties determined by its vibrational states in different ways.

In quantum field theory, when a string moving in the framework of time and space is so complex that three-dimensional space can no longer accommodate its motion orbit, up to nine-dimensional space must be available to meet the motion. Thus, all objects are considered a nine-dimensional space of the string. The string theory describes all fundamental forces and forms of matter and potentially provides a unified description of gravity and particle physics. Based on the original string theory, the universe's constitution is nine-dimensional space and one-dimensional time, which is interpreted as the product of ordinary 4-dimensional spacetime, and 6-extra-dimensional space, but 6-extra-dimensional spaces are yet unobserved [Scherk & Schwarz, 1975].

Many mathematicians and physicists have attempted to break (compactify) the constitution of a ten-dimensional space-time model through spontaneous symmetry breaking, to a four-dimensional one as our known world and 6-extra-dimensional space, which is compacted to be a tiny space, called Calabi-Yau space, as Planck space. Because there is no exact boundary condition to fit the real universe and work out a theoretically solid basic geometry, no proposed method meets perfection.

Without considering compaction, the nine-dimensional space should be symmetrical, i.e., it should be symmetrical with the same weight for each dimension of space. Therefore, the universe should still exist in an equal weight of nine-dimensional space plus one-dimensional time, so it can be argued that the string theory of the cosmic framework should still be able to maintain a complete ten-dimensional spacetime.

In multidimensional string theory, the force of gravity is the only fundamental force with effect across all dimensions. This explains the relative weakness of gravity compared to other fundamental forces (as electromagnetic force), which cannot cross into extra dimensions. In that case, dark matter could exist in extra-dimensional space, where it only interacts with matter in our space through gravity. Dark matter could aggregate in the same way as ordinary matter, forming extra-dimensional galaxies [Siegfried, 1999].

Georgi Dvali and his colleagues proposed that the extra dimensions of space do not curl up into a minimum but rather are infinite in size and uncurved, just like our ordinary three-dimensional view. In character of string theory, they rethink the "extra dimensions" problem, that is, gravity can roam to any additional dimension of space. They believe that the accelerated expansion of the universe was not caused by dark energy, but rather by gravity leaking out of our world. In particular, this theory predicts that the universe has extra dimensions into which gravity, unlike ordinary matter, can escape. This leakage would warp the spacetime continuum and accelerate the cosmic expansion. Thus, the extra dimensions do not need to be small and compactified, but may be large extra dimensions [Dvali, 2004], i.e., outside our ordinary three-dimensional space, there are the same six extra dimensions of other space usually in the universe.

2.2 Some cosmologists accept this multiverse concept at present

In the 1950s, Hugh Everett devised "the many-worlds interpretation (MWI)" of quantum mechanics. The core of the idea was to interpret in the quantum world that an elementary particle, or a collection of such particles, can exist in a superposition of two or more possible states of being [Everett, 1957].

In the 1980s, Leonard Susskind stated that it was the result of string theory, which was used as a tool or framework to describe cosmic phenomena (Susskind, 2006). MWI is a theory of multiple universes. In this case, scientists can offer the only possible explanation: these elementary particles do not exist only in our cosmos; they may also fly around other cosmoses that are not ours. This means that there may be multiple cosmoses, called multiverse, in space, but there are only subtle differences between them, so there are still cosmoses that we do not know about.

An important aspect is to extend physical theories within a multiverse framework. The dominant expectation so far for the theory of quantum gravity (QG) has been the "reductionist" hope that relies on QG producing a unique solution that resembles the general features of our universe, but scientists have failed. The three different and important theories: quantum mechanics, string theory, and inflation, predict the existence of the multiverse, which scientists believe is hardly co-incidental. The existence of the multiverse can be expected from the underlying fundamental theory.

David Deutsch is a leading figure in multiverse theoretical physics. He believes that this multiverse theory is the only explanation for the strange phenomenon in quantum mechanics because it is based on rigorous mathematical equations and many experimental results [Deutsch, 2010]. Although more than 50 years have elapsed since the first discussion of the "many worlds" by Everett, there is not any new step to set the foundations and the ontology of the multiverse and of this new field in physics.

2.3 The map of microwave background radiation fluctuations may provide hard evidence of another cosmos

In June 2001, NASA launched WMAP, which was designed to detect residual cosmic radiation heat in the universe after the Big Bang and drew a full map of microwave background radiation fluctuations throughout the universe. In 2009, the European Space Agency's partnership with NASA launched the Plank Satellite, which can detect tiny temperature fluctuations in this radiation. Then, a cosmic microwave background radiation fluctuation map was drawn with greater accuracy.

In general, scientists tend to think that the radiation is evenly distributed, but the full map shows a different fact ─ there is a powerful center in the sky in the southern half of the map and a seemingly hole-like "cold spot" that cannot be explained by existing physics knowledge, where galaxies are accelerating away [Rudnick et al., 2007]. From this anomaly, some scientists have proposed multiverse perspectives to explain the cold spot. Scientist have predicted that string theory does not predict a unique universe; on the contrary, it predicts a multiverse [Mersini-Houghton, 2008]. In 2005, scientists predicted that anomalies in radiation existed that could only have been caused by gravitational pulling on our cosmos from others as it formed during the Big Bang [Woit, 2013]. The "cold spot" in the southern half of the map of the universe may be the first "hard evidence" of another cosmos than ours that exist has been found by scientists [Leake, 2013].

3. Theories and methods

3.1 The universe should be a 3-cosmic framework from Causality and Anthropic Principles

Without compacting the nine-dimensional space of the universe, the ten-dimensional spacetime of string theory is considered to exist universally. According to "Causality", an effect cannot occur before its cause, which means that time has one direction and cannot be divided into different parts. Thus, one-dimensional time is taken as the common standard for the order of events in the universe.

According to "Anthropic Principle", which is the simple fact that we live in a universe set up to allow for our existence. This means that 3-dimensional space and 1-dimensional time, called 4-dimensional spacetime, are taken together as one cosmos as our living world. Therefore, the 9-dimensional space can be divided into three portions, each with a common standard time. It means there is a 3-cosmic framework in the universe, called triple cosmoses; in other words, the universe contains three cosmoses located in the same nine-dimensional space of the universe.

According to string theory, a 3-cosmic framework of the universes in which our cosmos describes the world of general matter as we know it, while others describe another world, which we know nothing. Among any other cosmoses, there are no fundamental forces of nature except gravity; in other words, the graviton in the field of gravity can penetrate all three cosmoses; however, light (electromagnetic wave) cannot that means among the cosmoses cannot be observed directly with each other.

According to this 3-cosmic framework of the universe, there are triple cosmoses in the whole space, namely 1st cosmos, 2nd cosmos and 3rd cosmos, where U_1, U_2, and U_3 are used instead. In the 3-cosmic framework of the universe, fundament forces do not exist between any two cosmoses except gravitational force, i.e., cosmoses cannot directly interact with each other, which is characteristic of dark matter. Therefore, dark matter, which will be discovered through gravity, should exist in cosmoses other than ours.

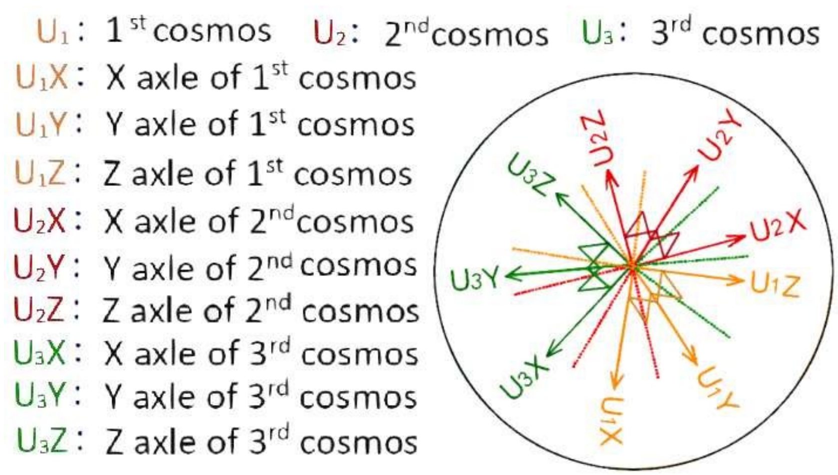

Figure1. Schematic representation of nine-dimensional space in 3-cosmic framework of the universe.

As the figure 1, all the 3 cosmoses (U_1, U_2, and U_3) exist, but none of the fundamental forces can affect each other except gravity; for example, if U_1 is our cosmos, we cannot observe U_2 and U_3. The 3 axles (X, Y, and Z) all perpendicular to each other in each cosmos. In the diagram, the center of the circle is assumed a point P, which has 9 coordinates: U_1Xp, U_1Yp, U_1Zp, U_2Xp, U_2Yp, U_2Zp, U_3Xp, U_3Yp, and U_3Zp in the universe [Ho, 2022]. Assuming a star at P position, which appears in our cosmos, the other cosmoses cannot observe the star; its coordinates are, ordinarily, denoted by Xp, Yp and Zp.

3.2 Exploring dark matter from the interior of the Earth

Based on original string theory and the 3-cosmic framework of the universe, we can investigate dark matter in cosmoses other than our own. The best method for exploring dark matter is to start from Earth, where we live. In 2019, we published a research article "Based on the Spacetime of string theory Exploring Dark Matter Inside the Earth" [Ho, 2019]. The abstract is as the follows:

According to the characteristics of the Earth's interior, by equitably examining its constitution, temperature, density, and pressure from a different perspective of the core, special arguments are proposed. It is inferred that the solid rock and the magma change states interact at the Crust-Mantle Boundary (CMB). In the low-viscosity F-layer of outer core, high temperature causes some elements and oxides of the magma to undergo oxidation-reduction reactions and separate due to gravity. The great number of heats, produced from radiogenic heat, chemical reaction heat, and nuclear fission heat, become the power sources for the geo-dynamo of great convection cell, which are the flows of the magma and the solid rock migrating up to the crust and down across the CMB to the F-layer as the figure 2. Therefore, a new earth model is established.

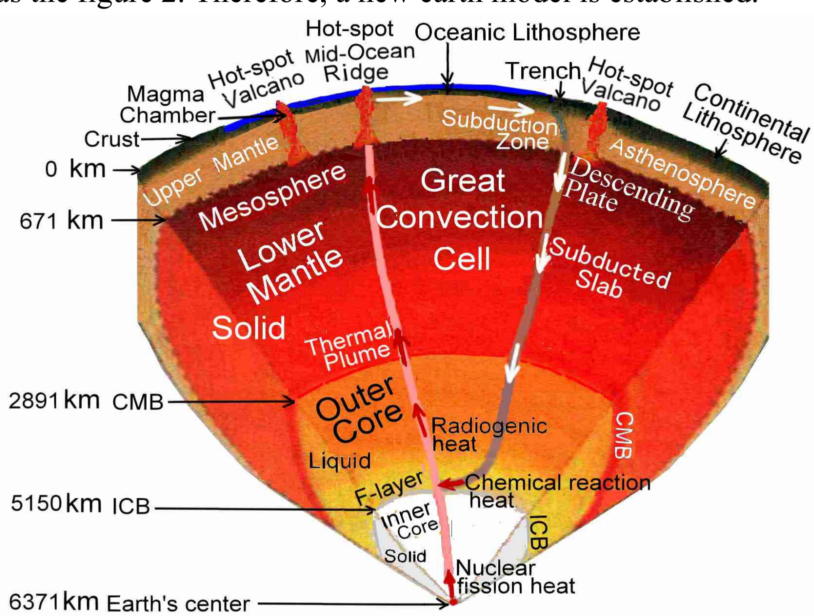

Figure 2: A schematic of the great convection cell, heat flow, and composition of the Earth's interior.

3.3 Evaluation of data in the new earth model obtains a dark planet

According to the conception of a new earth model, applying a simplified method attempts the different density distribution curves of models in the core to calculate the data of the Earth and compare them with the existing current data of the Earth [Ho, 1993]. The insufficient mass and moment of inertia belong to the missing objects, taken as the parts of dark matter, which may be in the interior of the Earth. Then, the Earth's mass and moment of inertia were found to be only 85.73% mass and 94.82% moment of inertia form the current data. The two insufficiencies in the Earth's data, which led to the formulation of reasonable assumptions, led to the identification of a planet of dark matter inside the Earth. The gravity and pressure at every depth within the Earth are then calculated to check suitability. Finally, a dark planet with a radius of 3700.375 km, approximately 1.33 times that of Mars, exists reasonably inside the Earth but in other space than ours. The dark planet inside the Earth, but in another cosmos, should be confirmed by Chandler wobble [Ho, 2024].

3.4 The Big Bang Theory is recognized

In the1930s, Georges Lemaître proposed "The Big Bang Theory". In the beginning of the Big Bang, the universe was made up of high-temperature and hot energy with uniformity and isotropy, but no matter [Lemaître, 1927]. When this hot energy expands rapidly outward, an exponential inflation occurs [Guth, 1982]. As the universe expands rapidly and temperature decreases, the distribution of energy changes slightly, according to Einstein's famous equation ($E=MC^2$) for gradual energy and mass interchange, creating the earliest substances. In 1964, the discovery of Cosmic Microwave Background by Radio astronomers Penzias and Wilson was the most important evidence to test the Big Bang Theory [Penzias & Wilson, 1965]. Then more and more astronomical and physical evidence came out, such as Cosmic Background Explorer (COBE) [Bennet, 1993], WMAP, and Planck Satellite, when their detected spectrum was measured to map its black body radiation curve, the Big Bang Theory became more complete, and scientists believed in it.

3.5 Dark energy should be the residual energy of the universe after the Big Bang

In 2018, the Planck Satellite detected tiny temperature fluctuations in the radiation of the universe. These fluctuations reflect the baryon density of the universe before galaxies formed. Normal matter from galaxies and stars accounts for only 4.94 % of the universe's composition, with the rest missing substance, including dark matter, which accounts for 26.64 %, and mysterious dark energy, which accounts for 68.42% [Aghanim et al., 2020].Dark energy is one of the most mysterious phenomena in current physics. To research dark energy, we applied the table of cosmological parameters of WMAP results and Planck Satellite results, whose Hubble constants nearly gradually decrease, were selected one set at each detection and are shown as follows.

The table of cosmological parameters obtained from WMAP and Planck Satellite data

Source / Symbol	1-year WMAP [Spergel et al., 2003]	3-year WMAP [Spergel et al., 2007]	5-year WMAP [Komatsu et al., 2009]	7-year WMAP [Komatsu et al., 2011]	9-year WMAP [Bennett et al., 2013]	Planck 2013 [Ade et al., 2014]	Planck 2015 [Ade et al., 2016]	Planck 2018 [Aghanim et al., 2020]
H_o	71.0	70.4	70.5	70.2	70.0	68.14	67.31	67.32
Ω_Λ	73.22%	73.2%	72.6%	72.5%	72.1%	69.64%	68.5%	68.42%
Ω_m	26.78%	26.8%	27.32%	27.43%	27.9%	30.36%	31.5%	31.58%
Ω_b	4.44%	4.41%	4.56%	4.58%	4.63%	4.79%	4.9%	4.94%
Ω_c	22.34%	22.39%	22.8%	22.9%	23.3%	25.43%	26.42%	26.64%
t_0	13.70	13.73	13.72	13.76	13.74	13.784	13.80	13.80

Description of parameter symbols and definitions are shown as follows:

H_o: Hubble constant (100h km/Mpc·s)

Ω_Λ: Dark energy density/Critical density

Ω_m: Physical matter density Critical density

Ω_b: Baryon density/Critical density

Ω_c: Cold dark-matter density/Critical density

t_0: Age of the universe (Gyr)

From the table, dark energy density Ω_Λ from 1-year WMAP results (2003) to Planck 2018 results for 15 years, the value from 73.22% decreases gradually down to 68.42%, decreasing 4.8%, but the total matter density Ω_m from 1-year WMAP results to Planck 2018 results, the value from 26.78% increases gradually up to 31.58%, increasing 4.8%. As the universe expands rapidly, its temperature decreases and gradually cools, and then energy transforms into the building blocks of matter. The results show that dark energy transforms into matter at the same percentage of the universe's content, which is consistent with the assertion of Big Bang theory.

The cosmological parameters of Planck 2018 results VI are taken as the current situation of the universe. We may imagine that, at the first time of the Big Bang, the full energy (100% energy density) of the universe gradually loses, after 13.8 billion years later, remains 68.42% energy density, which is called dark energy density, and creates 31.58% total matter density. Therefore, we should take the current dark energy as the residual energy of the universe after the Big Bang.

3.6 The 3-cosmic framework of the universe can hold dark energy

After the Big Bang, 68.42% dark energy density Ω_Λ is remainder, but the lost 31.58% dark energy density transformed into matter density Ω_m, which contained 4.94 % baryon (normal matter) density Ω_b in our cosmos and 26.64 % cold dark matter density Ω_c in space other than ours.

According to the table of Cosmological Parameters from 1-year WMAP results to Planck 2018 results, cold dark matter density Ω_c from the value of 22.34% increases gradually up to 26.64%, increasing approximately 4.3%, and baryon density Ω_b in our cosmos from the value of 4.44% increases gradually up to 4.94%, only increasing approximately 0.5%, which compares to the increasing rate of cold dark matter density Ω_c about 1：8.6.

Because matter transforms from energy after the Big Bang, the Ω_b increasing is so small, indicates that the energy in our cosmos is very poor. Temperature is a display of the thermal motion of microscopic particles; therefore, hot energy must display high Temperatures. After the WMAP and Planck Satellite detected, the current actual temperature of cosmic microwave background (CMB) is 2.725 °K (Kelvin), which is very close to absolute zero (0°K = −273.15°C), therefore, current energy is also poor, and it cannot contribute to the expand of our cosmos at an accelerating expansion.

Under the 3-cosmic framework of the universe, the rate of expansion in a high-energy-density cosmos is much higher than that of a low energy density cosmos as ours. According to the property of fundamental interaction forces of nature, except gravitational force, the other fundamental forces (including strong nuclear force, weak nuclear force, and electromagnetic force) cannot penetrate other cosmoses; therefore, the high energy of cosmoses cannot affect the other cosmoses. Therefore, the high energy of cosmoses cannot directly contribute to the expansion of our low-energy-density cosmos.

However, when a high-energy-density cosmos rapidly expands, its matter (i.e., dark matter) will expand at the same pace. From the 2018 Planck result, only normal matter (15.64% of total matter) exists in our cosmos; however, there are large amounts of dark matter 84.36% in other cosmoses, which are at higher expanding rate that will use gravitational force to drag the stars of our cosmos away at the same pace, causing the effect of tugging the stars and galaxies of our cosmos at accelerating expansion, i.e., the effect of pulling the stars of our cosmos accelerating expansion in our view.

4. Discussions and results

4.1 The quantum experiments indicate the existence of the multiverse in space

In classical physics, matter is made up of particles, which are entities that conform to a simple orbit and can calculate their motion, velocity, angle, and speed at any one time; for example, an elementary particle in atom ─ electron, in Newton's classical mechanics, rotates around the nucleus in a circular orbit, and the position, momentum, and orbit of each particle is fully predictable, and it is only in a single place at the same time. This idea is similar to the case in our solar system, but beginning in the 1920s, quantum experiments have shown that in the atomic structure, each electron surrounds the nucleus, not in a stable orbit, but appears intermittently in different places, which can only be counted by probability or statistics, i.e., the elementary particles do not have a purely exact position. The only explanation is that these particles exist not only in our cosmos but also in other cosmoses, indicating the existence of multiverses in space.

4.2 The universe is expanding because the current dark-energy density is greater than the matter density

Energy causes the universe's expansion because of its high temperature, but matter causes each other's shrinkage because of gravity; however, the current 68.42% dark energy density is larger than the 31.58% total matter density about 36.84%, therefore, this much dark energy certainly will accelerate the universe's rapid expansion. According to the Big Bang Theory, dark energy will decrease gradually, but matter increases gradually. When dark energy deceases to below 50% or less, and total matter increases to bigger than 50% or more, the universe may stop to expand and turn around to collapse in a "Big Crunch" due to gravity.

4.3 Result

The 3-cosmic framework of the universe should enable a new approach to breaking the bottleneck of research in the space of the universe. Under the 3-cosmic framework of the universe, triple cosmoses exist. The current dark energy should be taken as the residual energy of the universe, which is still in a high-energy state, so other high-energy-density cosmoses rapidly expand; its matter (i.e., dark matter for our cosmos) should be subject to a "drag" on the stars of our cosmos due to gravity, which causes the effect of pulling our cosmos accelerating expansion. The problems associated with dark energy in astrophysics can be roughly solved as above, i.e., dark energy can be unveiled on the 3-cosmic framework of the universe by string theory.

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