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Prolegomena to quantum astro-green criminology

Entanglement of quantum cosmology, dark energy, and super intelligence

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Abstract

Humanity has advanced exponentially in energy use from harnessing fire about half a million years ago to developing sustainable nuclear fusion in the coming decades. Eventually, we should be able to harness the full energy content of matter and convert it directly into energy and even annihilate matter and antimatter to produce more energy. It is estimated that ordinary matter is now considered to be only about 4% of the total matter-energy density in the observable universe, which also includes 22% dark matter and 74% dark energy. Since matter and energy cannot be destroyed but only converted from one type to another, there are almost unlimited amounts of energy for our civilization to keep expanding throughout the universe. The Earth, the Sun, the Milky Way galaxy, and the visible universe have more than enough energy to power our civilization for the following decades, centuries, millennia, and even billions of years into the future. In this research, from the perspective of 'quantum astro-green criminology', we pursue endeavors to elucidate the truth of unidentified dark energy and delve into the way super-intelligence could make a safe and sound relation with dark energy, avoiding environmental disasters in the universe and multiverse (Takemura, 2019; Lampkin and Takemura, 2025; Takemura, 2022; Takemura, 2024-2025; cf. Lampkin and White, 2023; Eski et al., 2025).

Keywords: quantum cosmology, universe, multiverse, dark energy, accelerated expansion of universe, super intelligence, safe and sound relation with dark energy

1. Introduction

In 1929 Edwin Hubble discovered that the universe is expanding (Osterbrock et al., 1993; cf. Lemaitre, 1948). In 1998 it was followed by an even more startling realization: the expansion is accelerating. In order to explain the reason why the universe is accelerating, cosmologists have produced two alternative ideas. One is the idea of 'cosmological constant', a mathematical term, which was introduced into the equation of general relativity by Albert Einstein. The other is the idea of 'vacuum energy' which is explained by quantum mechanics. The universe is filled with some unseen stuff, dark energy,' that counteracts the force of gravity, making objects repel instead of attracting one another. Either of which would revolutionize our understanding of the laws of nature. This enigma is one of the biggest unsolved mysteries in all of science.

Jonathan J. Halliwell (1991) explains the development of quantum cosmology which applies quantum mechanics to the universe as a whole. In recent decades, workers have begun to make some progress in applying quantum theory to the universe: quantum cosmology. Quantum cosmologists build on foundations laid in the 1960s by Bryce S. DeWitt, Charles W. Misner, and John A. Wheeler. Their studies mapped out how quantum mechanics might be applied to the entire universe. But the work was not taken seriously until the 1980s, after classical theories of cosmology began to falter in their attempts to explain fully the beginning of the universe (76).

Most notable among the investigators are James B. Hartle, Stephen W. Hawking, Andrei D. Linde, and Alexander Vilenkin. They put forward quite definite laws of initial conditions that must have existed at the very moment of creation. When adjoined with suitable laws governing the evolution of the universe, such proposals could conceivably lead to a complete explanation of all cosmological observations and would therefore resolve important problems that plague the foundations of conventional cosmology (76; Hawking et al., 1996; Hogan, 1990; Smolin, 2000; Smolin, 2007).

2. Quantum cosmology, universe, and multiverse

2.1. Problems of quantum cosmology

Like quantum mechanics, quantum cosmology attempts to describe a system fundamentally in terms of its wave function. One can find the wave function of the universe by solving an equation called the 'Wheeler-DeWitt equation', which is the cosmological analogue of the Schrödinger equation. In the simplest cases, the spatial size of the universe is the analogue of position, and the rate of the universe's expansion represents the momentum (Halliwell, 1991: 80).

A question that workers confront is the applicability of quantum mechanics to the entire universe. Quantum mechanics was developed to describe atomic-scale phenomena. The beautiful agreement between quantum mechanics and experiment is one of the great triumphs of modern physics; no physicist in his or her right mind harbors any doubts as to its correctness on the atomic scale. But a few raise dissenting voices if one suggests that quantum mechanics is equally applicable to macroscopic systems (80).

Another perhaps more complicated issue concerned the interpretation of quantum mechanics applied to cosmology. Niels Bohr laid the foundation of this translation, known as quantum measurement theory, in the 1920s and 1930s. He assumed that the world may be divided into two parts: microscopic systems (such as atoms), governed purely by quantum mechanics, and external macroscopic systems (such as observers and their measuring apparats), governed by classical mechanics. A measurement is an interaction between the observer and the microscopic system that leads to a permanent recording of the event (80).

During this interaction, the wave function describing the microscope system undergoes discontinuous change from its initial state to some final one. The quantity being measured takes on a definite value in the final state. The discontinuous change is referred to, rather dramatically, as the collapse of the wave function. For instance, the wave function could start out in a state of definite momentum, but if position is being measured, it 'collapses' into a state of definite position. Although many theorists feel this scheme, known as the Copenhagen interpretation of quantum mechanics, is philosophically unsatisfactory, it nonetheless enables predictions to be extracted from theory-predictions that agree with the observation. Perhaps for this reason, the Copenhagen interpretation has stood largely unchallenged for almost half a century (80; Freire Jr., 2022; Heisenberg, 1958).

In attempting to apply quantum mechanics to the entire universe, however, one meets with acute difficulties that cannot be brushed off as philosophical niceties. In a theory of the universe, of which the observer is a part, there should be no fundamental division between observer and observed (80; Munévar, 2023).

2.2. New way of thinking of quantum cosmology

Many worlds

Keeping such difficulties in mind, Hugh Everett III presented a framework for the interpretation of quantum mechanics particularly suited to the special needs of cosmology. He asserted that there exists a universe wave function describing both macroscopic observers and microscopic systems, with no fundamental division between them. A measurement is just an interpretation between various parts of the entire universe, and the wave action should predict what one part of the system 'sees' when it observes another (32; DeWitt et al., 2015; Byrne, 2007). Hence there is no collapse of the wave function in Everett's picture, only a smooth evolution described by the Schrödinger equation for the entire system. He made a truly remarkable discovery: the measurement appears to cause the universe to 'split' into sufficiently many copies of itself to consider all possible outcomes of the measurements. Theorists have hotly debated the reality of the multiple copies in Everett's uneconomical 'many worlds' interpretation (32-33; Saunders et al., 2010; Ball, 2018; Tegmark et al., 2001).

Yasunori Nomura (2017) insists that a surprising connection between cosmology and quantum mechanics could unveil the secrets of space and time. According to this picture of many quantum worlds, the state of the entire world continuously branches into many possible parallel worlds that coexist as a superposition. A human observer, being a part of nature, cannot escape from this cycle—the observer keeps splitting into many observers living in many possible parallel worlds, and all are equally 'real'. An obvious but important implication of this is that everything in nature obeys the laws of quantum mechanics, whether small or large. The multiverse and quantum many worlds are really the same thing; they simply refer to the same phenomenon—superposition—occurring at vastly different scales. In this new picture, our world is only one of all possible worlds that are allowed by the fundamental principles of quantum physics and that exist simultaneously in probability space (31, 35; Busso et al., 2012; Gilder, 2008).

Parallel universes

Max Tegmark (2003) shows that physical theories involving parallel universes form a four-level hierarchy, in which universes become progressively more different from ours. Level I is associated with inflation and contains Hubble volumes realizing all possible initial conditions. Level II assumes that different regions of space can exhibit different effective laws of physics (i.e., different physical constants, different dimensionality, and different particle content). Level III corresponds to the 'many worlds' of quantum theory. Tegmark argues that the other branches of the wave-function add nothing qualitatively new, even though historically this level has been the most controversial. Finally, Level IV invokes other mathematical structures, associated with different fundamental equations of physics (43-51; Tegmark, 2007: 123; Tegmark, 2004: 490; Tegmark, 2015; Carr, 2007: 19).

Holographic universe

Jacob D. Bekenstein (2003) states that "Theoretical results about black holes suggests that the universe could be like a gigantic hologram," and explains the holographic universe. A century of developments in physics has taught us that information is a crucial player in physical systems and processes. Indeed, a current trend, initiated by John A. Wheeler, is to regard the physical world as made of information, with energy and matter as incidentals (59; Moyer, 2012). Our universe, which we perceive to have three special dimensions, might instead be 'written' on a two-dimensional surface, like a hologram. Our everyday perception of the world as three-dimensional would then be either a profound illusion or merely one of two alternative ways of viewing reality. If the physics of our universe is holographic, there would be an alternative set of physical laws, operating on a 3-D boundary of spacetimes somewhere, that would be equivalent to our known 4-D physics. One step toward realizing these ideas is to study models that are simpler than our real universe (60, 63-64; Talbot, 1996).

2.3. Does the multiverse really exist?

George F. R. Ellis (2011) mentions that "Proof of parallel universes radically different from our own may still lie beyond the domain of science." and critically analyses whether multiverse really exists. The word 'multiverse' has different meanings. Those who subscribe to a broad conception of the multiverse have various proposals as to how such a proliferation of universes might arise and where they would all reside. They might be sitting in regions of space far beyond our own, as envisaged by the chaotic inflation model of Alan H. Guth, Andre Linde and others (Linde, 1994), exist at different epochs of time, as proposed in the cycle universe model of Paul J. Steinhardt and Neil Turok (Veneziano, 2004), exist in the same space wo do but in a different branch of the quantum wave function, as advocated by David Deutsch (Deutsch et al., 1994), or not have a location, being completely disconnected from our pace time, as suggested by Mark Tegmark and Dennis Sciama (Tegmark, 2003; Rees, 1999; Green, 2011). For a cosmologist, the basic problem with all multiverse proposals is the presence of a cosmic visual horizon. All the parallel universes lie outside our horizon and remain beyond our capacity to see, now or ever, no matter how technology evolves. In fact, they are too far away to have had any influence on our universe whatsoever. That is why none of the claims made by multiverse enthusiasts can be directly substantiated. The existence of other universes has not been proved – or ever could not be. Proponents for the multiverse, as well as greatly enlarging our conception of physical reality, are implicitly redefining what is meant by science (40-41).

Moreover, there are more philosophical and epistemological aspects of the multiverse proposal – especially the issue of its scientific legitimacy (Carr, 2007: 24). One example is Lee Smolin's 'cosmological natural selection' proposal (Smolin, 2007). Another version explored by Nick Bostrom is that the Universe is a computing simulation (Bostrom, 2003; Bostrom, 2005). John Barrow (2007) explains why, if we live in a simulated reality, we might expect to see occasional glitches and small drifts in the supposed constants and laws of nature over time. There may even be evidence for this form of astronomical observations, although the interpretation of these remains controversial (Barrow, 2007; Carr, 2007: 27). Paul Davies provides another possible interpretation. After reviewing several shortcomings of indiscriminate multiverse explanations, he explores the possibility of a 'third way', involving a radical reappraisal of the notion of physical law, and presents a toy illustration from the theory of cellular automata (Davies, 2007; Carr, 2007: 27).

Nonetheless, one of the emerging themes of 21st-century cosmology is that the known universe, the sum of all we can see, may just be a tiny region in the full extent of space. Several types of parallel universes that make up a ground 'multiverse' often arise as side effects of cosmological theories (Tegmark, 2003). We have little hope of ever directly observing those other universes, because they are either too far away or somehow detached from our own universe (Burgess et al., 2007: 53). Our universe is not the only one possible. Its properties could have been different. And in many of the multiverse proposals, the properties of the other member universes would be different. It is only through the rational pursuit of theories, even those that whisk us into strange and unfamiliar domains, that we stand a chance of revealing the expanse of reality (Green, 2011: 370).

3. Dark energy and accelerated expansion of universe

3.1. Dark energy and expansion of the universe in context

Dark energy appears to be the dominant component of the physical Universe, yet there is no persuasive theoretical explanation for its existence or magnitude. The acceleration of the Universe is the observed phenomenon that most directly demonstrates that our theories of fundamental particles and gravity are either incorrect or incomplete. Most experts believe that nothing short of a revolution in our understanding of fundamental physics will be required to achieve a full understanding of the cosmic acceleration. For these reasons, the nature of dark energy ranks among the very most compelling of all outstanding problems in physical science (Albrecht et al., 2006: i). According to Andy Albrecht and his colleagues (2006), over the last several years scientists have accumulated conclusive evidence that the Universe is expanding ever more rapidly. Within the framework of the standard cosmological model, this implies that 70% of the universe is composed of a new, mysterious dark energy, which unlike any known form of matter or energy, counters the attractive force of gravity (1).

One possible explanation for dark energy may be Einstein's famous cosmological constant. Alternatively, dark energy may be an exotic form of matter called quintessence, or the acceleration of the Universe may even signify the breakdown of Einstein's Theory of General Relativity. With any of these options, there are significant implications for fundamental physics. Conclusive evidence from supernovae and other observations shows that the expansion of the Universe, rather than slowing because of gravity, is increasingly rapid. This must be due to a substance that behaves as if it has negative pressure. This substance has been termed 'dark energy'. It is not at present possible to determine whether a cosmological constant, a dynamical fluid, or a modification of general relativity is the correct explanation of the observed accelerating Universe (1, 5-6; Kragh et al., 2014; Panek, 2023; Panek, 2011; Clegg, 2019; Tegmark, 2002; Papantonopoulos, 2010; Matarrese et al., 2011; Münzer, 2025).

Nonetheless, Michael S. Turner (2009) suggests the development of and future of the universe. It is assumed by most that our universe began with a hot big bang 13.7 billion years ago and has expanded and cooled ever since. It has evolved from a formless soup of elementary particles into the richly structured cosmos of today. The first microsecond was the formative period when matter came to dominate over antimatter, the seeds for galaxies and other structures were planted, and dark matter was created. The future of the universe lies in the hands of dark energy, as unknown form of energy that caused cosmic expansion to begin accelerating a few billion years ago (36).

Cosmologists do not yet know how the universe began, but this question has now come within the realm of science, with a number of speculative scenarios being discussed: Scenario A - No Previous Era (Matter, energy, space, and time begin abruptly with the bang); Scenario B - Quantum Emergence (Ordinary space and time develop out of a primeval state described by a quantum theory of gravity) ; Scenario C – Multiverse (Our universe and others bud off from eternal space); Scenario D - Cyclic Universe (The big bang is the latest stage in an eternal cycle of expansion, collapse and renewed expansion) (39; Del Popolo, 2021: 223-241).

On the other hand, predictable events such as galactic collisions dominate the near future. But the ultimate destiny of our universe hinges on whether dark energy will continue to accelerate cosmic expansion. Broadly, four fates are possible: Scenario A - Acceleration ends and the universe expands eternally - In 100 trillion years, the last stars burn out; Scenario B - Acceleration continues - In 30 billion years, cosmic redout, cosmic acceleration pulls all other galaxies out of our view - all evidence of the big bang is lost; Scenario C - Acceleration intensifies - In 50 billion years, Big rip, dark energy tears apart all structures, from superclusters to atoms; Scenario D - Acceleration changes to rapid deceleration and collapse - In 30 billion years, Big crunch, perhaps followed by a new Big Bang in an eternal cycle (42).

In short, cosmologists have only rudimentary clues as to what dark energy might be. To speed up expansion requires a repulsive force, and Einstein's general theory of relativity predicts that the gravity of an extremely elastic form of energy can actually be repulsive. The quantum energy that fills empty space acts in this way. The trouble is that theoretical estimates of the amount of quantum vacuum energy do not match the amount required by observations; they exceed it by many orders of magnitude. Alternatively, cosmic acceleration might be driven not by a new type of energy but by a process that mimics such energy, perhaps the breakdown of general relativity or the influence of unseen special dimensions (43; Riess and Turner, 2004; Krauss and Turner, 2004; Tyson et al., 2016: 400-424; Krauss and Scherrer, 2008; Frieman et al., 2008; Frank, 2012).

3.2. Theoretical ideas for the nature of dark energy

So, we are left with the puzzle of dark energy, its possibilities and potential futures and the question remain. Why is the expansion of the universe accelerating? After two decades of study, the answer is as mysterious as ever, but the questions have become clearer. For example, Adam G. Riess and Mario Livio (2016) try to crack the quandary of dark energy – the mystery of why the expansion of the universe is speeding up. Explanations for dark energy fall into the three main categories (41; Del Popolo, 2021: 195-222):

Model 1: Cosmological constant

Dark energy comes from space itself. If the vacuum of empty space has an inherent energy, it may push the universe to expand. The strength of such an energy would be constant through time and would act just like the cosmological constant term. The future is accelerating expansion forever (Peebles, 2003; Krauss, 1999).

Model 2: Quintessence.

Dark energy is a field. If the dark energy comes from a field that fills the cosmos, its strengths could change over time, either increasing to eventually rip all structures in space apart or decreasing and changing directions to allow the universe to contract in a Big crunch. There are two possibilities: 'Big rip' and 'Big crunch.'

Model 3: There is no dark energy.

> Dark energy may not exist at all, and the acceleration of the universe's expansion may instead indicate that gravity operates differently than we think on extremely large scales. On the scale of galaxies and clusters, gravity behaves as the general relativity predicts. On the scale of the universe as a whole, gravity grossly diverges from general relativity; the universe appears to accelerate. The future depends on how gravity works on large scales.

Because dark energy is denser in space than any other constituent of the universe, it exerts the dominant influence on the cosmos and will therefore control its fate. As the universe expanded over time, matter and radiation spread out, and dark energy overpowered them (43; Dvali, 2004; Tegmark, 2017: 203-248; Moskowitz, 2021; Ostriker et al., 2001).

Theoretical ideas on the nature of dark energy are also further developing. For example, Andrew Taylor (2008) examines some other theoretical ideas for the nature of dark energy which poses a major theoretical challenge (46).

The Extra Dimensions theoretical idea is that if the Universe is in motion through the extra dimension, an accelerating force is produced within the Universe, creating observed acceleration of the expansion (50-51). It has also been suggested that Cyclic Universe may have relevance. The possibility of extra spatial dimensions has also given rise to the possibility of cyclic evolution of the Universe. In some superstring models, we find two universes separated by a large extra dimension. The forces generated by the moving the two universes through the large extra dimension towards each other resulted in an accelerated expansion of the universe. In an interesting twist, the universes eventually collide. They would then bounce away from each other until their attraction pulled them back together again (50-52; Steinhardt et al., 2002; Bojowald, 2009). As mentioned previously, the Multiverse includes the unification of early superstring theories which implied that there was a vast number of potential and possibly actual universes. The properties of these universes are predicted to vary, for example in their values of fundamental constants, providing a 'landscape' of the possible universes. In different universes the actual value could be different (53-54; Susskind, 2006).

3.3. Dark energy survey: four approaches, new universe map, and evidence

As Joshua Frieman (2015) mentions, "The ambitious new Dark Energy Survey aims to solve the riddle of why space is expanding at ever faster pace.", and he explains the four approaches of cosmic acceleration. The Dark Energy Survey (DES) aims to find out the 'why' by observing four different signals. These four phenomena are 'supernovae,' 'signature of primordial sound waves,' 'gravitational lensing' (the bending of light by gravity), and 'galaxy clusters'. Collectively they tell us how fast the universe has expanded and how much matter has clumped together to form large-scale structures at different epochs of cosmic history (43-45; Amendola et al., 2010).

Likewise, Kyle Dawson and Will Percival (2021) mention that "A chart of millions of galaxies across 11 billion years of cosmic history helps to answer some of the biggest cosmological questions.", which explains how fast space is expanding. Dark energy is the mysterious force driving the universe to expand faster and faster. To understand dark energy, astronomers working on the two decades Sloan Digital Sky Survey created the largest-ever cosmic map to see how the expansion rate of space has changed over time. The final map was released by the extended Baryon Oscillation Supertelescopic Survey (eBOSS), part of Sloan that ran from 2014 to 2019. The map shows that galaxies are not distributed randomly. Instead, they cluster in patterns (36, 38-39; Landy, 1999).

Christopher J. Conselice (2007) suggests that "Dark energy does more than hurry along the expansion of the universe. It also has a stranglehold on the shape and spacing of galaxies.", that provides evidences for dark energy (37):

i) Supernova explosions

In an expanding universe, galaxies move apart at the speed that depends on the distance between them. Supernovae offer a way to measure this effect: their spectral redshift reveals the speed of their host galaxies, and their brightness reveals distance. The expansion rate must have increased over that time - the hallmark of dark energy (Hogan et al., 1999).

ii) Cosmic microwave background radiation

Images of the background radiation contain spots whose apparent size reflect the overall geometry of space and therefore the density of the universe. The background radiation has been slightly reworked by the gravitational fields of cosmic structures. The amount of reworking depends on how the expansion rate has changed over time and matches what dark energy would do.

iii) Galaxy configuration

Galaxies are arranged in patterns, one of which resembles the spots in the microwave background. It can be used to measure the total mass of the universe and confirm the need for dark energy.

iv) Gravitational lensing

A lump of mass can serve as a lens, its gravity bends light. Such a lens can produce multiple images if the light source is directly behind it. An alignment that becomes more probable, the bigger the universe is, which in turn depends on the amount of dark energy.

v) Galaxy clusters

X-ray observations trace the evolution of the mass of galaxy clusters. Dark energy is required to explain when and how they formed.

An accelerating universe dominated by dark energy is natural way to produce all the observed changes in the galaxy population. Dark energy could have had a profound effect on many different and seemingly unrelated aspects of the universe (41; Cliff, 2024: 208-250; Devereux, 2021; Panek, 2020).

3.4. Does dark energy really exist?

Another question is whether dark energy really exists. For example, Timothy Clifton and Pedro G. Ferreira (2009) insist that "dark energy does not exist," and critically analyze the existence of dark energy (48). Cosmologists may not actually need to invoke exotic forms of energy. If we live in an emptier-than-average region of space, then the cosmic expansion rate varies with position, which could be mistaken for a variation in time, or acceleration. A giant void strikes most cosmologists as highly unlikely but so for that matter does dark energy. Observations over the coming years will differentiate between the two possibilities (48).

i) Scenario 1: Expansion is accelerating

In the usual interpretation of supernova observations, the rate of cosmic expansion used to be slower than it is now. Consequently, the universe has taken longer to grow to its present size and supernova light has had more time to spread out, so that it appears dimmer to us. Driving this acceleration requires dark energy.

ii) Scenario 2: Universe is inhomogeneous

Alternatively, perhaps expansion is decelerating but at different rates in different places. If our neighborhood is emptier than other areas, it has less matter to retard the expansion and decelerates less quickly. As light from a supernova spreads out, it enters zones of increasingly rapid expansion— which has the same effect as cosmic acceleration but without any need for dark energy.

Although a cosmic void mimics dark energy, the match is not exact. Upcoming observations will look for telltale differences. Additional supernova observations will pin down the expansion rate and check whether it varies with position, as a void model predicts. Galaxy clusters reflect light and, in effect, let us view our cosmic neighborhood in the mirror. If we live in a void, we should be able to see it. Galaxies and galaxy clusters evolve at a pace that depends on the expansion rate at their location and therefore on the presence of a void. Neutrinos left over from the primordial universe could reveal a void (53; Lemonick, 2024).

Having laid out the foundational issues, the following delves into the realm of superintelligence and the possible relation with dark energy.

4. Super intelligence: safe and sound relation with dark energy

4.1. Different civilization classifications

Let us consider Nicolai Kardashev's typology (1964), which is based on a brief that we can categorize super civilization by their energy consumption. We can imagine an advanced civilization which can harness the energy of an entire galaxy with new physical laws. So, it is reasonable to create a new typology that is based on the possible spatial extents of an advanced civilization (Takemura, 2022: 29-34; Ćirković, 2015; Galántai, 2004; Galántai, 2006; Ivanov et al., 2020; Vakoch et al., 2013; Bostrom, 2014).

<u>Energy use/consumption civilization</u>

Remzi Yildirim (2023) offers the advanced classification based on Kardashev classification (13):

Type-0: Beginning - sub-universe civilization

This civilization obtains its energy and raw materials from organic-based coal, oil, petroleum, and water resources. The journeys of these civilizations will be slow, limited to our own planet.

Type-1: Planetary cultural civilization

This civilization has the ability to use all energy sources on the planet. These energy sources are solar, hydro-thermal, wind, hydrocarbon, coal etc.

Type-2: Interstellar-civilization

This civilization could get all of the sun's energy. The most obvious example of this is the Dyson Sphere.

Type-3: Galactic civilization

This civilization can benefit from all the energy sources of the galaxy it is in. For example, dark matter, dark energy, white matter, white energy, hot dark matter, cold dark matter, neutron stars, quasars etc.

Type-4: Universal culture-intergalactic civilization

This civilization is defined as an intergalactic cultural interaction covering the entire visible universe. The technology level will be the ability to harness the energy of trillions of stars in the universe. They will be able to travel between the stars. These communities will eventually have technology to ensure human longevity.

Type-5: Multi-cultural civilization

This civilization has the ability to change matter, space-time, and multi-dimensional structures on the scale of the universe and can reach not only galaxies but also the universe or multiverses.

Ability to modify and control motion of astronomical objects

Irina K. Romanovskaya (2022) proposes the classification of extraterrestrial civilizations according to their ability to modify and control motion of astronomical objects, from asteroids and planets in planetary systems to free-floating planets and stars traveling through the Galaxy (4).

Class 0 civilizations are not capable of modifying the motion of cosmic objects. *Class 1* civilizations use astronomical engineering to modify the motion of minor bodies, such as asteroids and comets, inside planetary systems. *Class 2* civilizations use astronomical engineering to modify the motion of planets for the purpose of changing the orbits of such planets inside planetary systems. *Class 3* civilizations use astronomical engineering to eject minor bodies, dwarf planets, and planets from their planetary systems. *Class 4* civilizations use astronomical engineering to modify the motion of non-stellar interstellar objects in the Galaxy (e.g., interstellar asteroids, free-floating planets). *Class 5* civilizations use astronomical engineering to modify the motion of stars (4-8).

Among other things, extraterrestrial civilizations can modify motion of astronomical objects to avoid existential threats and to take control of their journey through the Galaxy. This classification can be used to organize and categorize technosignatures that extraterrestrial civilizations produce when they modify motion of astronomical objects and use such astronomical objects for various purposes (4-8).

Light speed civilization

Yildirim (2023) offers an innovative approach depending on the level of world civilization, the speed of light, referred to as light speed civilization. Type (-) civilization represents civilizations under the speed of light. When the speed of light is reached, all kinds of science and technology known today will be in a very primitive state (16-23).

Type (0): Light Speed Age

Type (0) is the beginning of the light speed era or light speed civilization. A new energy source is found and then the appropriate technology is developed.

Type (1): Spooky Quantum Era

In the Type (1) civilization stage, many subatomic particles in the structure of matter will be purified and solidified. New energy sources will also be found in this period, science and technology will be realized to reach the multiples of the speed of light. For this, new energy sources such as light obtained from particles faster than photons will be invented.

Type (2): Quantum Entanglement Era

In the age of quantum entanglement in the structure of matter, the existence of particles moves independently of speed, time, and space. As the properties of subatomic particles cannot be determined exactly, there is no concept of velocity, time-space during the entanglement of subatomic particles. In other words, it is accepted that conjugates exist in various places at the same time.

The Type (2) civilization will be intergalactic and other inter-universe civilizations. They will allow the transfer of science and technology, subject to the permission of other galaxies. This will raise the level of science and technology in our world or other stars (24; Galfard, 2015).

4.2. Energularity

José Luis Cordeiro (2013) suggests the concept 'Energularity' in which a civilization has basically achieved total mastery of the resources of its home planet, which emphasizes the exponential increase in energy consumption by our civilization on Earth, and reviews the prospect (Scobie, 2025; cf. Kurzweil, 2005; Ganascia, 2017).

The conscious generation and use of external energy plays a unique role in our human and cultural evolution, from harnessing fire to developing nuclear fusion. This is fundamental for improving the living standards of all people around the world and for moving into the next planetary transition: energy is essential for solving humanity's needs on Earth and for exploring and colonizing the universe. This exponential growth is also explained by Michio Kaku (2002, 2005, 2018), who talks about different propulsion systems available to several types of civilizations: Type 0 - Chemical rockets, Ionic engines, Fission power, EM propulsion (rail guns); Type I - Ram-jet fusion engines, Photonic drive; Type II - Antimatter drive, Von Neumann nano probes; Type III - Planck energy propulsion (Cordeiro, 2013: 1, 12).

Space advocates have realized that there are almost unlimited amounts of energy available in outer space. That is why it is so important to reach the 'Energularity' and become a Type I civilization that can then explore and colonize the universe, beginning with our own solar system and galaxy (12; Johnson, 2022; Kennedy, 2024).

Solar energy is by far the largest external source of energy available to our civilization. However, we still have plenty of energy sources available on our planet to move us towards the 'Energularity.' Considering the visible and known universe, its total mass-energy is currently estimated at about 4×10^{69} J. There is certainly no lack of mass-energy in the universe. Moreover, ordinary matter is now considered to be only about 4% of the total matter-energy density in the observable universe, which also includes 22% dark matter and 74% dark energy as well. Since matter and energy cannot be destroyed but only converted from one type to another, there are almost unlimited amounts of energy for our civilization to keep expanding throughout the universe after reaching the 'Energularity' (13, 15).

The Earth, the Sun, the Milky Way galaxy, and the visible universe have more than enough energy to power our civilization for the following decades, centuries, millennia, and even billions of years into the future. It is thus possible to convert the immense energy supplies available in the universe into usable power, but it will certainly take massive investments and lots of imagination, creativity, science, and technology (15; Bostrom, 2014: 122-123, 137-138; Takemura, 2022).

4.3. Dark energy control and relation with space constituents

Although dark energy is said to be a cause of accelerating space expansion, its truth is not revealed. Fundamental information and influence of dark energy are as follows: Dark energy accounts for about 70 percent and accelerates expansion speed (energy density); It has antigravity characteristic and has an impact on galaxy formation and movements (relationship with gravity); It was discovered in 1998 and contributes to future estimation of space (history).

The theoretical framework and technological tasks for harnessing dark energy as energy resource are pursued. It is necessary to accurately measure and comprehend the nature and characteristics of dark energy in order to harness dark energy. It is difficult to directly observe dark energy with current technology and this stands in the way of its harnessing. Theoretical framework of energy extraction establishes the methods to directly harness dark energy as energy resource. An innovative approach based on the gravity field theory and cosmic model is being groped. The technology to convert one energy to another is needed to harness dark energy. The development of new technology applying unknown physical laws is demanded. Harnessing dark energy may have an influence on space structure and progress. For this reason, it is important to consider the theoretical and ethical aspects and long influence.

Suggesting a new theory, we can consider how dark energy and space constituents interact and influence space evolution. Dark energy plays a role opposing material gravity as a power causing accelerated space expansion. While dark matter interacts with ordinary matter with the aid of gravity from space structure, dark energy has a power opposing this structural progress. While ordinary matters are the foundation of forming stars and galaxies, dark energy functions as a factor deciding their fate. Having the influence of dark energy on interactions between dark matter and ordinary matter, possibility of changing space expansion speed is suggested (Rovelli, 2021). Understanding dark energy characteristics would give us a clue to forecasting the final destiny and structural change of the universe.

To understand the influence of dark energy on space evolution is an important key to cultivating our outlook on the universe. In particular, investigating how dark energy contributes to the speed of space expansion through interactions with dark matter and ordinary matter becomes an important theme for future research (Danca, 2024; Musser, 2015).

5. Concluding remarks

Dark energy not only plays an important role in the space evolution but also has the high potential to drastically change our outlook on the universe. The fundamental information and influence of dark energy can be summarized as follows: Dark energy accounts for about 70 percent and accelerates expansion speed (energy density); It has antigravity characteristic and has an impact on galaxy formation and movements (relationship with gravity); It is discovered in 1998 and contributes to future estimation of space (history).

Understanding the nature and characteristics and the harnessing or controlling of dark energy are the important themes of space science and physics. Here the theoretical framework and technological tasks for harnessing and controlling dark energy as energy resource are pursued. To understand influence of dark energy on space evolution is the important key to cultivating our outlook on the universe. In particular, investigating how dark energy contributes to the speed of space expansion through interactions with dark matter and ordinary matter becomes an important theme for the future research.

In order to make a safe and sound relation with dark energy without environmental degradation, harms, and disasters in the universe and the multiverse, we must pursue the followings processes: i) recognize dark energy phenomena or existence/non-existence; ii) understand the nature and characteristics of dark energy; iii) quest for the causes and developments of dark energy; iv) find the way of harnessing or controlling dark energy; v) find the pros and cons of dark energy application. As universes move through the extra dimensions, they may expand with acceleration, accounting for various cosmological mysteries.

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