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A New Perspective on the Universe: Actualization of Potentialities

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Article Info

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Abstract

The true nature of the universe remains elusive, despite an awareness and partial understanding of many processes. A limitation pertains to how theories are almost exclusively derived from physics, and essentially none from life sciences which can provide a unique and robust perspective. In this regard, interconnectedness and even interdependence, often taking the advanced form of symbiosis characterize natural occurrences. Given that the universe represents a natural entity, these features also apply. How space and time as space-time and matter and energy as matter-energy are linked, underscores this occurrence. It is proposed that space-time and matter-energy are deeply emmeshed and symbiotic, facilitating the actualization of potentialities, posited to be the primary process of the universe. Matter-energy provides future potentialities and influences probability, interactions between select potentiality waves and matter energy in the present moment actualize potentialities, and the actualized potentialities based on the form of matter-energy comprise the past. Space-time provides existence to matter-energy, with "space" for matter-energy actualization events and "time" for the progressive actualization of potentialities. Insights into the nature of space-time, limits and forces of the universe, entanglement, quantum gravity, existence/non-existence, and the role of information, are yielded by the actualization of potentialities perspective on the universe.

Keywords: Cosmology, space-time, matter-energy, dark energy, String Theory, Loop Quantum Gravity, actualization of potentialities, symbiosis, interconnectedness, existence, non-existence

Introduction

The true nature of the universe still remains elusive, even with research and theorizing that is almost as expansive as the topic itself. One reason for this occurrence consists of investigations being strictly physics related, when more comprehensive and interdisciplinary perspectives are typically required to understand complex phenomena. Of significance, perspectives from life science have been completely omitted despite having the potential to inform regarding the universe. In this regard a crucial concept is interconnectedness: everything in nature is interconnected and does not exist and persist in isolation. This interconnectedness and even interdependence constitutes a core feature of natural entities. For example, processes within a cell rely on extracellular events, that in turn depend on the environment surrounding the organism. The interconnectedness enables and accounts for the dynamic and active features of natural entities. Assuming that the universe has not been created, most likely a safe assumption, its many entities represent natural occurrences, and as such will be subject

to interconnectedness and interdependence. For example, based on quantum fields theory, all fields of the Standard Model are connected, ripples in one field causing changes in other fields (Caldwell, 2024).

A new perspective on the universe will be presented that emphasizes interconnectedness and interdependence, pertaining to its essential components including space-time and matter-energy. Even the linkage of space and time as space-time and matter and energy as matter-energy highlights how fundamental interconnectedness is to the universe. Enabled by the interconnectedness of space-time and matter-energy, the primary process of the universe is posited to be the actualization of potentialities. This dynamic occurrence can partially or fully account for several puzzling features of the universe including entanglement, the merger of quantum and relativity theories, the function of universal forces, and the role of information. The actualization of potentialities perspective will be presented in the following sections: the nature of space-time, entanglement, interconnectedness of space-time and matter-energy, and information.

The Nature of Space-Time

Space and time are commonly thought of as separate entities, but relativity theory clearly shows how they are connected as space-time (Einstein, 1920). Hence, with any discussion of space or time, it is to be understood that they are interconnected. Given that we observe space around us, this component of space-time is easier to grasp. However, with time we cannot see it leaving its nature more puzzling with several perspectives proposed. Each of these theories addresses future, present, and past, key components of the psychological arrow of time:

- 4-D Block Model referring to three spatial and one time dimension, maintains that past, present, and future are not absolutely distinguishable as part of the space-time landscape (Callender, 2008; Dainton, 2010). Hence, there is no actual passage from future to present to past; they just occur. In a diagram form they appear as an elongated rectangle without clear borders.
- Moving Spotlight Model indicates that past, present, and future are part of the space-time landscape, but suggests that there is a privileged advancing present, that can be represented by a narrow bar on the rectangle (Callender, 2008; Dainton, 2010).
- Growing Block Model holding that there is a past arising from a present, but no future (Callender, 2008; Dainton, 2010). In diagrammatic form, the forward section of the rectangle representing the future is missing.
- Presentism argues that only a narrow present occurs, the past and future not being real (Callender, 2008; Dainton, 2010).

Approaching time from an actualization of potentialities perspective suggests another option, and one that aligns with the psychological arrow of time, one of our most fundamental beliefs. Even intensely psychotic individuals process future, present, and past events, and statements such as, "Yesterday, I am going to buy a new coat," and, Tomorrow I purchased a car," elicit disbelief even from these unfortunate individuals, for the reason that such events never occur. While the laws of physics do allow for time reversal, such as time proceeding backwards, this never transpires for the various arrows of time, an occurrence known as the reversibility paradox (Barrow, 2007). Arrows of time include (Falk, 2008; Lockwood, 2005):

Psychological: The perceived progression of time from future to present to past.

Radiative: Spread of waves outwards from a contact point, such as when a rock lands in the middle of a pond and the ripples spread to the shore.

Thermodynamic: How entropy increases over time from low to high.

Cosmological: The progression of the universe from inflation.

Based on the reality that arrows of time reversals never transpire, the notion of progression from future to present to past, does appear to be valid. However, our perception of time in terms of future-present-past (the psychological arrow of time) has been discredited as an illusion (Barbour, 1999; Smythies, 2003), consistent with the 4-D Block Model. Casting doubt on the 4-D Block Model itself is how actual temporal sequences are evident in various biological and psychological occurrences, such as the progression of neural activity for events. Take the example of turning a corner and encountering an attack dog. According to Ledoux's (1994) fear circuit depiction sensory input travels to the thalamus, and then directly to the amygdala, producing a fear response in milliseconds. Occurring on a slower time scale, the information that reached the thalamus proceeds to the higher cortical regions, and based on the ensuing more extensive cognitive processing the person realizes that the dog is friendly and relaxes, this altered reaction to the dog entailing higher cortical suppression of the prior amygdala fear response (Ledoux, 1994). The passage of information from the thalamus to the amygdala, and the resultant conscious fear response, occurs prior to the passage of the information to the higher cortical regions, detailed processing, and suppression of the former amygdala response. There is a definite temporal sequence detectable at a neural level, with profound implications for evolutionary fitness: the thalamus to amygdala neural processing enables rapid millisecond responses to dangerous situations aiding in survival, and the more detailed thalamus to higher cortical regions processing facilitates adaptive modification of the immediate response. Another example of an actual temporal sequence in biological and psychological processes, consists of the evolution of conscious awareness in species varying in cognitive capacity: conscious awareness appears to have evolved to maximize the actualization of adaptive potentialities and minimize the actualization of maladaptive potentialities in the present moment, based on how

conscious awareness of the present moment enables rapid behavioral course corrections (Bowins, 2022).

Charles Darwin's (1858) natural selection theory, equal in robustness in the life sciences to quantum theory and relativity theory in physics, actually provides a logical proof of time distinctions (Bowins, 2017). The argument proceeds as follows: natural selection is a real process being well validated scientifically. Neural processes such as the fear circuit (Ledoux, 1994) and probably conscious awareness (Bowins, 2022), evolved on the basis of time distinctions to optimize evolutionary fitness. Hence, time distinctions must be real, because if invalid they could not influence evolution (Bowins, 2017).

Assuming that future, present, and past are valid components of time, what characterizes each? Although there are many potential options, a theme applicable to all three components consists of actualizations of potentialities. The future is the realm of potential occurrences varying in probability. For instance, in the next few minutes, the probability is high that I will continue to type on my computer, but others options like taking a moment to think of what I will write or get up and get a coffee are also robust possibilities. A tree falling on the room I am in and ending my writing session is another potentiality, but of far lower probability. What occurs in the present moment clearly has an impact on the probability of future potentialities, as only events somehow related to my writing will have any significant probability. Closeness to the present moment will also influence the probability, given that there are far fewer events that might intercede. The probability of my writing and in the same location a week from now is weaker because there are so many potentialities between now and then, and circumstances can shift the probabilities. The future might best be envisioned as potentiality waves spread out over space and time (space-time), with the amplitude indicating the probability. It might be imagined as hills, foothills to mountains, and various mountain peaks, ever shifting to reflect probabilities. As with a landscape the more distant ones will not be as clear. Adding to the depth and extent, the potentiality waves represent all aspects of the given event, such as all cellular, blood vessel, nerve, muscle aspects, and even psychological motivation, of a finger bending.

Both thought and practical experimental approaches can be applied to confirm the uncertain nature of the future with potentialities varying in probability. Regarding thought experiments, imagine yourself one hour back in time and what you were doing. Next consider all the possible things that could have been done between then and now. With a little imagination, numerous potential occurrences will be generated, varying in probability. Each of these potentialities will derive from the form of matter-energy one hour ago. For instance, if you are imagining events at your home, being in another country across the ocean cannot enter the picture, as the probability of that potentiality is zero given current modes of transportation; instead, all potentialities will pertain to your home and what might lead from that environment. The thought experiment will also include an awareness of what linked potentialities were actualized at various junctures to get to circumstances an hour distant in the now. Potentialities with probability values are clearly evident from this thought experiment. In probability theory, the probability for outcomes ranges from 0 to 1, with 1 representing a certain outcome. In your thought experiment the probability values for the various potential outcomes will be observed to range from 0, as with being in a country across the ocean to high, but not certain, as with so many potentialities and junctures even within an hour, none of the potentialities would be certain until actualized.

A practical experiment could consist of the following approach. A group of researchers generates a thousand potential occurrences varying in time frame, although far enough in the future to allow for the design and implementation of the project. Utilizing all available scientific information (and if desired the services of fortune tellers), probability values from 0 to 1 will be assigned to the potential outcomes. None of the potentialities targeted can be influenced by the investigators, and any that might be must be dropped from the experiment. If the future is certain then the probability predictions should emerge at 1, or close to allowing for some limitations in the information available to the researchers. Even though the future is apparently only potentialities varying in probability, the likely outcome of this practical experiment will consist of low accuracy of predictions in virtually all instances. Any outcome significantly below 1 for all the predictions confirms the uncertainty of the future. This uncertainty derives from the potential nature of the future, with potentialities varying in probability, and the numerous junctures where different outcomes emerge. Even those potentialities that rate 1 or close to it might be less certain at a finer level. For instance, although the motions of planets, solar systems, and galaxies can be predicted with quite a high degree of accuracy based on current scientific capacity, predictions cannot provide certainty regarding what gases and particles might be encountered in these movements given the very dynamic nature of cosmological events (Miller, 2024). A key notion is that in the absence of certainty, all events represent potentialities varying in probability!

The Now or present moment is where potentialities are actualized. Higher probability potentialities are more likely to be actualized but there is no certainty. For example, you approach a large puddle on your walk. If you are an adult the probability of walking left or right to go around it are of high and approximately equal probability. Some aspect, or even just random selection, takes you to the left side actualizing that potentiality. Although of lower probability, you might just walk through the puddle. If you are a young child that potentiality is of much higher probability than going to the left or right, with the linked potentiality of jumping in the puddle. Which potentiality you take is the one actualized. Despite our desires to undo what has just transpired when the event is negative, there is no possibility of undoing what has occurred over milliseconds to at most a few seconds. For

example, parents cannot reverse their child stepping into the puddle and soaking new shoes with dirty water.

Assuming that the future consists of potentiality waves the one actualized in the Now must stand out in some fashion. In quantum physics a superposition of multiple states representing a wave function occurs, the wave peaks corresponding to position, energy, and other crucial information pertaining to particles, with particles being more probabilistic in nature (Folger, 2018). This coherence breaks down into decoherence with a measurement producing collapse of the wave function for the option measured (Vedral, 2010, 2011). Decoherence events involve entanglement: all potentialities collapse into one and that one influences the system as a whole (Vedral, 2010, 2011). There are various proposals for how this might transpire including (Von Baeyer, 2013):

Copenhagen Interpretation: During a measurement an observer collapses a quantum state into a new state that describes the outcome of the experiment. The instantaneous collapse implies that actions can have effects that travel faster than the speed of light.

Guiding Field Interpretation: A real physical field is said to control the motion of a particle. However, the field breaks down as soon as several particles are involved, with them moving in an abstract space with three dimensions. The Guiding Field exerts an action as a distance force transmitting physical effects instantaneously over large distances.

Many-World's Interpretation: When an observation occurs the quantum state does not collapse but branches. Only the one we measure is observed by us with all others in some alternative universe. A problem is that it necessitates endless universes and branching, and cannot account for the actual measurement that led to the branching.

Spontaneous Collapse Theories: Observation is not required; instead, the quantum system collapses when it interacts with a macroscopic object. Any observation involved represents an interaction. This perspective requires an entirely new mechanism of collapse.

Qbism is another class of explanation indicating how with every observation we in a sense give birth to reality. This proposal requires an observation.

Consistent with Spontaneous Collapse, and also the Copenhagen Interpretation, the interaction of matter-energy with a future potentiality wave function produces collapse of that option, actualizing a potentiality. The chances of wave function collapse might even be increased with macro-objects: according to Continuous Spontaneous Localization, although the chances of any one particle wave function randomly collapsing is very low, when there are as many particles as there are in a macro-object, collapse of the wave function for one is inevitable triggering multiple collapses (Folger, 2018). Quantum probabilities spontaneously collapse into classical certainties!

Hence, with my writing in a few more minutes or you walking left around the puddle, that potentiality is actualized. A "potential" critique of this possibility is that collapse of the wave function is a quantum micro process, and simply cannot occur at a macro level, an accurate statement. However, macro form is derived from micro and largely quantum processes. For instance, the form of one's body is derived from countless atoms and molecules abiding by quantum processes. Likewise, numerous micro collapses of wave functions representing potentialities can provide for the actualization of a given form at a macro level, with no formal collapse of a wave function occurring at the macro level. Much as atoms and molecules make up a macro form, this form likely arises from micro-level quantum wave function collapse. Supporting the role of micro quantum events for macro objects, quantum processes operate within biological systems including at the cellular level (Hameroff, 2001; Hameroff & Penrose, 2014; Igamberdiev & Shklovskiy-Kordi, 2017; John, 2001; Reddy & Pereira, 2017). Furthermore, Hameroff and Penrose (2014) propose that consciousness arises from orchestrated objective reduction activity (Orch OR), based on the notion of objective reduction (OR) of the quantum state.

Actualized potentialities form the past in what might be referred to as a quantum actualization record (Bowins, 2017). According to the Unitary Principle of quantum physics information is preserved (Zyczkowski, 2013), although Quantum Fields theory suggests that quantum fields might destroy information, at least at a particle level (Weinberg, 2005). As a potentiality is actualized in the present, it enters the past providing a record of every potentiality actualized! The distinction of past from future is evident from the probability of potentialities: while potentialities varying in probability is sensible and logical for the future, it is not at all applicable to the past given that the events have already occurred with no further potentiality and full probability of the given actualized event. In the present moment potentialities with probability values are converted to fully actualized occurrences. The certainty of the past can be validated by both thought and practical experimental approaches. Regarding the former, attempt to undo or alter in any fashion that which transpired even a few minutes ago. The futility is readily apparent given that the probability is 1 with full certainty. It might be suggested that the past event can be viewed differently, but this only consists of future potentialities regarding how a past event is understood being actualized in the present. Much as with thought experiments, practical experiments have failed to identify any mechanism to undo or alter past events, and time travel options do not allow for changes to one's own past or that of others (Barrow, 2007; Deutsch, 1997; Falk, 2008; Folger, 2015; Lockwood, 2005; Maldacena, 2016). The validity of the past is confirmed by science, such as with astronomical observations of distant cosmological events derived from the time scale evident in red shifts of light signals, and geological and anthropological events based on analysis of chemical signatures.

The thought and practical experiments supporting the uncertainty of the future and certainty of the past, based on the actualization of potentialities process, counter the

perspectives that have been proposed for future-present-past: 4-D Block Model, Moving Spotlight Model, Growing Block Model, Presentism. The 4-D Block Model suggests that future, present, and past just occur and are not distinguishable. However, with the future characterized by uncertainty and potentialities varying in probability, the present actualization of select potentialities, and the past complete certainty, full probability and no potentiality, the three components of time are distinct. The Moving Spotlight Model argues that the present has a privileged role, but all three aspects of time play an equal and important part in the actualization of potentialities process. The Growing Block Model entirely negates the future, a scenario that does not acknowledge and align with the uncertainty and potentiality of future occurrences, nor yield an understanding of why present moment actualization events occur. Presentism neglects the future and past, without any account of what forms the basis of present moment actualization events and what happens to the actualized potentiality. In contrast, the arrows of time, and certainly the psychological arrow of time, acknowledge and equally value the future, present, and past.

Elaborating further on the past, the hypothesized quantum actualization record represents every detail of the actualized event, and so cannot be thought of as a written record. This exquisite detail includes all linked actualizations being recorded in close proximity. As an intriguing conjecture, accessing this quantum actualization record will provide information about all actualized events in the universe, regardless of how distant in space-time. We focus on space travel but the reality is limited given constraints including: the incredible time frame in light years; no biological organism can survive acceleration to any speed close to that of light; such speeds would result in annihilation of the space craft if contact occurred with even a grain of dust; the challenges of preserving bodies for countless years and then resuscitating them; almost certain intense risk of biological contamination upon contact between organisms lacking any immunity to the pathogens on another planet; numerous medical concerns, such as increased cancer risk from solar radiation, vision loss over time, muscle and bone deterioration without physical activity, and immune system impairment (Coburn, 2023). Access to the quantum actualization record would enable communication at enormous distances given that everything actualized, including communication that has just transpired, will be "recorded" and hence accessible. Given that this record only contains fully actualized occurrences it cannot be altered in any way. However, the potentiality of accessing it, if actualized, will enter into the quantum actualization record. An intriguing, although of course, highly speculative possibility.

The perspective presented pertaining to future-present-past yields an understanding of space-time that might be best referred to as an actualization space, or more appropriately, an actualization space-time. Potentialities as a superposition of potentiality waves varying in probability comprise the future, interactions between matter-energy entities and potentiality waves actualize select ones in the present, and actualized potentialities reside in the past. Future-present-past do rely on quantum processes, including an actual time sequence relevant to how events unfold, such as there cannot be both 3 and 5 on a dice roll (Callender, 2010). Given the numerous micro quantum potentiality waves that are involved in every actualization of potentialities macro event, with the progressive collapse of wave functions as the event proceeds, the transition from future to present to past will seem continuous, likely accounting for the feel associated with the psychological arrow of time. Furthermore, the consistency and stability of the macro matter-energy world is largely based on the actualization process, in that what occurs is highly predictable in a probability sense from what has come before and been actualized.

Supporting the notion of future-present-past based upon actualization of potentialities, is how no realistic option for time travel can violate the future or past. Time travel in the form of time dilation is possible (Folger, 2015; Lockwood, 2005, pp 79-82), whereby if a time traveller leaves the planet and travels close to the speed of light, that individual will age slower: the speed of light is in a sense the product of time and space, and if you travel through space near to the speed of light little is left for time, hence time slows. Aging more slowly means that time and hence the actualization of potentialities transpires at a slower rate for this person, than those still Earth bound. For example, cellular changes related to aging slow such that the person can live thousands or millions of years. When the "time traveler" returns to Earth he or she might only be a day or two older, but never younger, while people known to the person are now long deceased. However, even time dilation does not allow the time traveler to venture to his or her own past or future, or the other person's life prior to when they separated (Barrow, 2007; Deutsch, 1997; Falk, 2008; Lockwood, 2005). Other options for actual time travel, such as space-time fully warping around on itself or wormholes connecting distant regions of space-time, such that you return to your own past, seem to be impossible, or at least there is no evidence that this is viable (Folger, 2015; Maldacena, 2016).

Hence, the universe appears to be structured such that interconnected and entangled entities must abide by approximately the same future, present, and past. If the entities become disentangled in space (space-time) then time dilation is viable, but this is limited to returning to another person's future after separating. Another potential critique of the perspective presented entails that the theory might violate the notion, derived from special relativity, that time is relative to the observer (Einstein, 1920). In response to this potential objection, we return to the issue of interconnected or entangled entities. Presence on Earth interconnects or entangles entities providing for essentially the same time, although the subjective experience of time almost certainly varies between species based on their unique perceptual capacities. While in an entangled state, such as remaining on Earth, space and time are perceived in a similar fashion, but once the entanglement and connectedness end the experience and perception of time

also varies, as with that of the time traveller relative to those who remain Earth-bound. This might be viewed in terms of an inverse relationship between the degree of entanglement of entities and relativity variance: the more entangled the less variance in relativity related perceptions. The perspective presented then retains the critical relativity theory notion that time is relative to the observer.

As with the realities of time travel supporting the notion of future-present-past based upon actualization of potentialities, additional limits and forces of the universe appear to ensure that it is structured to actualize potentialities:

- Absolute zero temperature cannot be reached:

At this temperature no actualizations of potentialities will transpire, but with any temperature above a zero value they can occur, although slower consistent with relativity theory variance.

- No object with mass can reach the speed of light:

Even particles cannot be accelerated beyond 99.9% of the speed of light (Hawking & Mlodinow, 2005). At the speed of light time essentially diminishes to nothing, an occurrence that would remove any ongoing actualizations of potentialities. Of note, time might best be characterized, or even defined, by the progressive actualization of potentialities.

- Entropy:

Ensures that some change (actualization of potentialities) occurs even in the absence of interactions. The Oxford dictionary definition of entropy (1951, in Lockwood, 2005) states: Entropy in physics is defined as the measure of the unavailability of a system's thermal energy for conversion into mechanical work, in some contexts interpreted as the degree of disorder or randomness in the system. Order does proceed to disorder consistent with the thermodynamic arrow of time. For instance, our bodies age and do not return us to a younger state. Likewise, as the fuel supporting the work of an engine diminishes, the potential of the engine to do work does not increase (at least without adding more fuel) and the engine experiences further wear and tear with more use. In the rare scenario of no interactions, the progression of entropy from low to high (order to disorder) will ensure that some potentialities are actualized.

Potentialities applied to entropy are an important consideration for the universe, and the postulated perspective that actualizations of potentialities characterize the universe: low entropy such as at the start of the universe aligns with maximum potentialities, while high entropy as with the end of the universe is consistent with few or no potentialities. Penrose (2010) believes that the universe must take time asymmetry related to entropy, and certainly lowest gravitational entropy with inflation, into account when devising a theory of the universe but finds that physicists never do so. Based on gravitational entropy, Penrose (2010) indicates that gravitational energy is available to do work to the extent that gravitating matter remains spread out in space such as with inflation. Potentialities provided by matter-energy, including those related to gravity, will be maximal with inflation, and decrease with ongoing actualization of potentialities, to the point where eventually all the potentialities derived from matter-energy will likely be exhausted. It is possible that low gravitational entropy is actualized by any gravitational event, and that this actualized low gravitational entropy is embodied in the form of gravitational information communicated by the gravitational wave and transferred to space-time via the graviton (Penrose, 2010).

- Gravity:

A force of connectedness advancing interactions necessary for the actualizations of potentialities process. Without gravity every matter-energy entity would drift away from every other one, minimizing interactions and hence the actualizations of potentialities. Gravity is the only force that cannot be blocked, and only comes in a positive form, because the gravitational "charge" is matter which is just positive (Hawking & Mlodinow, 2005, p. 120). Other forces are positive and negative and in the realm of the very large they cancel out, such that gravity wins in this domain (Hawking & Mlodinow, 2005, p. 120). A major problem in cosmology is designing a theory of quantum gravity, which yokes to quantum and relativity theory incompatibility. To a certain extent it appears that they might be describing the same thing, but from different perspectives: quantum processes the stitches and space-time the fabric that appears continuous, analogous to a cloth fabric with fine stitches. However, there are various other points of incompatibility. Fortunately, the actualization of potentialities process does assist in reconciling the two perspectives and quantizing gravity, given that every actualization of potentiality event, which is largely a quantum process, involves gravity due to it being the only force that cannot be blocked and is always positive. With collapse of the potentiality wave function incorporating the influence of gravity, this major force is quantized. For example, every movement of every organism or inanimate object on Earth entails a gravitational influence, and with the actualization of these events and collapse of the relevant potentiality waves, this gravitational influence becomes quantized.

The unification of quantum and relativity theories related to gravity, encounters a problem derived from the seemingly infinite possibilities that arise with the addition of time, as space-time, and the gravity-based curvature of space-time, that overwhelm the capacity of math treatments (renormalization) to account for (Barrows, 2007, p 27, Hawking & Mlodinow, 2005, pp. 123-125). Given that future potentialities are derived from matter-energy configurations, that also strongly influence the probability of a given potentiality, infinite options could reduce to a manageable quantity that math treatments might be able to process. Also relevant to potentialities and probabilities, an additional way that the actualization of potentialities proposal assists with reconciling quantum and relativity theories pertaining to quantum gravity, arises from interconnectedness: via gravity

matter-energy shapes space-time and the resulting curvature of space-time guides matter-energy, in probabilistic ways. Both components of this interconnected reality are highly relevant to actualizations of potentialities incorporating gravity, and hence the quantization of gravity.

- Dark energy:

This mysterious force comprises approximately 68.5% of the universe (Panek, 2023) and is part of the fabric of space-time (Ford, 2004, pp. 244-247). Although its role is as mysterious as its nature, it does counterbalance gravity: unopposed gravity would result in the clumping of all matter-energy, thereby rapidly exhausting potential interactions and diminishing the ongoing actualization of potentialities. With the influence of dark energy as an expansive force matter-energy entities can continue to interact and actualize potentialities. Due to this expansive influence, most galaxies are currently separating from one another with increasing speed, however, within galaxies gravity still dominates ensuring ongoing connectedness in this realm as long as the attractive force is counterbalanced. Hence, dark energy does facilitate the ongoing actualization of potentialities by counterbalancing gravity.

Each of the limitations and forces of the universe do facilitate the ongoing actualizations of potentialities process, hypothesized to be the central function of the universe. Another fascinating and crucial process to consider is entanglement.

Entanglement

The fascinating phenomenon of entanglement underscores how strongly interconnected various components of the universe truly are. Entanglement applies not just to macro entities with connectedness, such as is relevant to time-travel, but also, firstly, in the form of decoherence of a quantum superposition of wave functions with collapse of the wave function, as discussed in the prior section (Vedral, 2010, 2011), and secondly, how a measurement of the state of one particle of a pair ensures a corresponding change in the other, even when separated at enormous distances ensuring that no medium or pre-existing force can account for this occurrence (Garisto, 2023; Hanson & Shalm, 2018). For this form of entanglement to transpire the particles must be part of an entity. A measurement yielding an up-state of one then ensures the instantaneous emergence of a down-state for the paired particle.

One of the key reasons for entanglement being such a mystery resides in how difficult it is to process when viewed from the perspective of space that we are familiar with. How can a particle on one side of our planet be linked to another on the opposite side, or worse, across the universe? However, when viewed from the perspective of an actualization space (actualization space-time), entanglement is inevitable and central! The future potentiality wave functions will ensure that parts of an entity are represented in a linked fashion, such that the potentiality options for both members of paired particles are in close proximity. With a measurement in the macro matter-energy realm of the present moment, collapse of the wave function for one particle transpires triggering a linked collapse of the wave function for the paired particle, even if the particles are separated at great distances in physical space. Related to interconnectedness, when one wave function collapse occurs with the actualization of potentialities process, connected ones will also collapse; the one wave function collapse triggers multiple collapses consistent with Continuous Spontaneous Localization (Folger, 2018). Likewise, the record of actualized potentialities comprising the past will maintain this linkage, with all connected actualizations being recorded in close proximity inclusive of space and time. The brief present moment actualization of potentialities gives us an opportunity to appreciate the nature of space-time as an actualization space-time, so long as we shift focus from a fixated perspective on space as we know it. Entanglement in an actualization space-time framework is essential and integral to the actualization of potentialities process.

A key feature of entanglement consists of an entity, with components undergoing actualization of potentialities together. Paired particles are part of an entity, and as such experience an actualization event simultaneously. In the realm of micro particles separation in space as we experience it is the norm, such as with electrons that do not actually have a position per se, but wave functions that describe the probability of a given position (Ford, 2004, pp. 184-119). In other words, in the micro realm parts of an entity do not have to be in actual physical contact, ensuring that entanglement can proceed across the space we perceive, with actualization of potentialities pertaining to the components of the entity being paramount. In the case of macro entities, such as a body, physical proximity is essential. If your arm is removed actualization events for that part, such as decay, are experienced separately from the remainder of your body. Hence, with macro-objects, actual physical connectedness is required for entanglement. A biological example of entanglement is provided by the capacity of birds to detect the inclination of the magnetic field: paired electrons in a molecule get enough energy to separate when in the presence of a magnetic field, and the magnetic field effects both differently such that through entanglement they influence the neurochemistry (Vedral, 2011). 100 microseconds, is the time recorded, compared to the longest in non-biological systems of 50 microseconds for entanglement (Vedral, 2011). The topics of the nature of space-time, entanglement, connectedness, and role of matter-energy in actualization events, necessitates an explanation of how space-time and matter-energy relate to one another.

Interconnectedness of Space-Time and Matter-Energy

Space-time and matter-energy are deeply connected and essentially emmeshed, consistent with what applies to biological entities. In the biological realm interconnectedness and interdependence often takes the form of symbiosis,

whereby entities benefit each other fostering enhanced evolutionary fitness for both (Horn & Penn, 2021). For example, coral polyps and algae (zooxanthellae) within the coral polyp assist each other—the coral polyp obtains energy from photosynthesis by the algae, and the algae are protected within the calcium carbonate walls of the coral polyp and also receive nutrients (Schwarz et al, 1999). Providing a broader example, essentially all terrestrial life depends on the symbiosis between plant life and fungi within the soil, plants providing sugars to the fungi and fungi transferring nutrients from the soil to the plant (Dance, 2017). It is hypothesized that, likewise, a symbiotic type relationship occurs with the interconnectedness and interdependence of space-time and matter-energy. Space-time provides the space for matter-energy interactions to transpire actualizing potentialities, and time for the progressive actualization of potentialities. Future-present-past characterize time, with future potentialities, present moment actualization of potentialities, and past actualized potentialities. Matter-energy is essential to each aspect. Regarding future potentialities, it is matter-energy that provides the form and probability. For instance, rotation of the Earth generates the potentiality of the sun rising in the eastern sky each day and provides a high probability for the relevant potentiality waves. Actualizations of potentialities in the present moment transpire with the interaction of future potentiality waves and matter-energy producing collapse of select wave functions. When the sun does rise in the eastern sky that potentiality is actualized with the relevant potentiality wave collapses. The past actualization record includes the form of the actualized events in every detail, derived from the form of matter-energy that the actualized events were based upon.

Speculating further regarding the potential symbiosis of space-time and matter-energy, a key feature of natural occurrences—existence and non-existence—might apply. In the vacuum of space particles without charge are continually "popping" in and out of existence; those with charge annihilate each other instantaneously due to positive and negative effects (Bischoff, 2023). In the biological realm there is naturally existence with the start or birth of a new organism, and non-existence with death. Hence, existence and non-existence characterize natural entities. Prior to the Big Bang all the matter-energy of the universe was compacted in a seemingly impossibly dense and small form, with essentially zero space (Hawking & Mlodinow, 2005). At 10^{-36} seconds after the Big Bang (a fraction of a second that begins with a decimal point and ends 35 zeros and a 1 later) inflation began and ended 3 more zeros after the decimal later, 10^{-33}, with the universe increasing in size by a factor of 10^{26} (Panek, 2023). Hence, in almost zero time the universe achieved its essential form prior to any matter-energy interactions. Non-existence to existence could account for both the size of matter-energy prior to the Big Bang and the speed plus extent of the size increase with inflation: matter-energy prior to Big Bang could have been in a non-existent, perhaps only potential, form, and with inflation acquired existence, achieving its lowest entropy (highest potentiality) form before the influence of universal forces. What might have provided actual existence to matter-energy? A possibility is space-time in a basic form lacking future-present-past dimensions. A relevant issue in this regard is whether or not space-time is essential or an emergent property of something else.

The proposition that space-time is an emergent property, arises from the struggle to merge quantum and relativity theories for quantum gravity when space-time is essential (Becker, 2022). There are 3 theories that see space-time as an emergent property:

String Theory: Seemingly unrelated systems are connected via entanglement. Closeness in space relates to the degree of entanglement with close entities highly entangled. The string theory perspective on space-time as an emergent property derives from anti-de Sitter (Ads)/conformal theory (CFT): CFT is like the 2-dimensional surface of a 3-dimensional sphere, with Ads the interior (Ananthaswamy, 2023). It is based on the hologram notion that the 2-dimensional surface can contain all the information including that of the interior (Ananthaswamy, 2023). Connections between the parts of the 2-dimensional sphere are based on entanglement. Space emerges from the entanglement and closeness; if no entanglement space would fall apart (Ananthaswamy, 2023; Becker, 2022). The opposite of Ads is what we are familiar with—a universe that expands and has a three-dimensional form with time. Although CFT can provide approximations for complex phenomena such as occurrences at the event horizon of a black hole, no researcher has ever demonstrated that it, or a similar duality, could apply to our physical universe characterized by three space dimensions and time, with a positive cosmological constant (Luminet, 2016). Related to these problems, a CFT universe is essentially empty and static (Luminet, 2016). With information dense future potentialities, present moment actualization of potentialities, and past actualized events over three-dimensional space and time, the universe is full and very dynamic. A problem for string theory which CFT is based upon, is supersymmetry—all known particles are said to have partner particles—but no such particles have been discovered.

Loop Quantum Gravity: Space-time is not continuous as with relativity theory, but lumpy broken into chunks or atoms evident upon zooming in (Becker, 2022, Smolin, 2002, 2023). This nature gives rise to the continuous perception based on 1-dimensional strings and 2-dimensional sheets connected into a "spin foam." (Becker, 2022; Smolin, 2002, 2023). An analogy is a sand dune from sand grains. Space-time emerges from the collective behavior of tiny grains of space-time, like a sloping sand dune from grains of sand (Becker, 2022, Smolin, 2002, 2023). Loop quantum gravity also posits that a system can be described via linkages between the parts without reference to time, that might be thought of as loops connecting them (Becker, 2022). This appears to align with how in general relativity change can be described by relating physical systems to one another rather than to some abstract notion of time, based on correlations.

Causal Set Theory: The world is a set of events, called a causet that grow as new events come into existence according to probabilistic rules, likely reproducing the features of space-time that we perceive. (Callender, 2010; Moskowitz, 2021). Sorkin suggests that space-time is fundamentally discrete—broken up into tiny chunks instead of being smooth and continuous (in Moskowitz, 2021). These discrete components represent building blocks of space-time and the universe.

String theory, loop quantum gravity, and causal set theory suggest that space-time might be an emergent occurrence, with the string theory version very questionable considering the limitations (Luminet, 2016). For loop quantum gravity and causal set theory, the emergence is from micro aspects that yield a macro space-time form. This results in a continuous space-time as detailed by relativity theory. These perspectives are consistent with the notion of micro quantum stitches and a macro space-time fabric. While it might be argued that, likewise, the fabric emerges from the stitches, the question of what is essential, though, would seem to be one of perspective: is the fabric, the stitches, both, or the interconnectedness, essential? In the case of a fabric, the interconnectedness is paramount, because without it the stitches do not amount to anything and there is no actual fabric. Interconnections between the stitches and current fabric are then essential. Likewise, with the universe it is the interconnectedness between space-time and matter-energy that enables the actualization of potentialities process, and hence the ever-changing form of the universe. As pertains to the quantum realm and space-time, both components and the interconnectedness are essential. The quantum realm provides potentiality waves varying in probability, present moment actualization of potentialities with interactions between select potentiality waves and matter-energy, and a quantum-based recording of the actualized potentialities. Space-time with future-present-past provides space for matter-energy interactions that actualize potentialities and time for the progressive actualization of potentialities. Much as connections between stitches yield a fabric, connections between matter-energy and space-time yield the universe.

Regarding existence/non-existence and the symbiotic relationship between space-time and matter-energy, it is feasible that space-time lacking future-present-past could exist and persist as a more basic variant. While highly speculative, dark energy might be a candidate for basic space-time, or at least be the energy of existence, a much brighter role than "dark" energy. This supposition is based upon how it is part of the fabric of space-time, a major component of the universe, and appears to be ever present despite its elusiveness. Additionally, dark energy is linked to the energy of both inflation and particles popping in and out of existence in the "void" of space (Panek, 2023). As the energy of existence, dark energy could facilitate expansion, thereby countering gravity and separating components of the universe.

Irrespective of the precise role of "dark" energy, a basic form of space-time (lacking future-present-past dimensions) could have connected with what might be referred to as a non-existent, and maybe only potential, matter-energy nugget (words do not suffice to describe non-existence) providing existence to matter-energy, with inflation marking the transition from non-existence to existence. Given that existence/non-existence is applicable to natural phenomena, and matter-energy in terms of virtual particles (Bischoff, 2023), it is feasible that it also applies to the Big Bang. The merger of basic space-time with matter-energy marked the start of the symbiotic relationship. For its role in this symbiotic relationship, matter-energy enabled a "future" for space-time by yielding potentialities varying in probability, a "present" with the actualization of select potentialities derived from the interaction between matter-energy and potentiality waves, and a "past" with actualized potentialities based on the detailed form of matter-energy. Interestingly, it might be argued that space-time with future-present-past, as opposed to the basic form, "emerges" from matter-energy, and reflecting the symbiotic relationship, matter-energy "emerges" in an existent form from space-time. Pertaining to what comes before the existence of matter-energy, the question is non-sequitur as what comes "before" is only meaningful if future-present-past characterize space-time. Solutions to some cosmological equations freeze time (Barbour, 1999), and perhaps this (if true) applies to basic space-time with no future-present-past.

Existence, or more precisely non-existence, is particularly relevant at extreme values. For example, extreme levels of physiological parameters typically result in non-existence of life forms. Within cosmology extreme values are referred to as singularities which create no shortage of problems when it comes to viable accounts. Singularities mark boundaries and occur at the Big Bang and black holes (Barrow, 2007, pp. 82-85). A feasible way to manage the notion of singularities associated with these occurrences is existence/non-existence, which certainly mark robust boundaries. In black holes matter-energy values reach extreme levels such that a shift to non-existence might occur; a form of localized matter-energy non-existence, represented both metaphorically and practically as a black hole, the latter perhaps as the optimal way to contain localized non-existence of matter-energy. With existence to non-existence (or the reverse), singularities can be avoided as there cannot be a singularity of a non-existent entity. Given the hypothesized symbiotic relationship between matter-energy and space-time (and also the coupling between the fabric of space-time and matter-energy in relativity theory), non-existence of matter-energy could trigger space-time in the localized area to revert back to its basic form lacking future-present-past. This occurrence might also apply on a much larger scale at the very end of the universe when matter-energy potentialities diminish to zero, eliminating the future of potentialities varying in probability, present moment actualization of potentialities, and further actualized potentialities in the past. In such instances, singularities or the problems they create, are managed via the boundary of existence and non-existence.

The hypothesized interconnected and emmeshed relationship between space-time and matter-energy, to the point of a deep symbiosis, provides a unique perspective on the relationship between these two critical players in the universe. Without matter-energy space-time lacks the future-present-past characterizing it, and without space-time matter-energy lacks the space and forward progression (time) for actualization events. Matter-energy relies on space-time for existence, at least in terms of space and time required for the actualization of potentialities, but also feasibly, a shift from non-existence to existence. As with biological natural occurrences, space-time and matter-energy do appear to be interconnected and interdependent, and such that symbiosis best describes the relationship. Also akin to biological entities that exist, space-time and matter-energy combined might conceivably be described as alive. The concept of "alive" is challenging and general definitions often pertain to not being dead, still in existence, exerting a force, operating in some fashion, and marked by activity (Cambridge, 2023; Merriam-Webster, 2023). Considering activity alone, the union of space-time and matter-energy, is best described as ever changing, evolving, and highly dynamic, features associated with being alive. Another feature of an alive state, or at least a dynamic entity, is information generation, that must be considered.

Information

The entire actualization of potentiality process provides information, making it a central feature. Future potentialities with probabilities, involve information in the form of potential information. The present moment, information pertaining to the actualization of specific potentialities, and the past information regarding all actualized potentialities, with the term "quantum actualization record" underscoring the information aspect. Rather than attempting to assign a value to the form of information, it is best to view them as just qualitatively different. The importance of information, likewise, applies to matter-energy, given how it influences future potentialities and the probabilities, present moment actualizations of potentialities, and the configuration of actualized events.

Entropy is also a relevant consideration, because information can carry low entropy. This occurrence is evident from the solution to Maxwell's Demon: James Clerk Maxwell envisioned a demon that with very little energy expenditure could allow certain particles through a gate, such that disorder proceeds to greater order with little infusion of low entropy (Ehrenberg, 1967). In 1929 Leo Szilard solved the problem by proposing that the demon collects or utilizes information each time, and that this information carries low entropy that exactly balances the entropy change produced by the demon (Ehrenberg, 1967). Beyond an interesting dilemma and solution, the relationship between information and entropy has practical implications. For instance, a biological analogy consists of mitochondria and the energy providing adenosine triphosphate (ATP) molecule. ATP with its phosphate groups represents low entropy, high potentiality, plus high potential information related to what the energy can do. Cells in mitochondria acquire the phosphate groups and apply the energy to cellular work, and in the process, high quality energy (low entropy) is actualized and embodied in the information content of the actualization process. In a similar fashion, as low gravitational entropy shifts to higher gravitational entropy, the information in a sense carries the low entropy: actualized low gravitational entropy embodied in the form of gravitational information communicated by the gravitational wave and transferred to space-time via the graviton (Penrose, 2010). Applying this process to actualization of potentialities, the low entropy of potentialities could be embodied in the information pertaining to actualized potentialities and transferred to the quantum actualization record, an occurrence that would facilitate the persistence and expansion of this defining aspect of the past.

With information so central to the actualization of potentialities process, information does characterize the universe. The most fundamental unit of existence could be information, and fundamental bits of information might exist on the Planck scale (Moyer, 2012). As pertains to micro and macro levels, information relevant to actualizations of potentialities could qualify as the stitches that connected to one another make up the space-time fabric inclusive of future-present-past. Loops and strings might provide for the stitches and interconnections, respectively. Learning how to decipher the information of the universe will facilitate both access to and an understanding of the hypothesized quantum actualization record. The information contained will yield knowledge of all actualized aspects of the universe in exquisite detail, and possibly provide a way to communicate with life forms that have also discovered and accessed this profound repository of information.

Conclusion

Life science, while seemingly unrelated to cosmology, can actually inform regarding the nature of the universe. Appreciating that all aspects of the universe are natural entities much like biological processes, and that the ultimate goal of science is discovering true outcomes regardless of applied theoretical orientation, facilitates the inclusion of perspectives derived from life science. A robust reality of biological natural occurrences is interconnectedness and interdependence, often taking the advanced form of symbiosis. Given that all entities and events in the universe are natural occurrences, these processes also apply to cosmology, with the possibility that matter-energy and space-time are symbiotic. Matter-energy enables future, present, and past for space-time: future potentialities and the associated probabilities derived from the form of matter-energy, present moment actualizations of select potentialities based upon interactions between matter-energy and potentiality waves, and past actualized potentialities an exact "recording" of the matter-energy derived actualization events. As part of the deep symbiosis, space-time provides both space for matter-energy interactions and time allowing

for the ongoing progressive actualization of potentialities. Additionally, the very existence of matter-energy appears to rely on space-time.

The actualization of potentialities perspective on the universe aligns with several crucial aspects of cosmology. Limits and forces of the universe including—the limits of time travel, impossibility of reaching absolute zero temperature, how no object with mass can achieve the speed of light, entropy, gravity, and dark energy—support the actualization of potentialities process, and this process provides insights into the nature of these limits and forces. Entanglement, a very mysterious and difficult to account for reality, is essential to and highly consistent with the actualization of potentialities process, and very understandable when the notion of space as the physical space we are accustomed to, is replaced with the concept of an actualization space-time. At the core of the universe resides information, in the form of future potentialities, present moment actualization of potentialities, and past actualized events, all derived from the primary process of the universe—actualization of potentialities.

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