OPINION AND PERSPECTIVES

# Making Room for Mental Space

**Robert W. Boyer**

**Abstract**

According to the consensus cosmological theory of the inflationary big bang, the universe originated about 14 billion years ago with no initial conditions, inherent nature, order, or purpose—from literally nothing. Instantaneously it was randomly fluctuating quantized gravity and Higgs fields that through spontaneous symmetry breaking formed into four fundamental particle-forces. The forces congealed into atomic structures, elements, stars, planets, organic molecules, living cellular organisms, and eventually humans with complex enough nervous systems to generate higher-order conscious mind with apparent causal control of its lower-order parts. How the closed physical causal chain unlinked and inserted a causally efficacious conscious mind at some stage of neural complexity is inexplicable; there is no room for it in the physicalist view—it must be epiphenomenal and a fundamental misperception. A coherent alternative is developing in quantum and quantum gravity theories of a proposed information space or nonlocal mental space underneath the physical. The progression of theories is overviewed with respect to the nature of space, and are shown to be increasingly consistent with holistic interpretations of ancient Vedic science that make room for a causally efficacious conscious mind.

**Key Words:** nonlocality, quantum gravity, nonconventional space, mental space, unified field

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## Introduction

Modern science views the universe as structured in levels from tangible macroscopic to microscopic and more abstract atomic, nuclear, sub-nuclear, and quantum levels. Increasing unification has been uncovered at more fundamental levels. The universe is now theorized to be fluctuations of four quantized particle-force fields (electromagnetic, strong and weak nuclear, gravitational). The 'Standard model' in physics unifies them into three (electroweak, strong nuclear, gravitational), and the 'Grand Unification model' into two (strong-electroweak and gravitational).

However, the gravitational field has resisted all attempts to be expressed within the framework of quantum mechanics and to connect it to the other three fields. Mathematical models attempting to integrate quantum theory and relativity theory concern quantum gravity, generally considered a key step toward a coherent theory of one single field as the *source of everything*—unified field theory. A viable unified field theory will be a monumental achievement, but remains a most daunting challenge. This is due in significant part to different views of space in the theories, the focus of this paper.

Corresponding author: Robert W. Boyer
Address: Institute for Advanced Research Malibu, CA
e-mail: rw.boyer@yahoo.com

A progression of views of space from Newtonian, relativistic, quantum, quantum gravity, and cosmological to unified field theories is outlined in the search for room to place a causally efficacious conscious mind. These views point to an emerging holism or unified framework with direct relevance to the mind-body problem that is a core issue in quantum theories, as well as contemporary cosmological theories. The progression can be viewed as toward the holistic view in ancient Vedic science that can be interpreted as describing three domains of nature: the infinite eternal unified field, the subtle relative nonlocal field generally associated with non-material information space and mental space, and the gross relative local field of particulate matter.

**Classical Newtonian space and time**

In classical Newtonian physics, space and time constitute an absolute, infinite eternal background in which physical objects interact. In this classical view, eventually two forces were identified to account for change in this non-changing background—gravity and electromagnetism. All change takes place *in* space and time; thus it is characterized as *background dependent.* Also, all observers have the same perspective of motion. There is an instantaneous 'now' everywhere that is the same for all observers, and measurement of distance and time is not affected by an observer's perspective, characterized as *observer independent*. This view fits ordinary everyday experience and has been incredibly successful in accounting for macroscopic time and distance scales. But as research advanced into more extreme scales, it could not account for the findings.

To add socio-cultural relevance to the abstract theories of space discussed in this paper, the Newtonian classical view was associated with popular beliefs in an absolute basis of nature, providing an ethical and moral foundation for daily life. When different views emerged in relativity and quantum theories, they were misinterpreted in popular social thought, contributing to deconstruction of ethical and moral foundations (Boyer, 2008). The socio-cultural impact of theories of space and time in physics will be noted briefly as we proceed in this paper.

**Einstein locality and relativistic spacetime**

Whereas Newtonian physics related to ordinary macroscopic time and distance scales, Einstein's general theory of relativity focused more on ultramacroscopic cosmology such as the motions of planets and galaxies and overall shape of the universe. The theory is a quite different view in which space and time are *background independent* and *observer dependent*—opposite of the Newtonian view for these characteristics. In relativistic theory space and time are relative, cannot be taken separately, and are integrated into one field of spacetime. Generally a smooth and continuous four-dimensional geometry, it can curve, twist, and fold back onto itself; extreme curvature can produce black holes, in which nothing escapes the gravitational pull of immense mass densities. Gravity is the curvature of spacetime, not a separate force that functions *in* it. In this theory there is nothing outside of the spacetime gravitational field. Space and time do not constitute a non-changing substrate in which objects interact. Spacetime is background independent; there is no substrate of any kind. Spacetime can expand or shrink, but questions of what exists outside of it—such as what it expands into or what remains where it shrinks from—are generally considered meaningless because there is no background.

Also the theory is observer dependent in the sense that the measurement of spacetime differs across observers in different frames of motion relative to each other. The observer is assumed to be in spacetime and subject to its nature. When observers have practically the same frames of motion, their measurements will be practically the same, and the results also will match calculations in the Newtonian view. But significant differences show up if relative motion were to become extremely different (approaching light-speed). For example, if you left your friends and took off in a spaceship to a nearby star traveling almost at light-speed, when you returned to Earth you would find that time slowed down for you from their perspective and sped up for them from your perspective. If your friends were your age when you left, they *actually* would be older than you when you returned.

In Einstein's theory of relativity all motion is limited to light-speed: objects with mass cannot travel faster, and mass-less objects 'travel' at light-speed. Space and time are not absolute, but their combination as the space-time interval is absolute. Also light-speed does not change with different observer perspectives. This is sometimes called *Einstein locality* or *Einstein causality*, the view that all causal relations are localized within light-speed. The speed of light and the perspective of an observer are core to the concept of the *light cone*. Because nothing can travel faster, there is no possibility of one object or event causally influencing another outside of the range of light-speed. The past light cone includes everything that could have influenced the particular observer from the past, and the future light cone expands at light-speed the range of potential influence into the observer's future. In general relativity theory, the notion that something exists 'now' outside of the light cone for a particular observer is undefined and cannot be known. For example it takes light photons about eight minutes to travel from the Sun to the Earth, so the sunlight we 'see' at this moment was emitted about eight minutes ago from the Sun. But we cannot know for sure whether the Sun is emitting light *this very moment*, because what may be happening on the Sun *now*, if it is still there now, is outside our light cone and cannot be known right now. In relativistic spacetime theory, the concept of *there right now* is undefined.

In the Newtonian view, space was sometimes conceptualized as an intangible substance subtler than any object in it, associated with the ancient concept of *ether*. In some ways, relativistic spacetime sounds even more like a subtle ethereal substance or medium. However, Einstein made strong arguments against this notion. It also was found that light did not change its speed relative to an observer moving in either the same or opposite direction in empty space, not expected if light existed in an ether. The notion of ether was rejected, but later was revived due in part to quantum theory, as noted by physicist Brain Greene (2004, p. 76):

> "Indeed, since 1905 when Einstein did away with the luminiferous aether, the idea that space is filled with invisible substances has waged a vigorous comeback… [K]ey developments in modern physics have reinstituted various forms of an aetherlike entity, none of which set an absolute standard for motion like the original luminiferous aether, but all of which thoroughly challenge the naïve conception of what it means for spacetime to be empty."

Einstein apparently also accepted the notion of ether, but not in the way it was interpreted in classical Western thought, exemplified in the following quote:

> "Space without ether is unthinkable; for in such space there not only would be no propagation of light, but also no possibility of existence for standards of space and time…nor therefore spacetime intervals in the physical sense. But this ether may not be thought of as endowed with the qualities of ponderable media, as consisting of parts which may be tracked through time… (Isaacson, 2007, p. 318)."

Again with respect to socio-cultural influences, relativity theory was popularly misinterpreted as supporting views that there is no absolute objective or subjective grounds for ethical and moral behavior; everything is relative. The point that this was inconsistent with Einstein's own beliefs is made in the following excerpt from a new biography of Einstein by Walter Isaacson (2007, pp. 278-280):

> "Indirectly driven by popular misunderstanding rather than a fealty to Einstein's thinking, relativity became associated with a new relativism in morality and art and politics… In both science and moral philosophy, Einstein was driven by a quest for certainty and deterministic laws. If his theory of relativity produced ripples that unsettled the realms of morality and culture, this was caused not by what Einstein believed but by how he was popularly interpreted… Whatever the causes of the new relativism and modernism, the untethering of the world

from its classical mooring would soon produce some unnerving reverberations and reactions."

With the tremendous accomplishments of integrating the concept of gravity into the concept of spacetime, and also establishing the equivalence of energy and mass ($E=mc^2$), Einstein was encouraged to pursue unification of all matter and energy with spacetime. He spent much of his later life on unified field theory, but was unable to complete it—challenged further by quantum theory that he helped develop. He had great concern for the assertion among prominent orthodox quantum theorists such as Neils Bohr that it is a complete theory.

**Space and time in quantum theory**

Whereas the general theory of relativity focused more on ultramacroscopic scales, quantum theory focused more on ultramicroscopic scales. It developed in the framework of the classical Newtonian view of space; however, important additions emerged in the search for the fundamental constituent of matter that led to quantum theory. For historical context, the objective approach in modern science has prominently applied a reductive strategy of probing smaller and smaller time and distance scales, and higher energy and temperature. In earlier physical theories, microscopic atoms were the 'uncuttable constituents' of nature. Eventually atoms were theorized to be made of much tinier sub-atomic particles surrounded by comparatively vast areas of empty space—about 99.999999999999% of the space within atoms was described as empty. It was later theorized that the comparatively vast areas of empty space between sub-atomic particles are suffused with invisible energy or force fields in space. Further research and theory proposed that sub-atomic particles are made of even more elementary particles (e.g., gluons, quarks), and subsequently to be fluctuations of more abstract quantum fields of potential energy.

The concept of a quantum embodies the discreteness of particle-like packets of energy and also the wave nature of unbounded potential energy fields. The mathematical properties of quantum wave functions are basically the same as ordinary waves such as sound or ocean waves. But a key issue is the difference between mental concepts and physical reality. The quantum wave function is a mathematical amplitude distribution, conceptualized as waves of possibility that are mental concepts in mathematical, conceptual, or imaginary space rather than *real* waves like sound or ocean waves. Infinite quantum wave potentia are conceptualized to superpose on each other as abstract tendencies to exist, proxy waves, or imaginary clouds or packets of potential energy. The abstract waves are quantized in the sense that they fluctuate only at certain intervals as mathematical wave packets of potential energy that somehow result in real particles and objects in ordinary space and time when measured. The pattern of fluctuation of the quantum field determines its role as either a particle or a force. Stable patterns of quantum potential are theorized to relate to the *particle* quality, and transient or 'virtual' patterns to the *force* quality. The abstract field also can be in a least excited ground state, or *vacuum state*. This is not zero energy with no fluctuations, but rather 'zero point energy'—quantum vacuum fluctuations—hypothesized to be an inherent dynamic quality of quantum field potentia.

The most fundamental of the four quantum fields is the gravitational field, and spacetime also is hypothesized to be quantized. The inherently dynamic quality of the potential quantized gravitational field relates to the concept of *spacetime foam*, sometimes likened to a soupy froth of virtual particles randomly created and destroyed at an incredible rate at the most basic scale of space and time. Classical Newtonian and relativistic theories view space as a continuum (analogue); but in quantum theory it is a bit more like a discontinuum (digital). This can be likened to a photo in which objects look continuous, but when magnified can be seen as tiny dots. In quantum theory the quantum is the fundamental unit and smallest possible size of ordinary space and time, the *Planck scale* ($10^{-33}$ cm, $10^{-43}$ sec), at which the notion of smaller scales is frequently held to be meaningless. Energy states of the quantized packets of potential energy are multiples of the Planck scale.

Because of the unbounded quality of the potential quantum wave as a mathematical amplitude distribution in Hilbert space, sometimes identified as infinite possibility space, there is at least some probability even if extremely low most everywhere of a physical object appearing almost anywhere in ordinary space and time when it is measured. This is sometimes interpreted to mean that a physical object on one side of a wall possibly could appear on the other side, without 'traveling' through the wall. This phenomenon—quantum mechanical tunneling—is described as a common process at very short distances, such as in nuclear radioactive decay. On a macroscopic level it has been described as decomposing at one location and recomposing elsewhere. This is the basis for speculations about *teleportation*, likened to slipping into the spacetime foam and re-appearing in another part of the universe. This theoretical possibility contrasts with Einstein locality and causality which view all motion as limited by light-speed and the light cone. The notion of locations that could be instantaneously 'ported' to even outside the light cone implies a 'now' outside the light cone, which in relativity theory is undefined—one of the challenges in reconciling relativity and quantum theories.

### *Mathematical space v. physical space*

Quantum theory itself contains fundamental dilemmas about space and time. A core notion in orthodox quantum theory is that a conscious observer is essential for the transition from indeterminate quantum possibilities to classical deterministic objects observable in ordinary space and time. The mathematical model of quantum possibilities—the Schrodinger equation or quantum wave function—needs to get from abstract random, unbounded mathematical possibility space to the discreteness of sensory actualities as causally interacting physical objects in ordinary space and time. According to orthodox quantum theory, this occurs via *instantaneous collapse of the quantum wave function* into classical discreteness upon observation by a conscious observer. However, the theory neither explains how and where the interaction of the observed with the conscious observer actually occurs, nor what a conscious observer is. Quantum theory importantly places subjective conscious mind as crucial even to objective physical reality. But also it tacitly assumes that conscious mind is in the classical discrete world and thus inaccessible to be examined and modeled quantum mechanically. In quantum theory there is no way to formulate a quantum wave function that includes the observer.

For example a researcher measures the amplitude of an acoustic signal using a dB meter, which indicates 60 dB. It might be said that the observation occurred when the sound waves contacted the dB sensor, or the indicator pointed to 60, or photons reflected off the indicator into the researcher's eye, or the retina was activated, or the optic nerve was activated, or the visual cortex was activated, or sub-cortical and frontal cortical neural groups were activated, or neural microtubules were activated, and so on. All of these events are describable theoretically in terms of quantum wave functions. No matter how far this chain theoretically is traced, until a conscious observer experiences the object there is no observation, no observer, and no relationship between the observed and observer. The observer, interacting with the object, in some sense *creates* what is observed. As fundamental time and distance scales are probed, it is increasingly apparent that objectivity is not independent of subjectivity. The theory that wave function collapse requires a conscious observer implies that the basic scientific premise of the independence of observer and observed, applied so successfully in classical physics, is an inadequate description in quantum theory. It implies that conscious mind has power to collapse the quantum wave function that no other object has, which makes subjectivity a core component. As Greene (2004, p. 11) explains:

> "[Q]uantum mechanics describes a reality in which things sometimes hover in a haze of being partly one way and partly another. Things become definite only when a suitable observation forces them to relinquish quantum possibilities and settle on a specific outcome. The outcome that's realized, though, cannot be predicted—we can predict only the odds that things will turn out one way or another."

The probabilistic quantum model and the deterministic classical model are not easily reconciled; but neither adequately account for the world. This entails a major quandary: the two fundamental and most successful theories in modern science—quantum theory and relativity theory—do not bridge the gap between observed and observer, objectivity and subjectivity. But the *most* fundamental theory emerging in modern science—unified field theory—logically necessitates that the gap be bridged completely if nature is unified. These and related issues have deeply challenged even the most eminent scientists. Einstein, for one, argued strongly that quantum theory is incomplete, against the positions of many of his colleagues. He believed that there must be unknown information or *hidden variables* that eventually will allow an objective deterministic account of nature. As Einstein asserted:

> "The belief in an external world independent of the perceiving subject is the basis of all natural science (Herbert, 1985, p. 201)."

> To the notion of quantum wave function collapse upon observation, Einstein said:

> "I cannot imagine that a mouse could drastically change the universe by merely looking at it (Herbert, 1985, p. 199-201)."

***Collapse of the quantum wave function and the Schrodinger's cat paradox***

Some of these core dilemmas are illustrated in the well-known thought experiment *Schrodinger's cat paradox*. A cat is in a box equipped with a Geiger counter and a piece of radioactive material with 50% chance of one of its atoms decaying within an hour. If the decay is recorded by the Geiger counter, it will trigger release of a lethal gas. If there is no decay, presumably the cat will still be alive. From the perspective of an observer who cannot look in the box, the cat is both alive and not alive at some probability. From the deterministic classical view, the cat is not in a smeared out state covering both possibilities. But there is no way for the observer to know what state the cat is in until an observation is made. According to the theory, the state of the cat is indeterminate until a conscious observation instantaneously collapses the wave function. Thus the cat is accurately described as alive and not at some probability, until observed.

Considering the reasonable assumption that the cat is conscious, however, wouldn't the cat be aware of its own classical state of being alive, and thus the wave function would have collapsed even when the outside observer had not opened the box to observe it? This brings up the issue of what happens when the cat loses consciousness (such as by falling asleep or expiring due to the lethal gas according to common meanings of consciousness) and thus is no longer able to collapse the wave function, but the observer has not yet opened the box. Would the cat return to a probabilistic quantum state of being alive and not until the observer opened the box, which again would collapse the quantum wave function into a discrete state?

Of course this is a thought experiment. The issue is that in quantum theory all observations are from an outside perspective, and the discrete state of the world cannot be known apart from an observation. In orthodox quantum theory there is no collapse without a conscious observer. It seems useful to recognize further, however, that without a conscious observer there would be no sense of radioactive material, Geiger counter, box, laboratory, or way to ask either a classical or quantum question. It would seem that according to the orthodox interpretation of quantum theory nothing discrete can happen without conscious observers (apparently not even evolution of a physical brain that supposedly generates conscious mind). How can any quantum wave function collapse occur in order to get a classical conscious observer when the classical observer is first required for the collapse?

More recently the probabilistic model associated with the quantum wave function is given the alternative explanation that if we were to take 32 boxes with a cat in each one and wait for five half-lives of the radioactive material, upon opening the boxes we would find on the average only one live cat. Even though the theory is that the wave function collapses upon observation, it is now sometimes explained that the observations would show on the average that one cat survived. In this view, what really happened inside the boxes when they could not be observed is a 'classical' question that is not appropriate because the answer to it cannot be known. Importantly, this explanation tacitly separates wave function collapse from an observation by a conscious observer, and also from the discrete state of the cat. It points toward recent quantum theory interpretations that offer a potential resolution of the paradox.

In the early orthodox interpretation, the quantum wave function was not thought of as physical or existing objectively in the world; it was only an abstract mental concept in mathematical possibility space. The discrete objective world was real, and quantum possibilities were only mathematical concepts. As Bohr asserted, "[T]here is no quantum world… [T]here is only an abstract quantum description (Herbert, 1985, p. 22)." But at the same time, the conscious mind was the only thing with the power to get from mathematical possibility space of the quantum wave function to the objective classical world of discrete objects in ordinary space and time. Through quantum theory there has been important recognition of the role of conscious mind in nature. But how the mind works, where it exists, and what the world is like or even whether it exists in-between observations have not been addressed in the theory.

Again with respect to socio-cultural influences, in a similar manner that relativity theory was misinterpreted in terms of cultural relativism, quantum theory was misinterpreted in terms of existential views associated with fundamental randomness and the meaninglessness of life. These views were espoused especially in intellectual, literary, and artistic communities, associated with devaluation of human existence and even nihilism. They have contributed to psychological angst, lack of fundamental grounding in daily life, erosion of traditional values, and a deep tear in the psychosocial fabric of modern and post-modern life fueling reactionary hedonism and overt hostility. However, views are emerging from recent advances toward unified field theory with potential to change societal trends to a more hopeful, positive understanding of nature. As physicist Henry Stapp (2007, p. 142) recently noted:

> "Science in the first quarter of the twentieth century had not only eliminated materialism as a possible foundation for objective truth, but seemed to have discredited the very idea of objective truth in science. But if the community of scientists has renounced the idea of objective truth in favor of the pragmatic idea that 'what is true for us is what works for us,' then every group becomes licensed to do the same, and the hope evaporates that science might provide objective criteria for resolving contentious social issues… This philosophical shift has had profound social and intellectual ramifications. But the physicists who initiated this mischief were generally too interested in practical developments in their own field to get involved in these philosophical issues. Thus they failed to broadcast an important fact: already by mid-century, a further development in physics had occurred that provides an effective antidote to both the 'materialism' of the modern era, and the 'relativism' and 'social constructionism' of the post-modern period."

Interpretations beyond orthodox quantum theory present different views of the interaction of objectivity and subjectivity, as well as where conscious mind fits, which entail new views of space and time. One progressive interpretation is that quantum wave collapse is an *objective reduction* not dependent on subjective observation; and others eliminate entirely the notion of instantaneous collapse of the quantum wave function upon observation. These interpretations imply that *quantum wave*s are not just a mathematical model of nature (the quantum wave *function*), but relate to a deeper ontological reality. This has major implications for views of space and time. For the first time in modern science, theories are moving toward making room for a logically consistent causally efficacious conscious mind.

Exemplified using again the Schrodinger's cat paradox, ontological distinctions can be made between levels of nature associated with the classical discrete state of the cat and the mathematical concept of the quantum wave function in the observer's mind. This is anticipated in a quote by physicist Christopher Fuchs:

> "When a quantum state collapses, it's not because anything is happening physically, it's simply because this little piece of the world called a person has come across some knowledge, and he updates his knowledge… So the quantum state that's being changed is just the person's knowledge of the world, it's not something existent in the world in and of itself (Folger, 2001, p. 42)."

This quote can be interpreted as consistent with the view that the 'collapse of the wave function' refers to a change in knowledge state in the mind of the observer when an observation is made—with little if any influence on the cat. In this interpretation the cat is in a real, classical state composed of discrete particles whether observed or not; when observed, the observer's knowledge changes from probabilistic to definite, but the cat does not instantaneously change from a probabilistic imaginary cloud or mathematical probability to a real, discrete state of being in which it is either alive or not. This interpretation suggests that the discrete, real, classical level is underlain by real quantum waves at a deeper sub-phenomenal level. The quantum wave *function* can be viewed as a mathematical concept in the mind, different from the ontologically real particle and real wave levels of nature. Not recognizing these levels has led to the *measurement problem* in quantum theory. Orthodox interpretations of instantaneous wave function collapse, fundamental randomness, and the meaninglessness of space and time beyond the Planck scale contributed to a psychological 'inviolable wall.' In the orthodox view quantum theory is complete and no levels underlie the physical. But recent interpretations are going under the 'inviolable wall' to theorized real levels of space that are more fundamental than the physical.

***Interpretations progressing beyond orthodox quantum theory***

The *continuous spontaneous localization* interpretation of quantum theory describes the collapse of the quantum wave not clouded by the vagaries of subjective measurement. The collapse is theorized to be a real, objective process occurring spontaneously as objects move through time. The quantum wave evolves deterministically, but contains a probabilistic stochastic perturbation insignificant in very small systems. When the small stochastic perturbations add together across large systems or objects, it becomes significant enough to collapse the wave function into discrete, localized position and other dynamic attributes typical of ordinary macroscopic objects—absent a subjective observer. If quantum 'objects' spontaneously turn into real physical objects in ordinary space and time, as in this interpretation, clearly they are not just imaginary mathematical concepts in possibility space. It implies that the uncollapsed quantum wave state and the collapsed particle state are both ontologically real levels of nature.

A more advanced variant further suggestive of the ontological reality of the quantum wave level is the *consistent histories* interpretation associated with the concept of *decoherence.* It concerns interactions between an abstract but real quantum object and its complex physical environment, with many small influences that don't substantially change the object but do limit its possibilities. These limits spontaneously narrow down quantum possibilities into an allowable consistent set of discrete physical states. The wave-like nature of objects moving in space and time is exhibited in the pattern of quantum wave interference effects, prominent when the wave pattern is coherent and not disrupted by environmental influences. Interactions with typical complex natural environments produce a *decoherent* effect that suppresses quantum interference. Physicist Brian Greene (2004) explains:

> "Once environmental decoherence blurs a wave function, the exotic nature of quantum probabilities melts into the more familiar probabilities of day-to-day life… If a quantum calculation reveals that a cat, sitting in a closed box… has a 50 percent chance of being alive… decoherence suggests that the cat will not be in some absurd mixed state of being dead and alive… [L]ong before you open the box, the environment has already

completed billions of observations that, in almost no time at all, turned all mysterious quantum probabilities into their less mysterious classical counterparts… Decoherence forces much of the weirdness of quantum physics to 'leak' from large objects since, bit by bit, the quantum weirdness is carried away by the innumerable impinging particles from the environment." (pp. 210-211)

"The wave function of a grain of dust floating in your living room, bombarded by jittering air molecules, will decohere in about a billionth of a billionth of a billionth of a billionth ($10^{-36}$) of a second… [F]loating in the darkest depths of empty space and subject only to interactions with the relic microwave photons from the big bang, its wave function will decohere in about a millionth of a second… For larger objects, decoherence happens faster still. It is no wonder that, even though ours is a quantum universe, the world around us looks like it does." (p. 514).

This interpretation not only emphasizes the context dependence of objects but also importantly their consistency through time from the perspective of an observer. The observer does not cause the collapse of the quantum wave. But the change from the quantum state to the classical state needs to be consistent in time and space from the perspective of the observer. The contextual environment serves as a selection process that narrows down quantum possibilities; and from the perspective of an observer these processes are consistent through time. Decoherence in a consistent histories framework is a start toward addressing the issue of the consistency of phenomenal experiences of actual observers. Sets of questions about nature related to observations are identified as decoherent if specific answers are not superpositions of answers to other questions. Physicist Lee Smolin (2001, p. 43) explains:

"This approach lets you specify a series of questions about the history of the universe. Assuming only that the questions are consistent with one another, in the sense that the answer to one will not preclude our asking another, this approach tells us how to compute the possibilities of the different possible answers."

The observer is included in this interpretation of quantum theory, but not in the same manner as wave function collapse due to observation in orthodox interpretations. There is one world with many different perspectives or minds in it. The world we get depends on the questions about it we ask, such as the measurement choices and historical contexts. Definite answers emerge from initial questions in a highly context dependent manner.

Decoherence is a key principle that clarifies to some degree how infinite initial abstract possibilities spontaneously narrow down to definite concrete actualities. It seems consistent with the important principles of the asymmetric direction to time—*arrow of time*—and the 2nd law of thermodynamics of increasing entropy in nature. Importantly, the association of initial conditions with initial observational questions implies initial order, and even an initial role for an observer. These become key issues when actual observers are considered. The consistency suggests that change in nature may not be fundamentally random, whether independent of an observer or not, and is consistent for an observer who experiences it.

These more recent interpretations of quantum theory can be viewed as major steps toward the ontological reality of the quantum level of nature. If quantum 'objects' and classical objects causally interact, then it suggests both are ontologically real. The quantum level seems no longer to be just a mathematical model of nature, but rather to be a theorized actual level of existence. These interpretations address the role of the observer quite differently than the notion of instantaneous wave function collapse upon observation. They further are beginning to address the ontological reality of conscious mind. A corresponding expanded view of space and time also is needed, and has become essential with the empirical validation of *nonlocality* that goes beyond spacetime as defined by Einstein locality and causality based on light-speed.

***The nonlocal fabric of spacetime***

One major concern for Einstein about quantum theory was that it posits a fundamental random component or indeterminacy at the very heart of nature that challenges the central scientific pillar of deterministic cause-effect relations. Reflecting on quantum uncertainty and probabilism, Einstein made his famous comment, "I cannot believe that God plays dice with the universe (Herbert, 1985, p. 199)."

After years of debate crucial experiments were designed to test whether there is an indeterminate component at the core of nature, or there are as yet hidden variables that can explain the indeterminacy as argued by Einstein and colleagues in their well-known *EPR paradox*. Actual experiments were conducted in the 1980s based on *Bell's theorem.* Key assumptions in this theorem include that nature is deterministic, exists objectively independent of the observer, and light-speed sets an absolute speed limit for anything, including information. Without going into details of the experimental set-up, when the predictions based on quantum theory and on Bell's theorem were compared in actual experiments, quantum theory was supported. The results validated *quantum entanglement*, the phenomenon of highly correlated behavior of elementary particles after they interact and separate—even when the limitations of light-speed would have disallowed them from exchanging any form of information or having any causal effect on each other. It turns out, however, that the results are *not* understood to be a test whether nature is fundamentally random or deterministic. Rather, the results are understood to be a definitive test of Einstein locality, demonstrating the belief that objects in nature interact only locally within light-speed is inaccurate. Greene (2004, p. 113) notes:

> "Einstein, Podolsky, and Rosen were proven by experiment—not by theory, not by pondering, but by nature—to be wrong… But where could they have gone wrong? Well, remember that the Einstein, Podolsky, and Rosen argument hangs on one central assumption...since nothing goes faster than the speed of light, if your measurement on one object were somehow to cause a change in the other…there would have to be a delay before this could happen, a delay at least as long as the time it would take light to traverse the distance between the two objects… We are forced to conclude that the assumption made by Einstein, Podolsky, and Rosen, no matter how reasonable it seems, cannot by how our quantum universe works."

The classical relativistic view was that all action is mediated by a continuous chain of mechanistic physical events that are local interactions within light-speed. In dramatic contrast, experimental tests of Bell's theorem showed that *nonlocal* interconnections must be a common feature of how the universe is built. This means that spacetime is not adequately characterized by Einstein locality. An adequate view needs to account for nonlocality, allowing relationships more fundamental than those limited to the known forces that diminish with the square of the distance from their source within light-speed. Physicist Nick Herbert (1985, p. 19) describes this nonlocal, interconnected level:

> "Undoubtedly we are all connected in unremarkable ways, but close connections carry the most weight. Quantum wholeness, on the other hand, is a fundamentally new kind of togetherness, undiminished by spatial and temporal separation. No casual hookup, this new quantum thing, but a true mingling of distant beings that reaches across the galaxy as forcefully as it reaches across the garden."

**Space and time in quantum gravity theories**

Quantum theory interpretations incorporating the principle of decoherence that posit quantum wave collapse as an objective reduction involving interaction with the classical environment imply an expanded ontology; and it also is implied by nonlocality. Further developments in this direction are evident in recent quantum gravity theories.

***String theory***

In both relativity and quantum theories, particles are treated mathematically as dimensionless points. The concept of a particle is represented mathematically as a point with no internal structure—no extension in space—and only the capability of motion through space. Mathematical attempts to integrate relativity and quantum theories using the point-particle framework repeatedly resulted in the inconsistency of infinite quantities of energy, indicating that the approach was untenable. A major relevant development in recent decades is *string theory*, based on the mathematical principle of super-symmetry. String theory replaces the mathematical model of the dimensionless point with a filament or string about the Planck size. A string has extension in space, and thus an internal structure with potential for complex higher-order fluctuations which add explanatory power to the theory. The higher-order fluctuations are significant at the ultramicroscopic scale; otherwise strings have much the same mathematical properties as dimensionless points.

In this theory strings may be the 'uncuttable constituents' of nature. There is generally one type of string, although M-theory that integrates some string theories proposes a range called branes (short for membranes). Strings and branes can fluctuate in a multitude of patterns theorized to produce the particles that make up all objects in the entire physical universe. One of the patterns matches the hypothesized super-symmetric graviton, which connects strings with gravity, and cancels the meaningless infinite quantities that had prevented a consistent finite theory of quantum gravity (Greene, 1999).

String and M-theories require mathematical *dimensions* in addition to the ordinary three spatial dimensions plus time. The extra dimensions—usually six or seven—are imagined as enfolded or curled up in the string, called *spacetime compactification*. Although extra dimensions are mathematical degrees of freedom in imaginary mathematical space used to model string motion, they also are conceptualized as higher-order spatial dimensions (Greene, 1999, 2004; Randall, 2005). Mathematical geometric strings and branes in compactified higher-dimensional space are theorized to be the source of physical objects in ordinary space. This seems to imply causal interactions between material objects and geometric mathematical 'objects,' suggestive that these geometric conceptual, mathematical 'objects' may refer to real objects in nature.

This again reflects the key issue of the relationship between mental concepts and physical reality, interpretable as a new variant of the old mind-body problem that is core to quantum theory. In the same way that quantum theories are moving toward the ontological reality of quantum waves, these new theories are moving toward the ontological reality of geometric 'objects' in mathematical, conceptual, or imaginary space and time—blurring a little more the distinction between ordinary space and conceptual, mathematical space. A model of an underlying ontologically real level of nature is emerging that is fundamentally different from ordinary space and time, and that has features of conceptual or mental space.

Although attempting to integrate quantum theory and gravity, string theories share generally with quantum theory the *non-relativistic* framework of background dependent Newtonian space and time. A consistent theory of quantum gravity that integrates fully the relativistic spacetime continuum, such that there is no separate background dependent field, has not yet been achieved. Also, string theory and super-symmetry are based on mathematical consistency and elegance; actual experimental evidence is yet to be found. These and other key issues need to be addressed in viable string theories of quantum gravity.

A new direction in M-theory explores a more fundamental *nonconventional* space underlying strings and branes that is theorized to produce ordinary space and time and all matter. It includes the concept of *zero-branes*, which Greene (1999, pp. 379-387) describes as existing:

> '…possibly in an era that existed before the big bang or the pre-big bang (if we can use temporal terms, for lack of any other linguistic framework)… [A] zero-brane… may give us a glimpse of the spaceless and timeless realm… [W]hereas strings show us that conventional notions of space and time cease to have relevance below the Planck scale, the zero-branes give essentially the same conclusion but also provide a tiny window on the new

> unconventional framework that takes over. Studies with these zero-branes indicate that ordinary geometry is replaced by something known as non-commutative geometry… In this geometrical framework, the conventional notions of space and of distance between points melt away, leaving us in a vastly different conceptual landscape… [I]t gives us a hint of what the more complete framework for incorporating space and time may involve… Already, through studies in M-theory, we have seen glimpses of a strange new domain of the universe lurking beneath the Planck length...”

This glimpse of a potential field underneath ordinary or *conventional* space and time limited to the Planck scale reflects another step toward an expanded ontology. Unlike background independent relativity theory, however, conventional space and time would be dependent on a background. In addition, although the general theory of relativity is described as observer dependent and assumes the observer is inside the theoretical system, quantum, string, and M-theories don’t address how a conscious observer fits into them.

***Loop quantum gravity theory***

The theory of loop quantum gravity attempts to incorporate the observer, in a manner similar to the observer dependent general theory of relativity. But like string theories and unlike relativity theory, it develops further the view of a background underneath ordinary spacetime. It draws more on cosmological research, as well as black hole thermodynamics. It also posits that spacetime is quantized. However, it attempts to *relativize* quantum theory by emphasizing the relational, observer-dependent nature of consistent decoherent events inside the spacetime continuum. The relativistic frame of reference is a partial consistent history of the universe from a particular observer perspective. In this theory, space is generated from topological relationships in a dynamically evolving network of intersecting loops, called a *spin network*. Smolin (2001, pp. 130-138) explains:

> “Translated into the loop picture of the gravitational field…the area of any surface comes in discrete multiples of simple units. The smallest of these units is about the Planck area… A spin network is simply a graph…whose edges are labeled by integers. These integers come from the values that the angular momentum of a particle are allowed to have in quantum theory, which are equal to an integer times half of Planck’s constant… The volume contained in a spin network, when measured in Planck units, is basically equal to the number of nodes of the network… A very large network can represent a quantum geometry that looks smooth and continuous when viewed on a scale much larger than the Planck length… In the spin network picture, space only seems continuous—it is actually made up of building blocks which are the nodes and edges of the spin network… The spin networks do not live in space; their structure generates space.”

A spin network of dynamic nonlocal processes is theorized to generate curved relativistic spacetime and localized particles, sometimes called *spin foam*—somewhat similar to spacetime foam. It is a mathematical theory of a deeper, abstract, non-material functional structure or *pure geometry* that is the source and generator of conventional four-dimensional spacetime. Adding principles from black hole thermodynamics, the spin network links the concept of bits of quantized pure geometry to bits of non-physical information in a formal mathematical relationship—the Bekenstein’s bound. Accordingly, the smallest possible surface area of space has an inherent mathematical limit to the amount of information it can contain.

This represents an additional step toward the ontological reality of an abstract field underneath conventional space, in this case a non-material *information space*. Matter has been reduced to fundamental quantized units of space, then to a non-material pure geometry more abstract than conventional space, and then further to quantized information space. This is said to provide a direction for linking string theory, loop quantum gravity, and black hole thermodynamics. A level of nature is posited that is an ontologically real underlying pure geometry of quantized information space, upon which conventional four-dimensional space is background dependent.[7]

Concerning the other characteristic of spacetime in the general theory of relativity of observer dependence, loop quantum gravity theory attempts to place the observer into the complex system of changing causal events by proposing one universe with a multitude of observers in it. It is a complex causal network of interacting light cones built of the smallest possible events or bits of information, with an unlimited number of separate but overlapping consistent perspectives of separate observers. Importantly quantum superposition is held to be at the level of the mind in terms of overlapping observer perspectives, drawing upon notions from the 'many worlds' (many mind-worlds) interpretation of quantum theory.[4-7] Superposition of histories that are independent of each other, each associated with a different observer perspective, allow for agreed-upon outcomes when there are the same initial conditions and similar consistent histories.

However, the concept of an observer in this system remains restricted. The observer still experiences a unitary state from outside the system, as in quantum theory. Also, core aspects of the observer—especially self-observation as an integrated functional self—are left out too, Smolin (2001, pp. 47-48) explains:

> "The quantum description is always the description of some part of the universe by an observer who remains outside it… If you observe a system that includes me, you may see me as a superposition of states. But I do not describe myself in such terms, because in this kind of theory no observer ever describes themselves. Rather than trying to make sense of metaphysical statements about their being many universes—many realities [for example the many worlds interpretation of quantum theory]—within one solution to the theory of quantum cosmology, we are constructing a pluralistic version of different mathematical descriptions, each corresponding to what a different observer can see when they look around them. Each is incomplete, because no observer can see the whole universe. Each observer, for example, excludes themselves from the world they describe. But when two observers ask the same questions, they must agree… One universe, seen by many observers, rather than many universes, seen by one mythical observer outside the universe."

Loop quantum gravity theory attempts to be background independent in the sense that gravity is integrated as the curvature of spacetime and does not function *in* spacetime. But at the same time it goes beyond relativistic spacetime to a deeper ontological substrate of information space, to which conventional spacetime is background dependent. The only place for an underlying information space that could generate conventional spacetime would seem to be *underneath* or subtler than the Planck scale, as implied by Greene (2004, pp. 350-351):

> "[W]hen you get down to the Planck length (the length of a string)… "going smaller" ceases to have meaning once you reach the size of the smallest constituent of the cosmos. For zero-sized point particles this introduces no constraint, but since strings have size, it does. If string theory is correct, the usual concepts of space and time, the framework within which all of our daily experiences take place, simply don't apply on scales finer than the Planck scale… As for what concepts take over, there is yet no consensus. One possibility…is that the fabric of space on the Planck scale resembles a lattice or grid [loop quantum gravity], with the 'space' between the grid lines being outside the bounds of physical reality… Another possibility is that space and time do not abruptly cease to have meaning on extremely small scales, but instead morph into other, more fundamental concepts. Shrinking smaller than the Planck scale would be off limits not because you run into a fundamental grid, but because the concepts of space and time segue into notions for which

> "shrinking smaller" is meaningless… Many string theorists, including me, strongly suspect that something along these lines actually happens, but to go further we need to figure out the more fundamental concepts into which space and time transform."

Mathematician and physicist David Bohm (1980, p. 244) also points to the possibility of a level of nature underneath the Planck scale:

> "[T]he current attempt to understand our 'universe' as if it were self-existent and independent of the sea of cosmic energy can work at best in some limited way… Moreover, it must be remembered that even this vast sea of cosmic energy takes into account only what happens on a scale larger than the critical length of $10^{-33}$ cm [Planck scale]… But this length is only a certain kind of limit on the applicability of ordinary notions of space and time. To suppose that there is nothing beyond this limit at all would indeed by quite arbitrary. Rather, it is very possible that beyond it lies a further domain, or set of domains, of the nature of which we have as yet little or no idea."

These quotes exemplify theoretical progress toward a field or space of some kind, not yet articulated, that underlies and is subtler than conventional space and time. These are major developments with many important implications. They point to an expanded ontology of space, fundamentally different from conventional space and time but that permeates it and is its underlying source.

Further, loop quantum gravity theory begins to address key issues of the consistency of experience of an observer and consensus across observers, based on the notions of consistent histories and initial conditions. These issues are fundamental to a logically consistent and consensually validated science. However, although the theory is said to be observer dependent inside the relativistic system, core aspects of the observer still remain outside.

A viable unified theory needs to account for everything emerging from it, without anything outside of it, including all aspects of the observer. It needs to account for the ability of the observer to self-observe, presumably for the observer to cause change in the system, and for consciousness itself. There still seems to be no place for a causally efficacious conscious mind in loop quantum gravity theory. But at least it recognizes the necessity of addressing these issues, which other approaches don't yet do.

The concept of an abstract non-material information space that generates conventional space can be viewed as another major step closer to a nonlocal mental space, through which these issues potentially can be addressed. Philosopher Colin McGinn (2000, p. 103) brings out the need for a new conception of space to account for conscious mind:

> "[I]n order to solve the mind-body problem we need, at a minimum, a new conception of space… We need a conceptual breakthrough in the way we think about the medium in which material objects exist, and hence in our conception of material objects themselves. That is the region in which our ignorance is focused: not in the details of neurophysiologic activity but, more fundamentally, in how space is structured or constituted. That which we refer to when we use the word 'space' has a nature that is quite different from how we standardly conceive it to be; so different, indeed, that it is capable of 'containing' the non-spatial (as we now conceive it) phenomenon of consciousness."

Mathematician and cosmologist Roger Penrose (1994, p. 420) further points to the need for a new approach in order to address the causal efficacy of conscious mind:

> "[W]ithout…opening into a new physics, we shall be stuck within the strait-jacket of an entirely computational physics, or of a computational cum random physics. Within that strait-jacket, there can be no scientific role for intentionality and subjective experience. By breaking loose from it, we have at least the potentiality of such a role… Many who might agree with this would argue that there can be no role for such things within *any*

 

scientific picture. To those who argue this way, I can only ask that they be patient… I believe that there is already an indication, within the mysterious developments of quantum mechanics, that the conceptions of mentality are a little closer to our understanding of the physical universe than they had been before."

To summarize the quantum gravity theories introduced above, space and time are proposed to be background dependent in the sense that there is a more abstract field of information space that generates conventional spacetime. This is like background dependent Newtonian theories and unlike background independent Einstein's general theory of relativity. Attempts also are being made to conceptualize how this underlying field is observer dependent, like Einstein's theory and unlike Newtonian theories. But core aspects of the observer—self-observation and causal efficacy of mind—remain outside. If these aspects of the observer exist, they also possibly could be in the theorized abstract information space below conventional spacetime, inasmuch as there seems to be no room for them in a supposedly closed causal physical nexus of conventional spacetime (Stapp, 2007; Boyer, 2008).

**Space and time in the neorealist interpretation of quantum theory**

One other interpretation of quantum theory, sometimes called *neorealism*, is outlined in a little more detail because it explicitly contains an expanded ontology of space applying nonlocality that has room for a causally efficacious conscious mind. Proposing the radical addition of a *sub-quantum* reality, the theory is primarily from Bohm, who had extensive talks with Einstein in the last few months of Einstein's life and which could have influenced Bohm's ideas, as noted by science writer Michael Talbot (1991, p. 39):

> "[Neils] Bohr and his followers…claimed that quantum theory was complete and it was not possible to arrive at any clearer understanding… This was the same as saying there was no deeper reality beyond the subatomic landscape… Inspired by his interactions with Einstein…[Bohm] began by assuming that particles such as electrons do exist in the absence of observers. He also assumed that there was a deeper reality beneath Bohr's inviolable wall… [By] proposing the existence of a new kind of field on this subquantum level he was able to explain the findings of quantum physics as well as Bohr could. Bohm called his proposed new field the *quantum potential* and theorized that, like gravity, it pervaded all of space. However, unlike gravitational fields, magnetic fields, and so on, its influence did not diminish with distance."

Bohm's neorealist interpretation has been described as a deterministic reformulation of quantum theory that doesn't invoke the subjectivity of the observer in wave function collapse. It can be understood to be a realization of the hidden variables approach favored by Einstein (Talbot, 1991; Bohm & Hiley, 1993). It is sometimes mischaracterized as a return to classical physics because it models elementary particles as ordinary classical objects with intrinsic dynamic properties. But a major change is that it posits an ontologically real, nonlocal wave field that *mediates* nonlocal effects—the *quantum potential* or *psi wave*—neither in classical relativity theories nor in other interpretations of quantum theory (Bohm. 1980). In this interpretation, the ordinary physical world is the same whether measured or not, which means there is no collapse of the wave function upon observation as theorized in the orthodox interpretation. The notions of determinism and objectivity independent of conscious observers extend beyond quantum mechanics. Like other approaches, such as string theory, major mathematical issues remain unresolved; but it is much more integrative than other quantum and quantum gravity theories.

Bohm's interpretation of quantum theory is a mathematical theory of the motion of particles in which the path of a real particle is guided by a real nonlocal wave—sometimes described as a resolution to the dilemma of wave-particle duality. The quantum entangled particles don't influence each other directly;

rather they are guided by the extremely subtle nonlocal quantum potential or psi wave. To match the behavior of objects according to classical and quantum mechanics, the psi wave must be connected to every particle in the universe, classically invisible, superluminal, and a common aspect of nature. A vastly more encompassing landscape is proposed that incorporates the relativity of spacetime in terms of two levels, domains, ethers, or mediums with different defining properties.

In this interpretation the wave behavior of quantum processes is due to the psi wave. It doesn't collapse upon observation, and is accounted for objectively in terms of decoherence effects. Quantum indeterminism is accounted for deterministically in terms of the path of a particle as a combination of the guiding psi wave and the myriad of local and nonlocal contextual influences that include about everything and everywhere in the universe. Together these influences are unfathomable and produce a jittery, complex path of motion that cannot be predicted exactly: it is both deterministic and probabilistic. Also in the sense that all components of the experimental set-up influence the results, discrete classical reality can be said to be *created* in the process of measurement; any change in the experimental set-up would alter the influences and thus the results. This accounts for the notion in orthodox quantum theory of quantum wholeness, based on nonlocality. Further, the psi wave carries non-random information through which it causally influences the motion of particles, but not via the strength of the forces as in the mechanics of the four known quantum fields. However, is it possible to guide the path of particles from the deeper level of the psi wave through intentional information? In other words, is this proposed subtler level of nature a field of causally efficacious mind?

Bohm has speculated that the nonlocal psi wave is a mental space or mind-like field that functions with extreme subtlety to allow sensitive but systematic information transmission. He has proposed this as a general framework for how mind influences matter (Bohm, 1980; Bohm & Hiley, 1993). At this theorized level, nature functions via highly interconnected nonlocal processes in mental space, which brings into this expanded version of the natural world and its causal chain the possibility of a causally efficacious mind. The closed physical causal chain does not mysteriously unlink to insert conscious mind at some stage of evolutionary complexity; the mind is nonlocal and influences physical events via the underlying subtler level.

This interpretation reflects further the disembedding of classical physical reality from the notion that it appears due to an unmediated instantaneous collapse of the quantum wave function. Adding an ontological level of nonlocal information or mental space underlying the classical physical world, it thus might be classified as a type of dualism rather than classical realism or monistic materialism. But not in the sense of Cartesian dualism that described mind as not spatially extended. Rather, the underlying psi wave field is in nonlocal *nonconventional* space much more extended than local conventional space. This also is quite distinct from Einstein's relativistic spacetime theory of gravity. Bohm and Hiley (1993, pp. 347-348) describe it as a sub-relativistic level of nature:

> "[W]e say that underlying the level in which relativity is valid there is a subrelativistic level in which it is not valid even though relativity is recovered in a suitable statistical approximation as well as in the large scale manifest world… Although there is no inherent limitation to the speed of transmission of impulses in this subrelativistic level, it is quite possible that the quantum nonlocal connections might be propagated, not at infinite speeds, but at speeds very much greater than the speed of light… As the atomic free path quantum indeterminacy or randomness is the first sign of a 'subcontinuous' domain in which the laws of continuous matter would break down at the quantum level, so the free path in our trajectories would be the first sign of a subquantum domain in which the laws of quantum theory would break down… The next sign of a breakdown of the quantum theory would be the discovery of some yet smaller dimension whose role might be analogous to the dimension of

> an atom in the atomic explanation of continuous matter [the classical microscopic level]. We do not as yet know what this dimension is, but it seems reasonable to propose that it could be of the order of the Planck length, where, in any case, we can expect that our current ideas of space-time and quantum theory might well break down."

To summarize, Bohm's interpretation posits a subtle ontologically real nonconventional information space underlying and generating conventional four-dimensional spacetime. It is characterized as nonlocal, unbounded as in quantum fields, apparently undiminished by distance, deterministic, quantized (in the sense of individual waves, not Planck-size particles), relative (in the sense of interconnected and entangled but not defined by Einstein locality), non-physical (not matter-like), a pure, non-physical geometry of information space (mind-like), a background for conventional spacetime underneath the Planck scale, and a mixture of observer dependent and independent properties. It can be associated variously with terms such as hyperspace, superspace, higher dimensional space, nonconventional space, mental space, and also quantum mind (though somewhat of a misnomer inasmuch as it is not quantized in the sense of Planck-size quanta). The difficulty of integrating relativity and quantum theories into quantum gravity may be because both are incomplete and don't account for a subtle, underlying, non-quantized, nonlocal background of information or mental space.

Carrying this interpretation further, the ether of classical relativistic spacetime can be characterized as a quasi-closed physical system limited to Einstein locality (light-speed and spacetime gravity per relativity theory) and Planck-size quantization (per quantum theory), containing the particle-wave force fields associated with ordinary physical existence and classical particle interaction (billiard ball-like) local causality. This includes the relativistic spacetime continuum from the ultramicroscopic Planck scale to the ultramacroscopic cosmos, the quantized particle-force fields, and all material objects in it. This physical domain or ether of conventional spacetime is now theorized to be permeated by a subtler domain—analogous to how earth, water, and air are permeated by ordinary space. The subtler level is characterized by nonlocal interactions with more object interdependence and less object independence, individualized but more wave field-like than discrete particle-like and not characterized by particle interactions or thermodynamics—involving superluminal motion, but not 'instantaneous.'

Elaborations of this interpretation identify the theorized subtler field of nonlocal mind as the *implicate order* (Bohm, 1980; Bohm & Hiley, 1993), contrasting it with the classical level of the *explicate order*. In distinguishing a grosser, local, classical explicate order and a subtler, nonlocal, non-classical implicate order, however, both are described as aspects of an *ultimate holism,* which seems consistent with unified field theory as well as, according to Bohm (1980), non-dual Vedanta in ancient Vedic science. In the following quote Bohm and his colleague B. J. Hiley (1993, pp. 385-386) summarize how the undivided wholeness of the implicate order relates to physical and mental phenomena:

> "One may then ask what is the relationship between the physical and the mental processes? The answer that we propose is that there are not two processes. Rather, it is suggested that both are essentially the same. This means that that which we experience as mind, in its movement through various levels of subtlety, will, in a natural way ultimately move the body by reaching the level of the quantum potential and of the 'dance' of the particles. There is no unbridgeable gap or barrier between any of these levels. Rather, at each stage some kind of information is the bridge. This implies that the quantum potential acting on atomic particles, for example, represents only one stage in the process… It is thus implied that in some sense a rudimentary mind-like quality is present even at the level of particle physics, and that as we go to subtler levels, this mind-like quality becomes stronger and more developed."

While this view posits two causally determinate relative levels of spacetime with different degrees of interconnectedness, it also emphasizes their causal seamlessness, and in this sense is a non-dual or monistic account. In the following quotes, Bohm (1980) elaborates by describing the explicate order as embedded in the implicate order, both arising from the *super-implicate order*, plenum, or universal flux—which would seem to have close affinity with the notion of the unified field as the source of everything:

> "So we are suggesting that it is the implicate order that is autonomously active while…the explicate order flows out of a law of the implicate order, so that it is secondary, derivative, and appropriate only in certain limited contexts. Or, to put it another way, the relationships constituting the fundamental law are between the enfolded structures that interweave and interpenetrate each other, throughout the whole of space, rather than between the abstracted and separated forms that are manifest to the senses (and to our instruments)." (p. 235)

> "[T]here is a universal flux that cannot be defined explicitly but which can be known only implicitly, as indicated by the explicitly definable forms and shapes, some stable and some unstable, that can be abstracted from the universal flux. In this flow, mind and matter are not separate substances. Rather, they are different aspects of one whole and unbroken movement. In this way, we are able to look on all aspects of existence as not divided from each other, and thus we can bring to an end the fragmentation implicit in the current attitude toward the atomic point of view, which leads us to divide everything from everything in a thoroughgoing way." (p. 14)

This neorealist interpretation of quantum theory represents another significant step toward the ontological *reality* of mind and its place and role in nature even beyond the theorized ontologically real quantum level of nature. This level is also attributed to be the causally efficacious intentional level. Thus it is theorized that there are real particles, underlain by real waves, associated with an even deeper, more abstract real information or mental space, all ultimately seamless and unified in the universal flux or plenum. In this interpretation, mind is nonlocal, and not just in the physical head as a product only of local neural activity.

Again with respect to socio-cultural influences, physician and science writer Larry Dossey (1989, pp. 1-7) comments on the significance of a potential nonlocal mind:

> "[S]omething vital has been left out of almost all the modern efforts to understand our mental life—something that counts as a first principle, without which everything is bound to be incomplete and off base… This missing element is the mind's *nonlocal* nature… If nonlocal mind is a reality, the world becomes a place of interaction and connection, not one of isolation and disjunction. And if humanity really *believed* that nonlocal mind were real, an entirely new foundation for ethical and moral behavior would enter, which would hold at least the possibility of a radical departure from the insane ways human beings and nation-states have chronically behaved toward each other. And, further, the entire existential premise of human life might shift toward the moral and the ethical, toward the spiritual and the holy."

**Space and time in holistic unified field theory**

A helpful strategy for envisioning the much more expansive view of spacetime that is unfolding in these cutting edge quantum and quantum gravity theories is to disembed from the reductive approach in which everything is brought down through smaller scales apparently to nothing with no space or time. The reductive approach involves starting with ordinary sensory experience and analyzing material objects to their most fundamental constituents. Applying this strategy, theories in modern physics are finally glimpsing an expanded ontology beyond the material domain. For a long time, such holistic concepts had been quite challenging, rendering the mind-body problem unanswerable. From the more expansive view, the reductive perspective has things upside down—or outside in. Instead of the universe narrowing down to an infinitesimal black hole or nothing, the theories can be seen as advancing toward the opposite view of subtler, more extended levels of nature toward an all-inclusive super-implicate order, plenum, or unified field. As mathematician C. J. S. Clarke (2000, p. 174) notes:

> "First we need to turn round physics, so that we could see the local Newtonian picture as a specially disintegrated case of the fundamentally global reality… Second we need to turn round our whole approach by putting mind first. We would be in a position to understand how it was that mind could actually do something in the cosmos… We have to start exploring how we can talk about mind in terms of a quantum picture which takes seriously the fundamental place of self-observation; of the quantum logic of actual observables being itself determined by the current situation. Only then will we be able to make a genuine bridge between physics and psychology."

In other words the principle that the whole is greater than the sum of the parts needs to be supplemented with the principle that the parts emerge from the completely unified (prior existing) whole, rather than the whole emerging from a collection of parts (Boyer, 2008). Bohm (1980, pp. 226-227) elaborates:

> "What distinguishes the explicate order is that what is thus derived is a set of recurrent and relatively stable elements that are *outside* of each other. This set of elements (e.g., fields and particles) then provide the explanation of that domain of experience in which the mechanistic order yields an adequate treatment. In the prevailing mechanistic approach, however, these elements, assumed to be separately and independently existent, are taken as constituting the basic reality. The task of science is then to start from such parts and to derive all wholes through abstraction, explaining them as the results of interactions of the parts. On the contrary, when one works in terms of the implicate order, one begins with the undivided wholeness of the universe, and the task of science is to derive the parts through abstraction from the whole."

In the reductive physicalist view consciousness and mind can be said to emerge from matter—here characterized as the *matter-mind-consciousness ontology*. If the conscious self is causally efficacious, in this view it would have to enter at some point of evolutionary complexity, break the physical chain of cause and effect, and somehow assert super-ordinate causal control over the fundamentally random bits of inert matter. Such views in which mind and consciousness are emergent properties of neural functioning in the physical brain are now being challenged by more expanded and integrated views. The brain is one kind of instantiation of an abstract information processing function, as is a computer—both of which are physical. But as deeper levels of physical structure are probed, concepts of non-physical networks of pure geometry, information space, and nonlocal mental space are developing.

An abstract field of higher dimensional space or pure geometry of functional information space that underlies and generates conventional spacetime is certainly leading beyond models of any object—including the brain—as just a highly localized material structure. In this view brain and mind are no longer just in the head, because brains, heads, and other ordinary objects are no longer *just* localized physical matter. As Clarke (2000, p. 174) succinctly puts it, "Mind breaks out of the skull." Astrophysicist Piet Hut and evolutionary psychologist Roger Shepard (2000, p. 319) elaborate:

> "Our conclusion is that attempts to *embed* consciousness in space and time are doomed to failure, just as equivalent attempts to *embed* motion in space only. Yes, motion does take place in space, but it also partakes in time. Similarly, consciousness certainly takes place in

> space and time, but in addition seems to require an additional aspect of reality…in order for us to give a proper description of its relation with the world as described in physics."

McGinn (2000, p. 103) further points to the need for a new understanding of the nature of space to account for conscious mind:

> "Consciousness is the next big anomaly to call for a revision in how we conceive of space—just as other revisions were called for by earlier anomalies. And the revision is likely to be large-scale… Clearly the space of perception and action is no place to fund the roots of consciousness! In that sense of 'space' consciousness is not spatial; but we seem unable to develop a new conception of space that can overcome the impossibility of finding a place for consciousness in it."

In contrast to the reductive physicalist view, the holistic view begins with unity, and sequentially unfolds the parts of nature within that unity. The parts emerge from and within the whole, rather than the whole emerging from combining the parts. The whole creates the parts (Boyer, 2008). This subtle change in perspective seems fundamental to a more inclusive and logically consistent science.

A contemporary holistic approach that incorporates this view is the interpretation of ancient Vedic science in Maharishi Vedic Science (Maharishi Mahesh Yogi, 1997). Implications of this approach will be discussed briefly in the context of recent cosmological big bang and unified field theories because it presents a more inclusive view of spacetime that has room for mental space and a causally efficacious conscious mind.

***Big bang cosmology: everything from nothing***

In standard big bang cosmological theory, the universe and spacetime apparently began from literally nothing, instantaneously becoming random quantum fields that through spontaneous sequential symmetry breaking formed into the four known quantum force fields and all physical matter. To explain symmetry breaking into particles with mass, the theory of an additional fundamental field has developed in recent years, the *Higgs field*, considered to be one of the most important concepts proposed in the past century in theoretical physics (Greene, 2004).

This theory proposes that in the third phase of symmetry breaking into the weak and electromagnetic forces, a Higgs field condensed to a nonzero value when the temperature of the universe dropped to about $10^{15}$ degrees, creating a Higgs ocean—analogous to steam condensing into water. The Higgs ocean can be described as a kind of viscosity (ether or medium) throughout space that resists change in motion, giving the property of *mass* to particles. A second Higgs field—grand unified Higgs—was proposed to explain the earlier second phase of symmetry breaking of the strong and weak nuclear forces, and another Higgs field was proposed to explain the first phase of symmetry breaking when gravity emerged (Greene, 2004).

Einstein's formulation of general relativity predicted that space, as well as the entire universe, could either shrink or stretch. Because this contrasted with his belief in a static universe, he added another term—the *cosmological constant.* This allowed the equation to contain a negative value, meaning that gravity could be repulsive rather than just attractive. If carefully chosen, repulsive and attractive forces could balance out, resulting in a static universe. When evidence showed that the universe is expanding, however, Einstein withdrew the cosmological constant, reportedly identifying it as his greatest blunder. However, it was later revived, associated with Higgs fields and the modification of the standard big bang model called *inflationary big bang theory*.

According to this theory, for an extremely brief time period of $10^{-35}$ seconds at the outset of the big bang, gravity became a repulsive force that drove the emerging universe into a colossal expansion. This inflationary event involved a Higgs field—the *inflaton field*— contributing a uniform negative pressure to space that produced a repulsive force so strong that the universe expanded by a factor as much as $10^{90}$. This is much faster than light-speed but is thought not to be inconsistent with it, because light-speed applies to motion *through* space whereas inflationary expansion refers to inflation *of* space itself. This also implies speeds faster than light-speed but not instantaneous, like in Bohmian mechanics (Bohm, 1980; Bohm & Hiley, 1993). It importantly seems to support a potential fundamental distinction between the inflationary field *of* space compared to relativistic spacetime as equivalent to the gravitational field limited by light-speed. The estimate of the age of the universe is about 14 billion years, but the estimated radius of the universe is about 48 billion light-years. This is further suggestive that the field of space is not the same as the space-time gravitational field, consistent with theories of a nonconventional level of space underlying the ether or medium of conventional spacetime of ordinary gravity and light-speed.

Inflationary big bang theory posits a total amount of matter and energy in the universe that is considerably more than the tally of visible objects, which contribute about 5% of the total. Astronomical research suggested that additional matter is needed to hold galaxies together, which led to the theory of *dark matter* based on principles of symmetry, estimated to account for an additional 25%. Observations that the universe is expanding based on measurements of the recession rates of supernova led to revival of the cosmological constant, associated with *dark energy* and super-symmetry. It was estimated that the rate of expansion requires a cosmological constant associated with an amount of dark energy that contributes about 70% of the total, which fits the remaining amount in inflationary theory. This theory is sometimes called the consensus view in contemporary cosmology, additionally strengthened because it is said to provide an explanation for how matter formed into stars and galaxies.

But what triggered inflationary expansion? How did *nothing* blast out? An elaboration of inflationary theory proposes that the big bang emerged from a *pre-inflationary* period, in which the gravitational field and the Higgs field were bumpy, chaotic, and highly disordered; and eventually a random fluctuation produced the values needed for inflationary expansion. But this certainly doesn't sound like everything came from nothing. Astronomer David Darling (1996, p. 49) points out the issue clearly:

> "What is a big deal is how you got something out of nothing. Don't let the cosmologists try to kid you on this one. They have not got a clue either… "In the beginning," they will say, "there was nothing—no time, space, matter, or energy. Then there was a quantum flutter from which…" Whoa! Stop right there… First there was nothing, then there was something. And the cosmologists try to bridge the two with a quantum flutter, a tremor of uncertainty that sparks it all… and before you know it, they have pulled a hundred billion galaxies out of their quantum hats… You cannot fudge this by appealing to quantum mechanics. Either there is nothing to begin with, no pre-geometric dust, no time in which anything can happen, no physical laws that can effect change from nothingness to somethingness, or there is something, in which case that needs explaining."

***The unified field as the lowest entropy, super-symmetric state of order***

In quantum field theory space is *not* empty nothing; it is more like ether with specific properties, in that it at least contains vacuum fluctuations. With the advent of unified field theory the universe is more appropriately viewed as manifesting from *something*—even from the source of everything—as reflected in the following quote from Bohm (1980, pp. 241-243):

> "As we keep on adding excitations corresponding to shorter and shorter wavelengths to the gravitational effects, we come to a certain length at which the measurement of space and time becomes totally undefinable… When this length is estimated it turns out to be about $10^{-33}$ cm [Planck length]. If one computes the amount of energy that would be in one cubic centimeter of space, with this shortest possible wavelength, it turns out to be very far beyond the total energy of all the matter in the known universe… In this connection it may be said that space, which has so much energy, is full rather than empty. The two opposing notions of space as empty and

space as full have indeed continually alternated with each other... Thus, in Ancient Greece, the School of Parmenides and Zeno held that space is a plenum. This view was opposed by Democritus, who was perhaps the first seriously to propose a world view that conceived of space as emptiness (i.e., the void)... Modern science has generally favored this latter atomistic view, and yet, during the nineteenth century, the former view was also seriously entertained, through the hypothesis of ether that fills all space… It is being suggested…that what we perceive through the senses as empty space is actually the plenum, which is the ground for the existence of everything…"

As described earlier, a key component of super-symmetric unified field theory is that the fundamental force fields emerged through spontaneous sequential symmetry breaking as the universe expanded and temperature dropped (Greene, 1999). This can be likened to phase transitions of $H_2O$ condensing from steam to water to ice as temperature drops; at each stage, symmetry is reduced. In this view the fundamental forces potentially *pre-existed* in the perfectly symmetric super-unified state. But as the source of continuously occurring vacuum fluctuations, random jitters, zero point motion or inherent dynamism, the unified field continues along with the symmetry breaking. If it continues even after the fundamental forces differentiated, then it would seem to be more than only unification of these forces. The underlying unity and perfect symmetry apparently doesn't vanish with the diversity of symmetry breaking—relevant to theories of the source of order in nature.

The quantum mechanical principle of the unbounded quantum wave as a coherent state that decoheres through interaction with the classical environment suggests that fundamental fields reflect increased symmetry, and also order (Greene, 2004). Further the unified field as the source of everything and thus the origin of the laws of nature suggests that it may be a field of perfect order. As well, the understanding that time is unidirectional (past to present to future, the 'arrow of time') and the second law of thermodynamics which states that change is from low entropy to higher entropy suggest that the source of change is a state of lowest entropy (Greene, 2004). These points support the view that order emerges from the theorized super-symmetric unified field, not from *fundamental* randomness.

If the universe were fundamentally random, any outcome would have equal possibility at every moment, making any consistency practically impossible.[7] There would be no basis for continuity—no memory whatsoever—for tying things together to make one moment consistent with the next. But 'when' the theorized big bang 'began,' an orderly temporal sequence also began. At least in the world as we understand it through science, an event manifests in an orderly manner from the previous event, which implies that the source of the universe may be a state of lowest entropy. Greene (2004, p. 271) also suggests that the universe was not initially random, but rather highly ordered:

> "[I]f the universe started out in a thoroughly disordered, high-entropy state, further cosmic evolution would merely maintain the disorder… Even though particular symmetries have been lost through cosmic phase transitions, the overall entropy of the universe has steadily increased. In the beginning, therefore, the universe must have been highly ordered."

If the unified field is the lowest entropy super-symmetric state, then pre-inflationary theory that holds low entropy came from inflationary expansion would seem to suggest the puzzling inconsistency that something existed *prior* to the unified field. Also of concern is how the pre-inflationary period reconciles with quantum gravity theories that posit information space, not characterized as just bumpy chaotic random fluctuations. It suggests considerable order, in that it generates the functional structure of spacetime and all matter. A more integrative view might consider pre-inflationary theory to be another angle in the attempt to understand the theorized subtle non-material, nonlocal, nonconventional level or domain underlying the Planck scale. This subtle level as a pre-inflationary period of 'pre-conventional' space would include the order that creates the gravitational field, Higgs field, and inherent dynamism—the immediate source of spacetime and quantized fields, again underlain by the unified field. In this more integrative view dark matter and energy also might be understood as initial attempts to characterize this subtle nonlocal field.

Taken together the theories of space described in this paper can be viewed as developing toward a model of three ontological levels of nature, which is consistent with ancient Vedic science albeit using different terminology: 1) conventional, local physical spacetime; 2) nonconventional, nonlocal information or mental space, and 3) the lowest entropy, super-symmetric unified field.[1] This fundamental trinity provides a basis for reconciling the contrasting views of space in relativity and quantum theories. In relativistic spacetime motion is limited to light-speed and the notion of time and place existing *right now* outside of the light cone is undefined. This can be related to the conventional local level, or gross ether. In non-relativistic quantum theories quantum mechanical tunneling anywhere in the quantum field is possible. This can be related to the nonconventional nonlocal level or subtle ether, not limited by light-speed but still not instantaneous. The notion of instantaneity can be related to the unified field, the infinite eternal source of nonlocal and local spacetime.

From this perspective string and loop quantum gravity theories can be understood as attempts to explain how the nonlocal wave field *becomes* quantized into particles. In the reductive perspective the Planck scale is where spacetime is compactified or enfolded and conventional spacetime becomes unfurled. But the opposite view may be more appropriate: quantization is the compactification of an unfurled nonlocal wave field into discrete localized enfolded particles appearing as independent in relativistic conventional spacetime.

***Levels of spacetime as limitations within the unified field***

From the holistic view the unified field would be beyond any form or relative conception of spacetime—infinite and eternal. However, these descriptors also might be thought of as applying to nothing. Conceiving of the unified field as *nothing* is from a reductive perspective, whereas the unified field as *everything* is from a holistic perspective. These perspectives can be related to the 'dual nature' of the ultimate singularity, unity, wholeness, or oneness described in Maharishi Vedic Science. The ultimate wholeness, or completely unified field prior to any parts, can be likened to mathematical concepts of empty set, or zero, or one (Oneness). It also is reflected in the contrasting terms of the eternal *Void* (emptiness) and eternal *Being* (fullness).

From the holistic view of unity beyond all diversity, phenomenal levels of nature can be described as ether-like mediums or fields with degrees of subtlety, density, viscosity, or limitation within infinite eternal spacetime. Space and time are relative to each other, but may fundamentally concern degrees of the textural interconnectedness or fabric of ethereal fields—relative degrees of the simultaneity of infinity and point, eternity and instant. The levels also can be thought of as concentric, one completely permeating the other—from infinite eternal to subtle nonlocal to gross local. The gross relative local domain would be the conventional spacetime field or ether limited by Einstein locality, Einstein causality, light-speed, and ordinary gravity—within which the point value rather than the infinite value of spacetime would be most prominent, and objects would appear to have local independent existence.

As the source of everything the unified field would contain all potential, all order, all phenomena; it would not be a static ground state needing something else to express it. All phenomenal realities would be partial reflections of the total reality of the unified field, the ultimate infinite eternal. The infinite eternal totality would limit itself into increasing levels of localization, discreteness, and mass—limitations of the infinite eternal *that is already present everywhere*. From that perspective spacetime would not have to begin at a point and expand out in all directions from an almost infinitely dense singularity, a Planck-size quantum, or nothing blasting out in a big bang (Greene, 1999). Rather infinite space and eternal time would phenomenally *condense* many 'points' simultaneously (everywhere) within the unified field. The subtlest finite space would be the closest to the infinite eternal. In gross conventional spacetime, the infinite would appear completely hidden such that discrete, independent, localized finite objects are the predominant phenomena (Boyer, 2008).

In the holistic view in Maharishi Vedic Science the phenomenal universe and the capacity to experience correspond to each other. No new dimensions of space and time would be needed to account for the origins of local matter or even nonlocality if they are limitations within the unified field. Deeper nonlocal levels would not be hidden because they are enfolded spatial dimensions, but rather because they are subtler, unfurled, and permeate the grosser localized levels—again, like ordinary spacetime permeates concrete objects in it. What makes for subtle or gross domains would not be hidden extra spatial dimensions, in that they would be limitations of the infinite eternal already existing everywhere. Each grosser level would be permeated by, built of, background dependent upon, and emerge from, its subtler underpinning. Four-dimensional spacetime could be viewed as sufficient to provide the experiential framework for the senses of perception at all levels of phenomenal experience.

This view also is consistent with the contemporary model of space as flat, in the sense of extending in all three directions without being curved. As Greene (2004, pp. 249-50) notes:

> "Normally, we imagine the universe began as a dot… in which there is no exterior space or time. Then, from some kind of eruption, space and time unfurled from their compressed form and the expanding universe took flight. But if the universe is spatially infinite, *there was already an infinite spatial expanse at the moment of the big bang…* In this setting, the big bang did not take place at one point; instead, the big bang eruption took place *everywhere* on the infinite expanse… as though there were many big bangs, one at each point on the infinite spatial expanse. After the big bang, space swelled, but its overall size didn't increase since something already infinite can't get any bigger. What did increase are the separations between objects like galaxies (once they formed)… An observer like you or me, looking out from one galaxy or another, would see surrounding galaxies all rushing away, just as Hubble discovered… Bear in mind that this example of infinite flat space is far more than academic… [T]he flat, infinitely large spatial shape is the front-running contender for the large-scale structure of space-time."

Infinite space can be thought of as flat and infinitely extended in all directions. With respect to finite levels, however, space can be thought of as curved—such as into a sphere. In the holistic view in Maharishi Vedic Science, the mechanics of manifestation at all levels are characterized as the *self-interacting dynamics* of the unified field *curving back upon itself* (Boyer, 2008). At the unified level it can be associated with *infinite self-referral*, infinity in each point. At the ultramacroscopic level it can be associated with a *mandala* form (like a circle or sphere) as in the concept of *Hiranya garbha* or cosmic egg, the manifest nonlocal cosmic expanse within infinite eternal spacetime. At the ultramicroscopic level it can be associated with curving back into discrete units such as point particles, quanta, and atoms which comprise the microscopic and macroscopic phenomena of our ordinary physical world. As described in the Vedic text, Bhagavad-Gita, 9.8 (Maharishi Mahesh Yogi, p. 103):

> "Prakritim swam avashtabhya visrijami punah punah, Curving back upon My own Nature, I create again and again."

### *Spacetime as the infinite eternal would not 'blast out'*

In unified field theory everything condenses from within the unified field. The wholeness of the unified field is prior to any of the parts of nature. There would be no *outside* of the unified field if it is the eternal infinite that includes everything. The whole creates the parts, and the parts would remain *within* the whole. Both reductive and holistic perspectives are needed to get a sense of these proposed ultimate dynamics of nature involving both point value of nothing and infinite value of everything simultaneously. As stated in Katha Upanishad 1.2.20 (Nader, 2000, p. 18), the whole is both *smaller than the smallest and bigger than the biggest*—which can be described as point and infinity in one, beyond ultimate reductionism and holism.

From that ultimate perspective there might be individual big bangs with respect to specific black holes within conventional spacetime and ordinary gravity. With respect to the entirety of existence, however, the big bang would not be an explosion to something outside the unified field, because everything resulting from it would remain *inside* it. It would not create spacetime but rather be a limitation of the infinite eternal unified field—perhaps a '*big condensation*' but not a 'big bang' creating spacetime from literally nothing (Boyer, 2008).

**Conclusion and Outlook**

This paper outlined a progression of views of space and time from Newtonian, relativistic, quantum, quantum gravity, and cosmological to unified field theories in the search for room to place a causally efficacious conscious mind. The progression can be viewed as toward a holistic view of three ontological domains: the infinite eternal unified field, the subtle relative nonlocal field associated with information or mental space, and the gross relative local field of matter. These three theorized domains, consistent with the ontology drawn from ancient Vedic science, can be characterized as infinite self-interaction, nonlocal wave interaction with object interdependence (entanglement), and local particle interaction with object independence.

Scientific psychology and neuroscience have had great difficulty in trying to locate mind and consciousness in the physical structure of the brain/body. This research is now progressing more reductively into the quantum level underlying ordinary biophysical processes. Concurrently structural theories of an ontologically real quantum level of nature and an underlying information space or field of nonlocal mind have been developing in quantum physics. This is suggestive that an expanded ontology underneath conventional spacetime and beyond the physical is needed in which to place conscious mind. In this more expanded holistic view mind is theorized to be nonlocal and causally efficacious via subtle wave fields in nonconventional spacetime that influence phenomenally inert particles in conventional spacetime. For the first time in modern science a coherent rational framework may be emerging from which to address the historical mind-body problem and the causal efficacy of mind. The more expanded and holistic views of nature outlined in this paper, although in a quite promising direction, require extensive careful examination for their unprecedented implications for modern science and society.

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