# International Journal of Mathematics and Consciousness

Volume 7, Number 1
2023–2024

Consciousness Is All There Is:
The Physics of Non-Dual Reality

Dr. habil. Eckart Stein

Evolution Of An Entity: Elaborating On The Theory That Consciousness Is All There Is

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# International Journal of Mathematics and Consciousness

Volume 7, Number 1
2023–2024

CONTENTS



A Publication of Maharishi International University
Fairfield, Iowa



**ISSN 2376-6751**

*The International Journal of Mathematics and Consciousness* is an annual journal dedicated to the mathematical description and understanding of consciousness. Address correspondence to: *International Journal of Mathematics and Consciousness*, Department of Mathematics, Maharishi International University, Fairfield, Iowa, 52556, USA; email IJMAC@miu.edu.

## EDITORIAL INTRODUCTION TO THE JOURNAL

Throughout history, natural phenomena have been ultimately mysterious. Some of these phenomena were explained by religious belief, others by philosophical analysis. Since the 17th century, the modern scientific approach has found that many phenomena in nature obey clearly describable physical laws. This success greatly widened the ambit of scientific inquiry beyond the physical into the realm of what previously had been considered metaphysical or nonmaterial. Today, the territory of scientific inquiry has expanded to include how matter leads to consciousness.

Most common and popular models of consciousness share the postulate that physical activity in the brain is prior to consciousness. No current theory, however, has been able to resolve the problem of how physical processes in the brain give rise to subjective experiences. Even quantum mechanical theories, while suggesting potential mechanisms that might create "unexplainable" phenomena, fall short of answering the fundamental questions about subjective experience. This gap—between the objective, material brain and the intimately known, private qualia of subjective experience, or "what it is like" to experience something—has so far not been bridged. Some thinkers have even rejected qualia out of hand, asserting that we have insufficient knowledge of the physical world to evaluate their existence.

Some believe that early *Homo sapiens* depended entirely on sensory experience as a reference for what does and does not exist, and that only as our understanding evolved did we come to challenge the evidence of our senses. Certainly, the discoveries of modern science changed the way we looked at the world. They gave us intellectual models of the universe that often seemed to contradict our sensory model but which provided in fact more accurate pictures and were eventually confirmed by experimental observation.

Perhaps the most notable example is the shift from a geocentric to a heliocentric view of the cosmos as a result of the work of Copernicus, Kepler, and Galileo in the 16th and 17th centuries. More recently, inquiry into very small and very large time and distance scales in relativity theory, quantum mechanics, quantum field theory, and cosmology has radically changed our beliefs about the nature of matter and physical phenomena as our senses perceive and our intellects apprehend them. We may ask, what actually exists for us? And we may agree that everything is continuously changing; we may even agree that whatever appears not to change is only one of an infinite number of simultaneously existing possibilities. For example, in some models a particle can be everywhere at once, and the fact that we find it here and now suggests either that we have collapsed the infinitude of its possibilities in a single act of conscious experience or that it continues to exist everywhere in an infinite number of universes parallel to the one in which we experience it.

In all this uncertainty, one fact seems undeniable: the fact of our own awareness. Without awareness, we can neither perceive nor apprehend, neither see nor think nor dream. Commonly, this awareness is called consciousness: the observer, the witness, the experiencer. If indeed this is the one undeniable fact, then it is timely that a scientific journal be dedicated to the study of consciousness as primary.

To be truly scientific requires that the journal obey rigorous methods of logic, research, and experimentation. At the same time, this requires that no *a priori* or unproven points of view stand in the way of new original postulates, previously explored theories revisited with new insights, or unconventional axioms.

The *International Journal of Mathematics and Consciousness* is founded in part to fulfill this need. The *Journal* opens the door to all mathematicians, scientists, and thinkers to present their theories of consciousness and the consequences thereof. With the requirement that such theories follow strict mathematical, logical argumentation and respect proven facts and observations, articles can be submitted for review, without restriction to their proposed axioms and postulates. The *Journal* also welcomes carefully reasoned articles that challenge commonly held, but not fully established, theories and beliefs.

## 1. Consciousness and "Consciousness at work"

Abstract concepts and subjective experiences such as love, friendship, beauty, devotion, happiness, inspiration, pain, despair, and deception, are, in and by themselves, hard to study scientifically because of their innate, subjective, personal nature. Even more difficult to study is the more abstract consciousness that seems to be like a screen on which these emotions, notions, and sensations are projected and experienced.

Modern cognitive neuroscience identifies various neural correlates of these mental states. The discipline of psychology attracted great thinkers who proposed various theories and methods of investigation, mostly focusing on the manifestations, observable or subjectively reportable signs and symptoms, and causes and effects of such inner experiences. Physicists recently have attempted to bridge the gap between the physical world and conscious experience through various quantum mechanical models.

Philosophy, metaphysics, and spiritual and religious studies delve into ontological, epistemological, and other fundamental questions, using more or less formal logic or a wide variety of opinions and postulates. In contrast, art forms such as music, painting, and fictional writing are outer expressions of inner experiences and creative thinking.

All theories, concepts, and creative work, whether scientific, psychological, philosophical, artistic, or spiritual are the manifestations of "consciousness at work." While it might be challenging to study "consciousness" as such, in and by itself, it may be easier to study "consciousness at work"—its dynamics and its manifestations.

The postulates that can be made about consciousness as an abstract phenomenon or epiphenomenon are most amenable to investigation by scientifically analyzing and studying "consciousness at work." The *International Journal of Mathematics and Consciousness* invites analyses of consciousness at work from various perspectives with a particular emphasis on mathematics.

## 2. Mathematics

Mathematics studies abstract forms, patterns, relationships, and transformations in an exact, systematic, and logical way. Forms and shapes like circles and triangles are the subject of geometry and topology. Patterns of number and operations lead to algebra. Relationships that change in time form the basis of calculus. Mathematics also includes the study of mathematics itself. The study of mathematical reasoning is undertaken by logic. Even questions about the limits of the mathematical method and the nature of mathematical knowledge can be addressed using the methodology of mathematics.

Using mathematical models of experimental observations of the physical world makes it possible to give a purely abstract formulation of real-life phenomena. Subjective mathematical reasoning, which is nevertheless entirely rigorous, applied to these models leads to new descriptions and predictions about the world.

Mathematics is fundamentally a method that finds patterns of orderliness in the subjective field of human intelligence and thought. Based on sets of axioms and postulates that are accepted without proof, mathematics gives a structure to the way our minds and intellects operate. It systematizes how individual human awareness perceives, discriminates, organizes, and expresses its own patterns of functioning. In our opinion, mathematics is certainly one of the most useful and scientifically manageable methods to study the interface between consciousness and physical phenomena.

Mathematics is in essence a subjective discipline that nevertheless allows us to organize and make sense of the physical universe in which we exist. Though subjective, it is precise and effective in objective scientific explorations. It is a fundamental and indispensable tool of all sciences, and at the same time, it is an expression of abstract human awareness and intellect.

## 3. Mathematics and Consciousness

The *International Journal of Mathematics and Consciousness* takes the position that methods of mathematics and mathematical modeling provide especially appropriate tools for studying the interface between consciousness and physical phenomena. As we have pointed out above, mathematics is a fundamental and indispensable tool of all sciences, and at the same time an expression of abstract human awareness and intellect. It is therefore the most precise scientifically reliable tool in the exploration of the dynamics of consciousness. It can be seen as the precise abstract representation of consciousness at work.

The ways in which human beings explore and express the experience of consciousness are as varied as nature itself. The following list contains some of the relevant sciences and other forms of human inquiry:

(1) Physics and chemistry (physical/quantum mechanical theories of consciousness at work)
(2) Biology and cognitive neuroscience (biological/electro-chemical/neural correlates of consciousness at work)
(3) Mathematics (abstract representation of consciousness at work)

(4) Psychology and cognitive sciences (objectification of subjective experiences of consciousness at work)
(5) Economics, particularly behavioral economics (production, distribution, and consumption of resources as models of the dynamics of consciousness at work)
(6) Philosophy (discursive representation of consciousness at work)
(7) Arts (subjective creative representation of consciousness at work)
(8) Religion (individual/group belief in the origins and dynamics of consciousness and consciousness at work)
(9) Spirituality (personal and totally subjective experience of consciousness at work)
(10) Study of pure consciousness itself (the field or screen "phenomenon" on which or by which all aspects of consciousness at work take place)

The *International Journal of Mathematics and Consciousness* maintains the position that of all such pursuits, mathematics, because of its rigor, depth, and effectiveness, is the most suitable discipline to study the interface between consciousness and the physical world. This *Journal* is devoted to exploring this interface using the rigorous approach of mathematics. We invite all mathematicians, scientists, and thinkers to submit papers using a mathematical approach to consciousness and "consciousness at work" in all its aspects.

Tony Nader, MD, PhD, M.A.R.R.

# CONSCIOUSNESS IS ALL THERE IS: THE PHYSICS OF NON-DUAL REALITY

DR. ECKART STEIN

Abstract. Consciousness is all there is—this is the proposal of Dr. Tony Nader presented in an article on mathematics and consciousness in the first volume of this Journal and in the book *One Unbounded Ocean of Consciousness.* This non-dual definition of consciousness goes back to the tradition of Vedānta. The Upanishads proclaim: *Brahm is the One without a second. Manifest variety is unmanifest—there is nothing else.* We discuss this statement from the perspective of physics. We conjecture that the question *If consciousness is all there is, then how is it that consciousness becomes physical?* has the same answer as the question *How does the quantum universe become the classical universe?* Having addressed this point, we proceed to demonstrate that the postulates underlying quantum physics closely parallel those proposed to define consciousness in the work of Nader [15]. Given that quantum physics is fundamentally concerned with the description of the material world, this correspondence suggests that matter can be understood as an expression——or structured manifestation——of consciousness. More pointedly, if one assumes that a quantum universe is the only consistent formulation of physical reality, then it follows that the universe itself and all its parts may be interpreted as consciousness.

## 1. Introduction

The discussion of the connection between consciousness and quantum physics is as old as quantum physics itself. In contrast to classical physics, the observer is assigned a special role here. The very act of observation affects the physical system, and thus the question "Who or what is the observer?" arises in a very natural way. And this ultimately requires understanding of what Einstein called the "ganzer langer Weg"—the long path from the observed to the observer's consciousness.

This debate ultimately is subject to two fundamental problems: There is no agreement in science as to what consciousness is, and there is no agreement in science as to how to "understand" quantum physics.

In this article we will follow the non-dualistic Vedāntic approach to consciousness [15]: *Consciousness is all there is; there is nothing else.* Therefore from the very start we have to follow a non-dualistic approach also to physics: *Quantum is all there is; there is nothing else.* This rejects from the outset the essential dualistic or



Received by the editors June 3, 2024.

1991 *Mathematics Subject Classification.* 81P05, 81P15, 81P40, 81P65, 03A05, 00A30.

*Key words and phrases.* Consciousness, Evolution, Nader's Theory, Quantum Mechanics, Veda, Vedic Philosophy.

The author would like to thank Peter Swan for numerous insightful discussions and for proofreading the manuscript.

"external observer" formalism of quantum physics, even though this is the standard formalism of quantum theory as presented in most textbooks today, commonly known as the Copenhagen interpretation. In the Copenhagen setting we have on one hand the quantum mechanical system under study, and on the other hand the ultimate classical observing equipment outside that system. See Figure 1.

Upon observation the wave function collapses to one of the eigenstates of the possible outcomes; the result of any experiment can be predicted only with a certain probability that can be calculated from a wave function. So the theory is dualistic and non-deterministic in nature. In this approach it is commonly assumed that consciousness resides somewhere in the brain of the observer; the quantum physical system itself is not necessarily assigned a reality on its own, but comes into being only when observed.

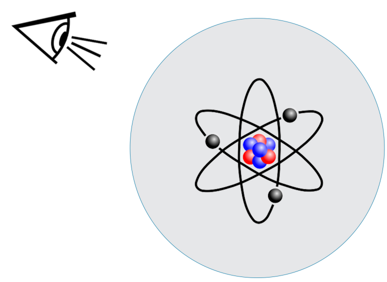

FIGURE 1. An external observer studies a quantum physical system. The apparatus of observation is a macroscopical device. The quantum object is described by a wave function that collapses upon observation to one of the possible outcomes. Quantum physics allows for the calculation of probabilities. This is the essence of the Copenhagen formulation and is the version of quantum physics most commonly taught.

This view of quantum theory as merely describing stochastic dynamics on a microscopic level embedded in an otherwise classical world leads to the well-known wealth of "paradoxes" such as Schrödinger's cat or the spooky action at a distance (the EPR-experiment) [6]. The most famous critic of this theory is Einstein himself with his famous declaration, "God does not play dice."

The Copenhagen interpretation also triggered a debate as to whether the conscious observer collapses the wave function just by attention. Or as Einstein put it: "Is the moon there only when I look at it?"

Now what happens if we consider a quantum universe? In such a universe there cannot be an outside observer, because everything is inside the system. There cannot be a border between the classical and the quantum domain—everything is quantum. If there is a classical world, it can only be a result of the quantum field interacting within itself.

Such a radical departure from our classical worldview was proposed by Everett in his seminal paper in 1957 in which he presented a "relative state formulation of quantum theory" [8]. Measurements are then nothing more than interactions within the system. The special role of an outside observer no longer exists. Every observer is treated as being within the quantum system according to the rules of quantum physics.

Conceptually, this was a revolutionary approach. One has to realize that it departs from Einstein's maxim which defines physical reality as that which exists independent of the observer. For Einstein, "Physics is an attempt conceptually to grasp reality as something that is considered to be independent of its being observed. In this sense one speaks of 'physical reality'" [7].

In the Everettian approach, however, the observer is by definition part of the physical reality. Wheeler, Everett's doctoral advisor, has compared this break with the traditional view to the great paradigm shifts in physics: Newton suddenly associated gravity with action at a distance; Maxwell described this action at a distance by a Theory of Fields; and Einstein completely denied the existence of a privileged coordinate system at all [21].

Through the postulate *Quantum is all there is* the observer becomes part of the universe with which he interacts, and he himself is only defined relative to the rest of the totality of the universe. See Figure 2.

If we want to find a Vedāntic approach to physics, this is clearly the way to go.

## 2. Consciousness is all there is

The essence of Vedānta is that there is one ultimate reality that is all-pervading, and all the forms and different spheres of the phenomenal world are nothing but manifestations of that unmanifest reality of absolute nature. This ultimate reality is *one* consciousness that appears in the multitude of all possible forms.

It is interesting to note that Schrödinger himself was a proponent of the Vedāntic worldview [18].

Schrödinger writes, referring to different conscious experiences: "There is obviously only one alternative, namely the unification of minds or consciousnesses. Their multiplicity is only apparent, in truth there is only one mind. This is the doctrine of the Upanishads." And "Consciousness is never experienced in the plural, only in the singular. Not only has none of us ever experienced more than one consciousness, but there is also no trace of circumstantial evidence of this ever happening anywhere in the world."

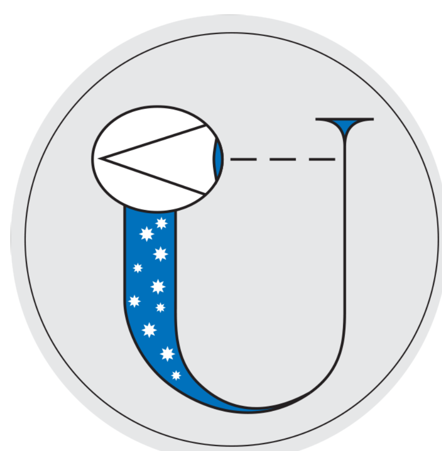

Figure 2. In the non-dual quantum universe the observer is treated as being inside the system—observations are relative correlations within the quantum system. This figure is taken from [24].

Despite Schrödinger's deep engagement with consciousness and Vedāntic philosophy, most physicists today shy away from such discussions, citing the lack of a clear scientific definition—even though conscious experience is something everyone knows directly from within.

## 3. Quantum is all there is

We want to emphasize that the notion "quantum is all there is" does not imply that the world is made out of discrete particles and quantum jumps. Technically it means we restrict ourselves to the basic postulates of quantum theory and deal with the classical as an emergent phenomenon. Later we will see that, on the contrary, this suggests that there are no particles and no quantum jumps [23].

In Everett's approach there is one quantum state that is all that there is, and only through interaction within itself, from that abstract quantum state, the classical world emerges. Let us see how far we can get in relating that abstract quantum system to consciousness.

First we outline how the physical (or classical) world arises from an unmanifest quantum substrate. We will do that briefly, mainly summarizing the current understanding in the scientific community. We also want to make clear what is accepted in the community and what is still subject to debate.

Taking the Vedāntic approach will allow us to shed more light on this discussion, which in a sense suffers from the inability to experimentally decide which of the different understandings is correct and which is not. Even Schrödinger himself mentioned that to advance that understanding, referring to the subjective science of consciousness would help [18]:

"Our [Western] science has cut itself off from an adequate understanding of the Subject of Cognizance, of the mind. This is precisely the point where our present way of thinking needs to be amended, perhaps by a bit of blood-transfusion from Eastern thought."

## 4. Postulates of quantum physics

In a non-dualistic quantum theory the postulates become surprisingly simple:

(0) There are quantum systems.
($i$) The state of a quantum system is represented by a vector $\psi$ in Hilbert space.
($ii$) Evolution of the system is unitary, that is, it is generated by a Schrödinger equation.

We emphasize that these postulates form the foundational core of all quantum theories, whether in the context of non-relativistic quantum mechanics, relativistic quantum field theory, or quantum gravity.

Postulate (0) usually is taken for granted; it simply means that we can consider different systems inside the universe. For something to actually happen one has to allow for the universe to be separated into systems [25].

The postulates ($i$) and ($ii$) are first and foremost completely abstract mathematical formulations. The notion of Hilbert space is a generalization of the mathematical tools that we are familiar with to describe the three-dimensional space we experience daily. Three-dimensional space we can formalize on the basis of three orthogonal vectors. This mathematical construct is called $\mathbb{R}^3$, which itself is one of the many possible Hilbert spaces. Roughly said, if we extend the mathematical concept of the three-dimensional space into arbitrary dimensions (including infinite dimensionality) and generalize the basis vectors to more general mathematical structures, again we have a Hilbert space, which however completely escapes our visual imagination.

Postulate (*ii*) then says that all we are considering are rotations of state vectors in that abstract Hilbert space, and these rotations are determined by a Schrödinger equation:

$$i\hbar\frac{\partial}{\partial t}\left|\psi(t)\right\rangle = H\left|\psi(t)\right\rangle \tag{4.1}$$

where $H$ is the Hamilton Operator of the system. Roughly speaking, the Hamiltonian corresponds to the total energy of the system, the sum total of all kinetic and potential energy—the evolutionary force that drives the development of the state vector at time $t_0$ to the state vector at the later time $t$.

The solution to this equation is:

$$\left|\psi(t)\right\rangle = U(t)\left|\psi(t_0)\right\rangle \tag{4.2}$$

where $U(t)$ describes the unitary transformation (rotation) of the state $\left|\psi(t_0)\right\rangle$ at time $t_0$ to the state $\left|\psi(t)\right\rangle$ at time $t$. Knowing the system at time $t_0$ the Schrödinger equation allows us to calculate the system at a later time $t_1$. Everything is completely deterministic as in any classical theory and unless additional postulates are added the theory will stay deterministic. So what is it that makes quantum physics special? Again, in a classical theory we would have certain equations of motions that describe the movement of particles in our three-dimensional space, which we can visualize. Rotations of abstract state vectors in an abstract mathematical space requires us to take some further steps to relate that to our experience.

Before we do that, let us highlight some general consequences of these postulates: the principles of superposition and entanglement.

## 5. Superposition

The Schrödinger equation Eq. (4.1) is linear, and therefore the superposition principle holds. If the state vectors $\left|s_1\right\rangle$ and $\left|s_2\right\rangle$ solve the equation, then any linear combination of these vectors again is a solution:

$$\left|\psi\right\rangle = a_1\left|s_1\right\rangle + a_2\left|s_2\right\rangle \tag{5.1}$$

where $a_1$ and $a_2$ are complex numbers. While this is well known for solutions of classical linear equations such as electromagnetic wave equations, this superposition principle turns out to be one of the peculiarities of quantum physics that still puzzles physicists. For an explanation see Figure 3. Schrödinger put this in the spotlight in his famous thought experiment: If the states "cat alive" $\left|\smiley\right\rangle$ and "cat dead" $\left|\frownie\right\rangle$ are permissible, then the state "cat dead and alive" $1/\sqrt{2}(\left|\smiley\right\rangle + \left|\frownie\right\rangle)$ must also be a legitimate state. So how is it that, while we observe microscopic superpositions, we never see macroscopic superpositions? The answer became known under the concept of "decoherence."

Before explaining what is meant by decoherence, let us shed light on a very special form of superposition that has become even more famous: "entanglement."

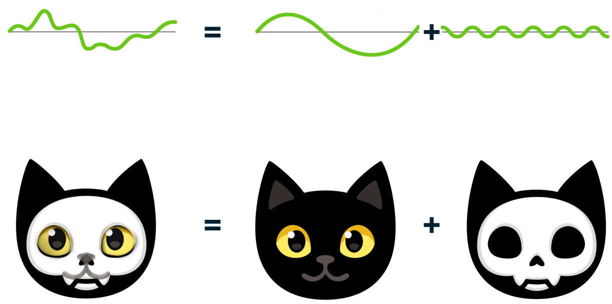

FIGURE 3. The superposition principle is another special feature of quantum physics. If there are two solutions of the Schrödinger equation of the system, then also every linear combination of these solutions is again a legitimate solution. In our figure we have the superposition of waves, which is well known from classical physics, which however becomes strange if we consider superpositions of other objects, such as the infamous Schrödinger cat, that is the result of the superposition of a dead and a live cat.

## 6. Entanglement

The most peculiar consequence of the mathematical structure of quantum physics is entanglement. This name was coined by Schrödinger (German "Verschränkung"). Schrödinger writes [17]: "When two systems, of which we know the states by their respective representatives, enter into temporary physical interaction due to known forces between them, and after a time of mutual influence the systems separate again, then they can no longer be described in the same way as before, viz. by endowing each of them with a representative of its own. I would not call that *one* but rather *the* characteristic trait of quantum mechanics, the one that enforces its entire departure from classical lines of thought."

A superposition is a linear combination of basis states in a single system's Hilbert space, such as in Eq. (5.1) reflecting the system's potential to yield different outcomes upon measurement.

Entanglement arises when the joint state of a composite system cannot be factorized into a product of individual subsystem states.

While superposition captures coherence within a single degree of freedom, entanglement encodes nonlocal correlations between distinct subsystems.

It is interesting to note that, firstly, entanglement is the feature of a quantum universe, but, secondly, it is exactly the nature of entanglement that gives rise to the appearance of a world that we perceive as a classical world.

## 7. Decoherence and the measurement process

Entanglement means that two or more systems that start to interact form a new entity that is different from its constituent systems. However, if we follow our assumption that consciousness is all there is, or quantum is all there is, then from the start we only have one single entity, one system, the evolution of which is determined by the Schrödinger equation.

It is interesting to note that as long as we deal with one single indivisible quantum system all interpretational problems of quantum physics do not arise.

In other words, as long as there is no observer or measurement, nothing spectacular happens [25]. The Schrödinger equation Eq. (4.1) is completely deterministic, and according to Eq. (4.2) the evolution of the state vector $\psi$ can be calculated to predict the future—there is no randomness, no indeterminacy. Or in other words, if we consider the evolution of the totality of the universe as a whole, everything is set.

The physical world appears only if we start to slice that absolute system into pieces. Note that it is not merely the partitioning into subsystems but effectively losing the vision of the whole. We do separate into systems by invoking postulate (0) of quantum physics "There are quantum systems." Only then can we meaningfully speak of relative correlations within the system.

Decoherence now proclaims that the minimal number of systems that we need for a useful description of a quantum system is three. Dividing a system only into observer and object of observation does not eliminate from the theory the spooky cat that is dead and alive at the same time.

This requirement that for a consistent treatment of the measurement process three systems are needed was noted by the German physicist Zeh in 1970 [22]. Firstly: The observer himself should be treated as a quantum physical system, since after all, all his constituents (atoms, electrons, photons, and so on) are also quantum objects. Secondly: Neither the observer nor the observed system is free from interaction with the environment (the rest of the universe). Thirdly: The quantum system is under observation itself.

Therefore, not only the observer and observed system, but also the complete interaction between observer and observed, should be taken into account and this is channeled and influenced by the environment, since whatever tiny molecule will interfere with the process of observation will alter the outcome. We therefore also consider the environment $|\mathcal{E}\rangle$ in addition to the state of the observer $|\mathcal{O}\rangle$. Strictly speaking the environment is the sum total of all other "observers" that are "watching" what is going on in the relation between observer and the system.

Therefore consider a Hilbert space consisting of an observer, a system that is being observed, and the rest of the universe, which we call the environment.

$$\mathcal{H} = \mathcal{H}_{\mathcal{O}} \otimes \mathcal{H}_{\mathcal{E}} \otimes \mathcal{H}_{\mathcal{S}} \tag{7.1}$$

Note that this is a mathematical application of postulate (0) "There are quantum systems" where we attributed to observer $|\mathcal{O}\rangle$, observed system $|\mathcal{S}\rangle$, and all interactions in between, the environment $|\mathcal{E}\rangle$ of separate Hilbert spaces. The total system is the direct product of these three Hilbert spaces.

We consider first a physical system under observation that we somehow have disentangled from the rest of the universe.

And this state should be in a coherent state—let us call it a "cat-state," the superposition of a dead and a live cat $|\circleddash\rangle$.

$$|\circleddash\rangle = \frac{1}{\sqrt{2}}(|\smiley\rangle + |\frownie\rangle) \tag{7.2}$$

Decoherence explains why we do not see such a state under practical circumstances.

Now, if we want to observe this state in the Copenhagen approach, the classical observer would through the process of observation destroy the superposition, that is, collapse the wave function and observe only one of the possible outcomes: A cat that is either alive or dead. The result could be predicted only with a certain probability. In this example there should be a 50% chance to see the cat alive and a 50% chance to see the cat dead, but never would we observe a cat that is dead and alive at the same time.

For the product Hilbert space consisting of observer, environment, and cat-state (the observed system), $|\mathcal{O}\rangle\,|\mathcal{E}\rangle\,|\circleddash\rangle$ we can write

$$|\mathcal{O}\rangle\,|\mathcal{E}\rangle\,|\circleddash\rangle \quad \overset{decoherence}{\longrightarrow} \quad |\mathcal{O}\rangle\left(|\mathcal{E}_{\smiley}\rangle\,|\smiley\rangle + |\mathcal{E}_{\frownie}\rangle\,|\frownie\rangle\right) \tag{7.3}$$

where $\longrightarrow$ is a short notation for the fact that we evolve the combined system with the unitary operation (4.2).

What was shown by Zeh [22], Zurek [26], and others is that the unavoidable entanglement with the environment singles out stable over unstable states. In our example the cat state is not stable under the interaction with the environment—the coherence gets lost and a dead or a live cat are the only possibilities that an observer could see. Or stated differently: Before the observer is able to glimpse a cat that is dead and alive at the same time, the interaction with the environment has destroyed this delicate state. See Figure 4. The decoherence time for a system at centimeter size and at typical room temperature would be less than $10^{-23}$ seconds [24].

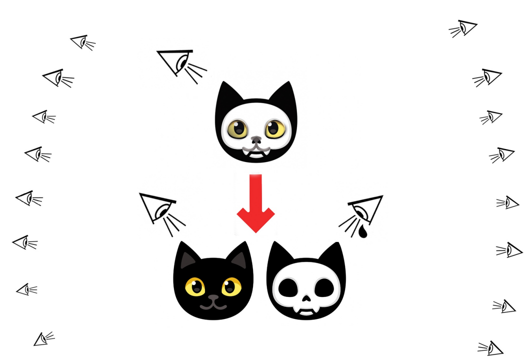

FIGURE 4. Schematic illustration of decoherence and the quantum measurement process: Under all practical circumstances a so-called cat state, the superposition of a dead and a live cat, is never isolated from the environment. The environment provides multiple observers (air molecules and so on) that themselves start to entangle with the cat state, as a result of which it loses its coherence, and upon observation only two possibilities remain: The observer sees a live cat, or as the other possibility he sees a dead cat.

The near-instantaneous timescale of decoherence highlights a profound insight: when the environment is properly included, quantum theory operates without discontinuities. In this view, quantum jumps and particles vanish as fundamental entities.

The apparent discontinuities in time (quantum jumps) and in space (particles) follow objectively from the continuous process of decoherence [23].

Upon observation—that is, the interaction of the cat state that has lost its superposition of a dead and a live cat with the observer—the system branches out into a system where one observer observes a live cat $|\mathcal{O}_{☺}\rangle$ and another observer who observes a dead cat $|\mathcal{O}_{☹}\rangle$. So continuing from Eq. (7.3) upon observation we arrive at

$$\xrightarrow{measurement} |\mathcal{O}_{☺}\rangle\,|\mathcal{E}_{☺}\rangle\,|☺\rangle + |\mathcal{O}_{☹}\rangle\,|\mathcal{E}_{☹}\rangle\,|☹\rangle \tag{7.4}$$

This leads us to the next consequence of a purely quantum physical universe that later became known as the "many worlds interpretation," since according to Eq. (7.4) now we see that both possible outcomes—the observation of a dead and the observation of a live cat—are potentially realized.

## 8. Many worlds

In the non-dual approach we are following here, there is nothing but a universal state vector evolving according to a Schrödinger equation. There is nothing else, no external observer and no collapse of a wave function. This is the essence of Everett's approach. Everything is quantum.

Decoherence fits perfectly into this framework, as the relative correlations within the system lead to what we perceive as the classical world—the world that allows for either dead or alive cats, but not a superposition of the two.

However, this approach comes at a cost: Basically, it predicts that all alternatives consistent with the initial conditions of the general wave function will be realized. In our example, unitary evolution branches the initial state of the observer $|\mathcal{O}\rangle$ into one observing the living cat $|\mathcal{O}_{☺}\rangle$ and one observing the dead cat $|\mathcal{O}_{☹}\rangle$. At this point the question again arises: who or what is the observer? We will come to this point later when we address the question in the context of Nader's "consciousness is all there is" approach [15].

In the original paper of Everett there is no emphasis on "many worlds"—the phrase is not even mentioned. Only later did others popularize that term and only the concept of decoherence (Zeh and later Zurek) made this approach acceptable to parts of the physics community. It was decoherence that solved the "preferred basis" problem of the Everett approach.

Note that even Zeh's seminal paper that introduced decoherence [22] was initially rejected by several journals during 1967 with the usual answer *quantum theory does not apply to macroscopic objects.*

We wish to emphasize, however, that the quantum universe becoming a field of all possibilities is not merely a fanciful notion proposed by physicists, but rather a direct mathematical consequence of the assumption that quantum reality is all there is—an assumption encoded in the postulates presented in Section 4, when applied to the universe as a whole.

## 9. Probability

In the Copenhagen interpretation, the wave function does not describe ontological reality itself. Rather, it encodes what we might know about a physical system. Only upon observation is the wave function abruptly transformed into an observed particle.

This evokes Einstein's famous question: "Is the moon only there when I look at it?" The outcome of a single quantum event cannot be predicted; instead, we can only calculate the probability of a particular result. This is done using Born's rule, which states that the probability of a quantum event—such as finding a particle at a specific location—is proportional to the square of the amplitude of the particle's wave function.

In the non-dual approach there is no randomness, no uncertainty; everything is set, and everything that can occur will occur. Note that this does not mean randomness; we have a gigantic superposition that splits into all the alternatives that are consistent with the initial conditions.

However, seen from the perspective of the single observer who sits on one of the branches—one of the possible alternative outcomes—the quantum event looks as if driven by randomness. This was discussed by different authors, who derived Born's rule in the framework of Everettian quantum physics. See [19] and references therein. Note that here the Born rule, which is usually taken as a postulate, has been derived as a consequence of the structure of quantum physics.

## 10. My world

So far we have taken a bird's-eye perspective onto this "many worlds universe." Physicist Roger Penrose of the University of Oxford calls this the *Omnium*, the superposition of all possibilities in the state vector of the universe. How does this universe look from inside, from the frog perspective, from the observer who is inside the system? If we consider the state $|\psi_I\rangle$ representing the observer $I$ then $\langle\psi_I\,|\Psi\rangle$ is the branch of "my" world; this is my point of view of the universe, and I only see my reality—in my world there is only the cat that is alive. For me there is absolutely no possibility for interacting with or observing the other possible world, where the cat did not survive. Decoherence separates myself from all the other possible worlds.

From the previous discussion, we have seen that for the classical world to emerge we need to have three components: the observer, the system that is being observed, and the interaction between the two. We have also seen in previous discussion on decoherence, that the interaction between observer and observed is colored by the environment, which is the channel for that observation. Therefore we considered a Hilbert space consisting of an observer, a system that is being observed, and the rest of the universe (which we call the environment) which channels the interaction; see Eq. (7.1).

The general state of the universe is then written as the sum of all possible observers, systems of observation, and corresponding environments according to

$$|\Psi\rangle = \sum_{i,j,k} a_{i,j,k}\,|\psi\rangle_i\,|\phi\rangle_j\,|\omega\rangle_k \tag{10.1}$$

where $|\psi\rangle_i$, $|\phi\rangle_j$ and $|\omega\rangle_k$ are the basis vectors for the observer, the environment, and the system, respectively. My point of view is then given by:

$$\langle\psi_I\,|\Psi\rangle = \sum_{j,k} a_{I,j,k}\,|\phi\rangle_j\,|\omega\rangle_k \tag{10.2}$$

where we have assumed an observer basis where $\langle\psi_I\,|\psi_i\rangle = \delta_{Ii}$. Equation (10.2) is my view of the universe: The sum total of all my environment, and all my possible observations.

Note that in Eq. (10.2) the point value of the ultimate observer is meant to be the point value of consciousness—the awareness that uses the brain to think, the hand to write, the eyes to see. Brain, hand, eyes are part of the environment, or if observed, part of the observed system. So what is it that observes?

## 11. Quantum physics and consciousness

In the Copenhagen interpretation we do have an a priori "classical world" which serves as an observer for the strange quantum domain. This quantum domain is driven by randomness and has no physical reality unless observed by a classical observer who registers only one of all the possible outcomes of a measurement. What consciousness is, remains mysterious. The observer can be the classical measuring apparatus or the brain or the eyes of the observer, and so on.

However, in the non-dual "quantum is all there is" approach there is no randomness and no need for a border between quantum and classical reality. Instead the classical is an emergent quality of the quantum world. The observer is always inside the system and therefore consciousness is also integral to the system.

The quantum world is "real," deterministic—but it is also a field of all possibilities, sometimes called many worlds.

So how does it come that we see and experience only one of the myriads of possibilities, only one world?

The answer to that must and only can be found in the answer to "What is consciousness?"

"Even if one accepts 'many worlds'," says Roger Penrose, "one needs a theory of consciousness, in effect, to explain the physics that we actually perceive going on in the world." "Without it," he argues, "the many-worlds theory is putting the cart before the horse" [3].

In general, physicists shy away from consciousness because consciousness usually is seen as the result of complicated interactions in the human brain that would be far too complex to be addressed with the conventional mathematical tools of physics.

However, if one follows the *consciousness is all there is and there is nothing else* approach as proposed in [15], everything becomes surprisingly simple.

For what follows, we assume that the reader is more or less familiar with the "consciousness is all there is" paradigm.

Rather than going into the details of this non-dual approach, we will simply compare the postulates of quantum physics and the axioms defining consciousness presented in [15] which read:

- **Axiom 1** $\mathcal{C}$onsciousness exists, $\mathcal{C}$onsciousness is all there is, and $\mathcal{C}$onsciousness is conscious.
- **Axiom 2** $\mathcal{C}$onsciousness = $\mathcal{C}$onsciousness($O^R = ALL^R$, $O^G = ALL^G$, $O^D = ALL^D$)
- **Axiom 3** For each entity $E$, there exists a self $s_E$, called the *self of E*, defined by $s_E = s_E(M_1, M_2, ..., M_k; P_1, P_2, ..., P_m; N_1, N_2, ..., N_n)$.

Axiom 1 postulates, firstly, the existence of consciousness, and secondly, that there is nothing else but consciousness. Thirdly, the quality of consciousness, "to be conscious," is elaborated in [15]: "We mean that there is an observer, an observed, and a process of observation linking the observer and observed." This is basically the content of Axiom 2. Axiom 2 defines consciousness as the triple of all observers $ALL^R$, all observing $ALL^G$ and all that is observed $ALL^D$. This clearly corresponds to the factorized Hilbert space that we find in Eq. (7.1) and Eq. (10.1). Axiom 3 then defines the point value of consciousness, the individual self.

How does this relate to the postulates of quantum physics in Section 4? Note that we do not say the state vector $\psi$, the wave function of the universe, is all that there is, and therefore we equate it with consciousness—instead we argue that the postulates of quantum physics presented here are fully equivalent to the axioms describing consciousness in [15] and therefore that what is described by quantum physics—the physical world—in reality is nothing but consciousness.

Postulate $(i)$ and postulate $(ii)$ of Section 4 correspond to Axiom 1 of $\mathcal{C}$onsciousness. If we then apply postulate (0), we can derive Axiom 2 and Axiom 3.

Postulate $(i)$ asserts the existence of a fundamental entity that constitutes "all that there is": the state vector $\psi$. This pure existence is not arbitrary—it has a specific nature, determined by the fact that it evolves according to the Schrödinger equation, as stated in postulate $(ii)$.

So far these two postulates do not lead to any dynamics. Dynamics only arise if we invoke postulate (0) which states that we can separate "that which is all that there is" into systems and it is the dynamics of these systems relative to each other that gives rise to the classical world.

Only in conjunction with postulate (0)—that there are quantum systems, meaning that we can divide the totality into subsystems—does the appearance of the physical, or classical, world emerge.

Experience then shows, Eq. (7.1), that the minimum number of systems is three. And therefore it follows from the postulates of quantum theory that the minimal formula to describe the general state of "all that there is" is given in the form of Eq. (10.1), which in turn is completely equivalent to Axiom 2 in [15].

Eq. (10.2), which here is just a simple consequence of the quantum theoretical postulates, then corresponds to Axiom 3 in [15].

The following table summarizes the key points discussed above, offering a comparative overview of Nader's theory of consciousness and non-dual quantum physics.

| **Nader´s Theory of Consciousness** | **Non-dual Quantum Physics** |
|---|---|
| **Axiom 1:** $\mathcal{C}$onsciousness exists, $\mathcal{C}$onsciousness is all there is, and $\mathcal{C}$onsciousness is conscious | **Postulate *(i)* and *(ii)*:** There is a state vector $\psi$, which is universal, and its nature is given by its mathematical structure, namely Hilbert space and Schrödinger equation |
| **Axiom 2:** $\mathcal{C}$onsciousness is the sum total of all observers, all observing, and all observed: $\mathcal{C}$onsciousness = $\mathcal{C}$onsciousness($ALL^R$, $ALL^G$, $ALL^D$) | **Postulate (0):** The Hilbert space and wave function separate into subsystems—the simplest being observer, observed, and the environment: $\vert\Psi\rangle = \sum_{i,j,k} a_{i,j,k} \vert\psi\rangle_i \vert\phi\rangle_j \vert\omega\rangle_k$ |
| **Axiom 3:** Singling out one observer gives the individual a (limited) point of view on the world. $s_E = s_E(M_1, ...; P_1, ...; N_1, ...)$, the sum over all Modes, Patterns and Networks | Applying the postulates (0), ($i$), and ($ii$) we project out one individual observer $\langle\psi_I \vert\Psi\rangle = \sum_{j,k} a_{I,j,k} \vert\phi\rangle_j \vert\omega\rangle_k$ leading to the sum over all his observations and environments |

## 12. Nader's theory of consciousness, quantum physics and Vedānta

**Axiom 1:** *Consciousness is all there is.* This corresponds to Postulate (i) and (ii). *Argument:* If the universal wave function $\psi$ is the only real thing, and it evolves without reference to any "outside," then it is ontologically primary. No external classical observer is required or allowed. This matches the idea of a non-dual, self-contained consciousness. There's no "stuff" outside of $\psi$, just as there is no "world" outside of consciousness in Vedānta.

**Axiom 2:** *Consciousness knows itself by being both observer and observed.* This corresponds to Postulate (0). The observer is not external to the system—it is a part of the system entangled with the rest. The "experience" of the observer is encoded in its interaction with observations and its environment. This means the universe knows itself by internal differentiation, which is Vedānta's point in Axiom 2.

**Axiom 3:** *All multiplicities are points of view within consciousness.* This branching structure is precisely the multiplicity of experiences within a single universal wave function. No branches are "outside" consciousness—they are all facets of the universal $\psi$. This is what Vedānta asserts: multiplicity is an appearance within one unbounded ocean of consciousness.

## 13. Conclusion

In this paper, we have reviewed the structure of quantum theory—a framework for which, over the past hundred years, no experimental evidence has emerged to call its validity into question or suggest that its predictions might ever fail to be confirmed. Notably, even those arguments historically raised against the completeness of quantum theory—most prominently the Einstein-Podolsky-Rosen (EPR) paradox—have led to experimental tests, such as Bell-type experiments, that have consistently confirmed the predictions of quantum physics and ruled out local hidden variable theories.

Instead, the quantum description of the world, initially thought to be relevant only to atomic and subatomic domains, has been shown to exhibit measurable effects on massive macroscopic scales.

Recently, deterministic quantum entanglement has been measured in macroscopic objects of the order of the diameter of a human hair [13]. A gravity-wave detector must be treated as a quantum harmonic oscillator even though it may weigh a ton [2].

Apart from being so successful in its practical application, quantum theory still suffers from a fundamental problem of understanding associated with the so-called quantum measurement paradox, and this lack of understanding is deeply connected with the unavoidable role a conscious observer plays.

In this contribution we have shown that this fundamental problem is easily solved by following the proposal of Nader that "consciousness is all there is."

We have shown that the paradigm "consciousness is all there is" is equivalent to the paradigm "quantum is all there is."

We have done so by deriving the axioms on consciousness presented in [15] from the basic postulates of quantum physics.

The relevance of this finding is straightforward and important in many ways.

In physics: Since there is a complete theory of "consciousness is all there is," this allows for inspiration in the field of physics. It helps to sort out which of the many interpretations of quantum theory align with it and which probably do not (See Appendix B). It further provides direction in assessing and comparing competing approaches to a unified theory of physics, or "Theory of Everything" (see Appendix C). Additionally, it recasts the quantum measurement process not as a conceptual problem or paradox, but as a natural and well-defined consequence of unitary quantum evolution. Importantly, it poses a substantial challenge to the physical sciences by implying that, in principle, mental phenomena should be amenable to formal treatment within the mathematical structure of quantum theory.

In social and physiological science: This proposal bridges the gap between physical, social, and physiological sciences. Simple questions of how a conscious thought might influence matter (such as, I am now going to lift my arm) are still deep mysteries. Or: Why and how does my conscious brain activity change the physical structure of my brain? Nobody knows. With the shift of paradigm proposed by Nader [15], answers to those questions become almost trivial.

The simple postulates of quantum theory—and the understanding that they are equivalent to those that define consciousness—lead to far-reaching implications. While the theory is, on the one hand, fully deterministic in its evolution, it also rests on a foundation that presents a field of all possibilities.

Thus, despite its deterministic nature, quantum theory offers the observer a form of freedom: the freedom to choose among the many possible "Everett branches."

Therefore even though completely deterministic, it opens the gate to free will, the freedom of choice.

The discussion of all these consequences and a more comprehensive review of the parallels with the science of consciousness will be elaborated in a future publication. However, to deal with some of the more obvious questions, we have added an Appendix in the form of frequently asked questions.

## Appendix: frequently asked questions

A. **How does all this relate to the Unified Field?** In the search for a theory of everything, one typically begins with classical physics and progresses through increasingly unified theoretical frameworks, ultimately aiming to arrive at a single, comprehensive description encompassing all fundamental force and matter fields. The central idea is that distinct interactions—such as electromagnetism, the strong and weak nuclear forces, and eventually gravity—become indistinguishable below a certain distance scale, emerging as different manifestations of a single underlying Unified Field.

We know, for example, that the scale of electroweak unification is at the level of $10^{-18}$m or equivalently at an energy around 250 GeV. At this scale, photons (from the electromagnetic interaction) and the weak ($Z$ and $W$) bosons are treated as equal members of a perfect symmetry group $U(1) \times SU(2)$. This symmetry is broken at lower energy—in our daily life we see only the photons, but no weakly interacting bosons.

In our approach, we do not start from a Lagrangian of the Unified Field from which all force and matter fields can be derived; instead, we start with a universal wave function, of which we do not need to know anything more than that it obeys the laws of quantum physics.

This means that the arguments presented in this article rely only on the few postulates of quantum physics and are not bound by any other specific assumptions. This general approach draws its strength from the fact that in the more than 100 years that have passed since the discovery of quantum physics, not a single experiment has been done that contradicts the statements of the theory.

B. **What about other interpretations of Quantum Physics?** There is a wealth of approaches to quantum physics that have been developed and debated since the foundational work of Werner Heisenberg and Erwin Schrödinger, whose formulations of matrix mechanics and wave mechanics, respectively, marked the formal emergence of quantum theory. We have taken two examples: the Everett, or many-worlds, and the Copenhagen interpretation. The Everett approach is the simpler approach because only two key elements are used and nothing else: There is a vector in Hilbert space and a Schrödinger equation. That's it. Together with the phenomenon of decoherence, which is a result of these two simple elements, this approach works perfectly well in describing the world that we live in. The proponents of the many-worlds approach are sometimes called the $\psi$-ontologists (psi-ontologists), as they take the wave function as real.

What bothers critics are the many worlds.

It is only from there that interpretations start: Do we take the additional worlds that the theory predicts to be real or not? In the interpretation that has been offered here, consciousness is real, and it is all that there is, so we have a field of all possibilities where consciousness can observe itself from all possible angles. I, as a conscious being, then have the perfect freedom to take whatever angle I want. But once I have taken an angle, all the other possible worlds are virtual entities as they are not in my triple as explained in [15]; they are just virtual worlds. Note that in different wording this is also the pragmatic approach of the founder of decoherence, Zeh. The many-worlds theory describes a hypothetical reality that for reasons of consistency of the theory has to be taken into account.

Having said that, we can put the wealth of other approaches into two categories. One category is that which takes the core element, the postulates (0), (*i*) and (*ii*) presented here, and adds some more postulates, mainly to get rid of the other worlds. The added element usually is a God who plays dice—the element of chance or randomness. The other category refers to approaches that try to alter the core elements, mainly by departing from a purely unitary evolution, that is, by changing postulate (ii). To be concrete let us see the list of interpretations, which does not claim to be complete, and put it in those categories. For completeness we will also add a third category that somehow involves consciousness.

B.1. *Interpretations that add to the core postulates.*

- Copenhagen
- Consistent histories
- Pilot wave

The Copenhagen interpretation has been discussed at length. Basically what is done is to invoke a mechanism through which, upon measurement, the unitary evolution of a system breaks down and the result can be predicted only with a certain probability, arguing that at microscopic scales things are different from in the real world. However, quantum effects are now measured more and more at macroscopic scales so the idea that the small and the big are fundamentally different loses its persuasive power.

The approach of consistent histories can be considered to be a sort of refined way of dealing with the Copenhagen interpretation. While in the Copenhagen approach the probability only enters when something is actually measured, in consistent histories it is said that all quantum time dependence is probabilistic and given by Born's rule [10]. It seems that the consistent histories approach is in a way similar to the many-worlds approach with added randomness. There is only one world, but which one actually exists is decided by chance.

The pilot wave approach is mainly about what attitude to have regarding the $\psi$ function (wave function). The wave function here plays the role of guiding a point-like particle. Then all measurements can be reduced to measurements of positions of point-like particles that are actually real, only their behavior can be inferred from the pilot wave that guides the particle. This interpretation goes back to Broglie and Bohm [1].

B.2. *Interpretations that alter the core postulates.*

- Wave function collapse as a real gravitational effect
- Spontaneous collapse theories

The basic problem of the so successful Copenhagen interpretation is that unitary evolution of a wave function together with the postulate of a collapse of a wave function are mathematically inconsistent with each other. So objective collapse theories require the departure from the unitary evolution in Eq. (4.2). One example is the work of Penrose, who attributes the collapse of the wave function to gravity [16]. The most prominent example of the spontaneous collapse theories was proposed by Ghirardi, Rimini, and Weber who envision that the wave function does not follow the unitary evolution of the Schrödinger equation but undergoes occasional spontaneous collapses [9]. The advantage of the proposals that postulate a deviation from the purely unitary evolution of the wave function is that in principle any deviation should be measurable; that is, the theory can be either confirmed or disproved.

It should be noted that interpretational issues of quantum physics is not really a hot topic in physics today. Rather than philosophizing about the meaning of all that, generally the preferred approach today is to take the mathematical tools that have proven to be successful and apply them in not-yet explored domains—and especially stay away from anything that might look like consciousness. Some people call this the "Shut up and calculate" approach to physics.

However there are some attempts to include consciousness in quantum physics.

B.3. *Interpretations that take consciousness into account.*

- The conscious observer collapses the wave function
- Consciousness is more abstract than we think

As a proponent of the conscious collapse theories we refer to Stapp, who is a supporter of the orthodox Copenhagen view, but insists that quantum mechanical effects in the brain give rise to consciousness and the process of observation of that consciousness collapses the wave function [20].

It is difficult to find definitions of consciousness that are different from the idea that consciousness is a result of some activity in the brain.

An outstanding example of a worldview that differs from that is Schrödinger himself, who was a proponent of Vedānta.

Mensky from the Lebedev Physical Institute in Moscow defines consciousness as the ability to separate between differences and proposes an Extended Everett Concept where consciousness itself decides which of the different possible branches are realized. While there are similarities with the concept of consciousness collapsing the wave function, this approach is more holistic and includes the possibilities of different states of consciousness, for example, states of consciousness that can experience the field of all possibilities [14]. This definition of consciousness is much broader than attributing it to the result of some brain activity.

Hagelin [11] presents an approach connecting physics and pure consciousness, describing how the relative world emerges in the framework of string theory.

B.4. *Conclusion on the Interpretations of Quantum Theory.* The discussion surrounding the various interpretations and formulations of quantum theory is complicated by the fact that, from an experimental standpoint, they are often empirically indistinguishable. This lack of decisive experimental differentiation makes it challenging to determine which, if any, interpretation truly reflects the underlying nature of reality.

In the science of Vedānta, as well as in the work of Nader [15], there is—as Einstein has put it—no God who plays dice. There is no uncertainty and no randomness—everything is set. And this rules out all types of approaches to quantum physics that are non-deterministic. In the Everett approach we do have a field of all possibilities. Which of those possibilities is realized is up to the point of view of the observer—the world is as you are. These different possibilities might look random; however from the holistic standpoint this is never the case.

C. **What about the Big Bang?** We have argued that the inherent structure of quantum theory gives rise to the physical world through relative correlations within the system. But how does this emergence actually occur in practice?

Conventionally, we understand that something significant happened at the origin of space and time—the Big Bang. From this event, the physical universe has evolved over billions of years into its current form.

Our inference that a Big Bang occurred is grounded in Einstein's classical theory of general relativity. The standard approach, then, is to begin with a classical framework—such as curved spacetime, strings, or loops—and attempt to "quantize" it. From this quantized model, one then seeks to derive a unified theory, a so-called theory of everything.

"Quantum is all there is," works the other way around; the world is quantum from the start, and we limited human beings only perceive a classical reality.

So how does space emerge?

The first step toward this answer is to derive space from the general wave function. The key to that is to define subsystems and define a measure of their distance. And experience tells us that quantum systems that are nearby are more entangled than those that are farther away. From this one takes the logical step and defines that the degree of entanglement should be taken as a measure of distance. Or to put it another way: the more a system is entangled, the closer it is; the less it is entangled, the farther apart it is. And so we see how from the degree of entanglement the notion of space arises [5].

From the notion of space the next step to be taken is to arrive at the theory of gravity.

Jacobson has derived Einstein's equation of general relativity as an equation of state [12], thereby implying that gravity is not a fundamental force but one that can be derived from thermodynamics and entropy.

Physicists now try to use the deep connection of quantum entanglement, space, and entropy to formulate gravity as an emergent property of a quantum universe [4].

While the classical framework, grounded in Einstein's field equations, envisions consciousness as a late emergent phenomenon arising in the long temporal evolution following the Big Bang, the perspective presented here adopts a fundamentally different angle.

Consciousness interacting within itself gives rise to a physical classical universe that is real in appearance only.

The logical steps taken are: Hilbert space, Unitary transformation and $\psi$-function $\rightarrow$ systems $\rightarrow$ entanglement $\rightarrow$ space $\rightarrow$ gravity $\rightarrow$ physical universe. These subsequent steps can be related to the description of the appearance of the physical universe according to the Vedic view in [15] in an obvious way.

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# EVOLUTION OF AN ENTITY: ELABORATING ON THE THEORY THAT CONSCIOUSNESS IS ALL THERE IS

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Abstract. We aim to deepen the understanding of evolution by investigating consciousness as the foundation of all existence. We aim to present a mathematical framework for modeling the evolution of an entity through conscious experiences, focusing on supplementary concepts implied by the theory of Tony Nader that consciousness is all there is. Our analysis seeks to provide insights into the theory and explore its implications for the evolution of human consciousness. We propose a mathematical formalization of interactions between entities, extending the model to clarify the role of conscious experience in evolutionary processes. By drawing an analogy with the wave function in quantum mechanics, we aim to illustrate the probabilistic nature of future experiences. Furthermore, integrating aspects of Vedic philosophy to connect modern mathematical concepts with ancient wisdom contributes to our understanding of consciousness and its evolution. Finally, we briefly discuss the broader implications of this theory for understanding the nature of consciousness and existence across other fields of knowledge.

## 1. Introduction

Philosophers and scientists have long grappled with the nature of consciousness, engaging in centuries of profound and enduring debate. Philosophers such as Descartes in the 17th century, Kant in the 18th, and more recently Chalmers in the 20th century have sought to understand the fundamental nature of consciousness and its relationship with the physical world, questioning whether it can be fully explained through materialistic approaches [1]. Scientists, particularly in the fields of neuroscience and cognitive science, have sought to unravel the mechanisms underlying conscious experience, exploring how neural processes give rise to subjective awareness [4].

Despite significant advancements, the "hard problem of consciousness," that is, the challenge of explaining how and why we have subjective experiences, remains unresolved [1]. Traditional materialistic approaches have struggled to fully account for the qualitative aspects of consciousness, leading some researchers to explore alternative frameworks that position consciousness as a fundamental aspect of reality.

In response to these challenges, Nader, in his paper "Consciousness Is All There Is: A Mathematical Approach with Applications" [7], posits that consciousness underlies all phenomena. According to the theory, all entities, experiences, and objects are expressions of consciousness itself. This perspective offers new insights



2000 *Mathematics Subject Classification.* 03A05, 00A30, 81P05, 81P15, 81P16.

*Key words and phrases.* Consciousness, Evolution, Nader's Theory, Quantum Mechanics, Veda, Vedic Philosophy.

into the nature of reality and human evolution, suggesting that consciousness is the fundamental reality rather than a byproduct of physical processes.

Nader's theory introduces *Bits of Consciousness* and *Modes* as the basic building blocks for understanding the unfolding of experiences. We define a *Bit of Consciousness* as a unit of experience described by a triple $(x, y, z)$, where $x$ denotes an observer, $y$ a process of observation, and $z$ an object of observation [7]. All experiences and interactions within consciousness arise from these Bits. A *Mode* is a collection of *Bits of Consciousness* that share specific properties; Section 3 provides the exact definition.

The term *Entity* refers to any aspect of consciousness, ranging from physical objects and living beings to abstract ideas and concepts. We focus primarily on human entities, whose rich and complex experiences provide a suitable foundation for deeper exploration and which are particularly relevant due to their direct familiarity. Furthermore, the concepts of *Observerhood range*, *Observinghood range*, and *Observedhood range* represent the potential roles that an entity can assume as an observer, observation process, or object of observation.

Building on Nader's foundational principles, this paper introduces additional mathematical tools and concepts to extend the theory. By doing so, we aim to expand upon these established foundations, enriching our understanding of how entities evolve within consciousness, and considering the broader scientific and philosophical significance of this evolutionary process. Specifically, we seek to:

- **Formalize** the relationships between *Entities*, *Bits*, and *Modes*, introducing supplementary concepts such as detailed decompositions of *Observerhood*, *Observinghood*, and *Observedhood ranges*.
- **Examine** the probabilistic nature of these interactions and the role of *Modes* in shaping future experiences, drawing analogies with the wave function in quantum mechanics.
- **Incorporate** insights from Vedic philosophy, connecting modern mathematical models with ancient wisdom—particularly through concepts like *Karma*and *Jyotish*, and the symbolism of *Ganesha*—to offer unique perspectives on the evolution of an entity within consciousness.
- **Explore** the implications of our enhanced framework for understanding the evolution of human consciousness and its potential applications across various fields.

We organize the paper as follows:

- **Section 2:** We delve into the concept of *Observerhood*, examining how entities interact within consciousness and evolve through their experiences as observers.
- **Section 3:** We introduce the concept of *Mode* and discuss how entities assume various roles within *Bits of Consciousness*, influencing their evolution.
- **Section 4:** We explore the possibility of an entity being an observer in multiple *Bits* simultaneously, examining how this multitasking ability relates to the limitations of the human brain and the potential for expansion in higher states of consciousness.

- **Section 5:** We focus on the evolution of an entity, exploring how sequential experiences contribute to an entity's evolutionary trajectory.
- **Section 6:** We draw an analogy between *Modes* and the wave function in quantum mechanics, highlighting the probabilistic nature of future experiences.
- **Conclusion:** We summarize our findings and discuss the broader implications of this theory for understanding the nature of consciousness and existence as well as potential directions for future research.

By expanding upon Nader's original framework and integrating modern mathematical formalism with ancient philosophical insights, this paper seeks to contribute to a more precise and holistic understanding of the mechanics of consciousness and its role in the evolution of entities. We hope that this interdisciplinary approach will stimulate further research and dialogue across fields such as mathematics, neuroscience, physics, and philosophy, contributing to a deeper understanding of consciousness and its fundamental place in reality.

## 2. Observerhood range

To understand how entities evolve within consciousness, it is essential to explore their role as observers. *Observerhood* represents the collection of the roles an entity can assume while observing, directly shaping its experiences. These experiences drive the growth and evolution of the entity.

In this section, we explore the concept of Observerhood, focusing on how it defines an entity's interaction with the world and influences its potential for evolution. Understanding Observerhood clarifies how entities engage with consciousness and evolve through the experiences they accumulate as observers.

Nader [7] presents two concepts of Observerhood; they have similar names but differ in nature. To clarify the differences and facilitate further research, we introduce an additional concept that connects them and makes their relationships obvious. Recall the definitions of the Observerhood range, where an "observer" is an "entity assuming its observer roles":

**Definition 2.1.** The *Observerhood range of an entity $E$*, denoted $O^R_E$, is the collection of all possible observer roles that $E$ can assume [7, p. 10, footnote 2].

**Definition 2.2.** The *Observerhood range made possible by Bit $b$*, denoted $O^R(b)$, is the collection of all observers made possible by the Bit $b$ [7, p. 19].

The first definition pertains to all possible observer roles of an entity; it is the entity's total Observerhood range. The second deals with the observer roles made possible by a specific Bit $b$; it encompasses parts of the Observerhood ranges of many entities.

An important relationship between these two definitions arises when considering an entity $E$ and a Bit $b$. If $E$ has observer roles made possible by $b$, then there is an overlap between $E$'s Observerhood range $O^R_E$ and the Observerhood range made possible by $b$, $O^R(b)$. This common region represents the observer roles that $E$ can assume due to Bit $b$.

We formalize this overlap with the following definition.

**Definition 2.3.** The *Observerhood range of an entity $E$ made possible by Bit $b$*, denoted as $O_E^R(b)$, consists of all the observer roles that the entity $E$ can assume due to Bit $b$. Mathematically, this is the intersection of $O_E^R$ and $O^R(b)$:

$$O_E^R(b) = O_E^R \cap O^R(b).$$

This intersection identifies observer roles that belong to $E$'s inherent potential $O_E^R$ and arise specifically due to Bit $b$, i.e., $O^R(b)$.

To visualize this relationship, consider the Venn diagram in Figure 1. The circle representing $O_E^R$ encompasses all possible observer roles of the entity $E$, while the circle representing $O^R(b)$ includes all observers made possible by Bit $b$. Their intersection, $O_E^R(b)$, represents the observer roles that $E$ can actually assume due to Bit $b$.

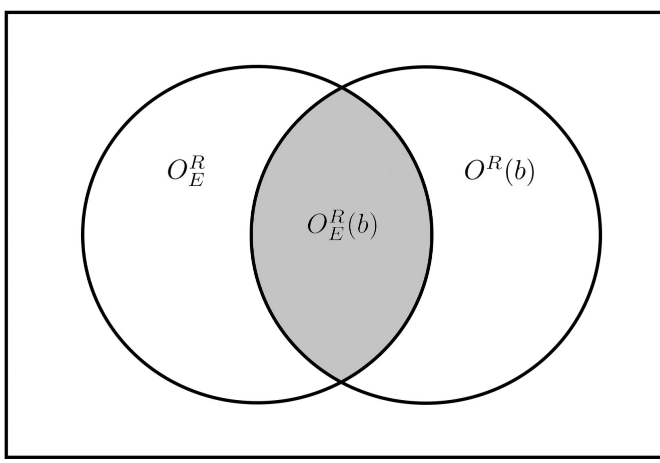


FIGURE 1. A Venn diagram illustrating the overlap between the Observerhood ranges $O_E^R$ and $O^R(b)$. The shaded area shows $O_E^R(b) = O_E^R \cap O^R(b)$, the observer roles that entity $E$ can assume due to Bit $b$.

This explicit intersection emphasizes how the observer roles that entity $E$ can assume due to Bit $b$ are those that are both within $E$'s inherent potential ($O_E^R$) and are made possible by the specific Bit ($O^R(b)$).

For example, if entity $E$ is a student and Bit $b$ represents a moment of a classroom lecture, $O_E^R$ includes all possible observer roles the student can assume (for example, listening, questioning, note taking). The collection $O^R(b)$ includes all observers made possible by the lecture (for example, students attending and guest auditors). The intersection $O_E^R(b)$ would then consist of the observer roles that the student $E$ can actually assume during that lecture, such as listening to the lecture and asking questions, which are both within the student's capabilities and made possible by Bit $b$.

There are three roles an entity can play in the context of a Bit of Consciousness: observer, process of observation, or observed. To further explore these roles, we can use a three-dimensional coordinate system as an analogy, where each axis corresponds to one type of role. A segment along an axis represents the range for each role. The Observerhood range $O^R_E(b)$ made possible by Bit $b$ is a portion of the total Observerhood range $O^R_E$ of the entity $E$, as shown in Figure 2.

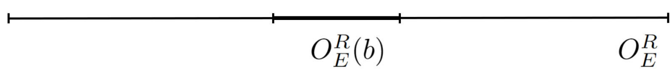


FIGURE 2. Visual representation showing how the Observerhood range $O^R_E(b) = O^R_E \cap O^R(b)$, determined by Bit $b$, is a subset of the complete Observerhood range $O^R_E$ of entity $E$. This illustrates how specific observer roles are influenced by individual Bits of Consciousness.

We now employ mathematical notation to formalize these concepts and better understand the intersections and unions of Observerhood ranges. Assume that there are $k$ different entities $E_1, E_2, \dots, E_k$ whose observer roles are made possible by Bit $b$. Then, $O^R(b)$ can be considered as the union of the Observerhood ranges of all these entities:

$$O^R(b) = O^R_{E_1}(b) \cup O^R_{E_2}(b) \cup \cdots \cup O^R_{E_k}(b),$$

where each $O^R_{E_i}(b) = O^R_{E_i} \cap O^R(b)$ represents the collection of all possible observer roles of an entity $E_i$ made possible by Bit $b$ (Definition 2.3). Note that these $O^R_{E_i}(b)$ are disjoint as they belong to different entities. Similarly, the ranges for Observinghood $O^G(b)$ and Observedhood $O^D(b)$ are defined:

$$O^G(b) = O^G_{E_1}(b) \cup O^G_{E_2}(b) \cup \cdots \cup O^G_{E_k}(b)$$

and

$$O^D(b) = O^D_{E_1}(b) \cup O^D_{E_2}(b) \cup \cdots \cup O^D_{E_k}(b).$$

In the classroom setting, this concept can be illustrated by the roles that students and teachers can assume. The total Observerhood range of the teacher $O^R_{\text{teacher}}$ includes all possible observer roles the teacher can have. If Bit $b$ is a moment during the lecture, the Observerhood range made possible by $b$, $O^R(b)$, includes all observers in that context (for example, the teacher presenting and each student listening). The intersection $O^R_{\text{teacher}}(b) = O^R_{\text{teacher}} \cap O^R(b)$ represents the collection of the specific roles that the teacher can assume as observer during the lecture, such as presenting information or asking questions.

Similarly, a student's Observerhood range $O^R_{\text{student}_i}(b) = O^R_{\text{student}_i} \cap O^R(b)$ represent the observer roles that student$_i$ can assume during the lecture, such as listening attentively or asking questions.

In a larger system, multiple entities can observe a single phenomenon from different perspectives. For example, in a sporting event, the coach, players, and audience all observe the same game but from different points of view and with varying levels of engagement. Their individual ranges of observation—their Observedhoods—overlap as they engage with the same event, even though their observational experiences differ.

This framework not only helps to describe how entities interact with their environment at any specific instant but also plays a critical role in understanding the evolution of entities over time. Observerhood, Observinghood, and Observedhood together define the experiences available to an entity. As an entity evolves, it undergoes a sequence of experiences that progressively modify and expand its Observerhood range, thereby enhancing its observational capacity and interactions.

This evolving Observerhood range represents an entity's progression through different stages of consciousness as it moves from one Bit of Consciousness to the next. As these ranges expand, the entity experiences a broader spectrum of reality, directly tied to the evolutionary process discussed later. The changing roles within these ranges (observer, observed, and observing process) constitute the foundation for the growth of an entity in consciousness and experience. Therefore, understanding Observerhood is foundational to the larger discussion of how entities evolve through interactions within Bits of Consciousness.

This connection between Observerhood and evolution will be explored further in Section 5, where the expansion of an entity's Observerhood range over time, as a result of interactions in new Bits of Consciousness, is examined.

## 3. Mode

The previous section's exploration of an entity's possible observer roles, termed *Observerhood*, clarified its interaction with consciousness. However, to fully understand how an entity evolves through its experiences, we need a more comprehensive tool—one that captures all the roles an entity can assume within a *Bit of Consciousness*. This introduces the concept of *Mode*, which encompasses not only Observerhood but also the process of observation and the role of being observed. Analyzing the *Mode* of a Bit of Consciousness provides insights into how entities interact with their environment, advancing their evolution.

Building on the previous discussion, we apply a similar method of decomposition to the concept of a Mode, providing a more nuanced framework to understand an entity's participation in the environment and the evolutionary process.

Recall the definition of a Mode from [7, p. 19]:

**Definition 3.1.** Given a real Bit of Consciousness $b$, the *Mode* $M(b)$ of $b$ is defined as the collection of triples $(x, y, z)$ where at least one of the following statements is true: $x$ is an element of the *Observerhood* range $O^R(b)$, $y$ is an element of the *Observinghood* range $O^G(b)$, or $z$ is an element of the *Observedhood* range $O^D(b)$.

We can rewrite the definition symbolically. Mathematics often employs symbols to represent abstract concepts clearly and concisely, making notation more compact. Curly braces { } denote a set, the vertical bar | means "such that," the symbol $\in$ indicates "is an element of" or "belongs to," and the wedge $\vee$ represents logical "or." To better explain this definition, the *Mode* $M(b)$ of a *Bit* $b$ represents all possible triples $(x, y, z)$ where the observer $x$ belongs to the *Observerhood* range made possible by $b$, the process of observation $y$ belongs to the *Observinghood* range made possible by $b$, or the observed $z$ belongs to the *Observedhood* range made possible by $b$. This relationship can be formally expressed as

$$M(b) = \{(x, y, z) \mid x \in O^R(b) \vee y \in O^G(b) \vee z \in O^D(b)\}.$$

To illustrate how a Mode $M(b)$ is constructed from a specific Bit $b$, let us consider a concrete example.

3.1. **Example: Constructing a Mode from a specific Bit.** Scenario: Imagine a classroom setting where a teacher, Ms. Smith (Entity $E_1$), is giving a lecture on biology and a student, Alice (Entity $E_2$), attends the lecture. Every moment of this lecture is a specific *Bit of Consciousness*; we will choose one and denote it as $b$.

In this Bit $b$, the roles are as follows:

- Observer ($x$): Alice ($E_2$)
- Observing Process ($y$): Listening
- Observed ($z$): The biology lecture delivered by Ms. Smith ($E_1$)

Mathematically, the Bit $b$ is represented as:

$$b = (x, y, z) = (\text{Alice}, \text{listening}, \text{biology lecture by Ms. Smith})$$

**Step 1: Determine the Observerhood, Observinghood, and Observedhood Ranges Made Possible by Bit $b$.**

Using the definitions:

- $O^R(b)$: The set of all possible observers made possible by Bit $b$.
- $O^G(b)$: The set of all possible observing processes made possible by Bit $b$.
- $O^D(b)$: The set of all possible objects of observation made possible by Bit $b$.

For our example:

- $O^R(b)$ includes the teacher and all the students attending the lecture who can observe the lecture in their observer roles. So,
$$O^R(b) = \{\text{Alice}, \text{Bob}, \text{Charlie}, \dots\}.$$
- $O^G(b)$ includes all possible observing processes in this context, such as listening, watching, note-taking, and so on. So,
$$O^G(b) = \{\text{listening}, \text{watching}, \text{note-taking}, \dots\}.$$
- $O^D(b)$ includes the content of the lecture, visual aids, the teacher, students, and so on. So,
$$O^D(b) = \{\text{biology lecture}, \text{slides}, \text{Ms. Smith}, \text{students}, \dots\}.$$

**Step 2: Construct the Mode $M(b)$.**

According to Definition 3.1, the Mode $M(b)$ is the collection of all triples $(x, y, z)$ where at least one of $x \in O^R(b)$, $y \in O^G(b)$, or $z \in O^D(b)$.

Therefore, $M(b)$ includes all possible combinations of observers, observing processes, and observed entities made possible by Bit $b$.

**Examples of Triples in $M(b)$:**

(1) $(\text{Alice}, \text{listening}, \text{biology lecture})$
(2) $(\text{Bob}, \text{note-taking}, \text{slides})$
(3) $(\text{Charlie}, \text{watching}, \text{Ms. Smith})$
(4) $(\text{Alice}, \text{note-taking}, \text{slides})$
(5) $(\text{Bob}, \text{listening}, \text{biology lecture})$

(6) (Charlie, listening, biology lecture)
(7) (Alice, watching, Ms. Smith)
(8) (Bob, note-taking, slides)
(9) ...

These combinations represent possible experiences that can arise from Bit $b$.
**Step 3: Understand the Roles of Entities in the Mode.**
For each entity, we can identify the roles they can play in Bits of the Mode $M(b)$:

- **Alice ($E_2$)**:
  - Observer roles ($O^R_{E_2}(b)$): Observing the lecture, note-taking, asking questions.
  - Observing processes ($O^G_{E_2}(b)$): Listening, watching, note-taking.
  - Observed roles ($O^D_{E_2}(b)$): Potentially being observed by others (for example, if she asks a question).
- **Ms. Smith ($E_1$)**:
  - Observer roles ($O^R_{E_1}(b)$): Observing students' reactions.
  - Observing processes ($O^G_{E_1}(b)$): Delivering the lecture, using teaching aids.
  - Observed roles ($O^D_{E_1}(b)$): Being observed by students.

**Step 4: Analyze How the Mode Represents Potential Experiences.**
The Mode $M(b)$ represents all the potential experiences that can arise from the initial Bit $b$. It encompasses not only the actual event but also the possible variations and interactions that could occur.

For example:

- Alice might decide to ask a question, changing her role from just listening to actively engaging.
- Another student might join the class late, adding new observer roles and observed entities to the Mode.
- Ms. Smith might use a different teaching method, introducing new observing processes.

Each of these possibilities is included in $M(b)$ as they are made possible by the initial Bit $b$.
**Step 5: Understand the Temporal Aspect.**
While Bit $b$ occurs at a specific moment, the Mode $M(b)$ unfolds over time, representing the future possibilities that emerge from $b$. Since all the ranges in their definitions use the phrase "made possible" in the past tense, this highlights a cause-and-effect relationship and implies a temporal separation between the Bit $b$ and its Mode, as illustrated in Figure 3.
**Conclusion of the Example:**
By constructing the Mode $M(b)$ from the specific Bit $b$, we have illustrated how a single event gives rise to a multitude of potential experiences. These experiences are defined by the possible roles that entities can assume and by the interactions between observers, observing processes, and observed entities. This example demonstrates how Modes serve as a comprehensive tool to understand the evolution of entities through their conscious experiences.

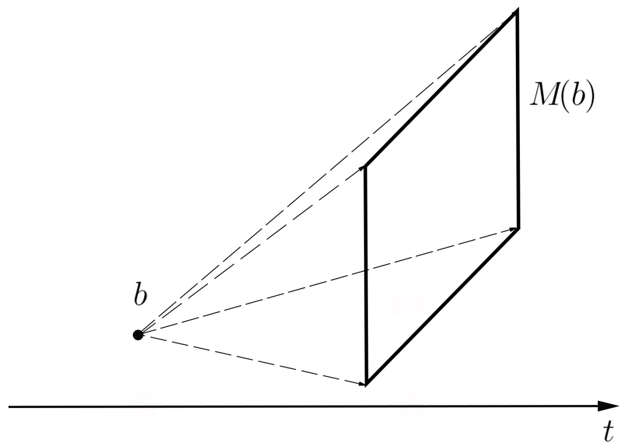


FIGURE 3. Bit $b$ makes its Mode $M(b)$ possible over time.

Having explored this example, we return to the general formulation of Modes in the context of entities and their roles.

3.2. **Decomposition of Modes based on entities.** Having already introduced $O^R_{E_i}(b)$, the Mode of $b$ can now be expressed in terms of smaller, more manageable parts:

$$M(b) = M_{E_1}(b) \cup M_{E_2}(b) \cup \cdots \cup M_{E_k}(b),$$

where each $M_{E_i}(b)$ is a subset of $M(b)$ consisting of all Bits where entity $E_i$ takes on at least one of the roles: observer, observation process, or observed. Specifically, $M_{E_i}(b)$ includes all triples $(x, y, z)$ such that:

- $x \in O^R_{E_i}(b)$ (entity $E_i$ acts as the observer),
- $y \in O^G_{E_i}(b)$ (entity $E_i$ acts as the process of observation), or
- $z \in O^D_{E_i}(b)$ (entity $E_i$ acts as the observed).

Mathematically, this is expressed as follows:

$$M_{E_i}(b) = \{(x, y, z) \mid x \in O^R_{E_i}(b) \vee y \in O^G_{E_i}(b) \vee z \in O^D_{E_i}(b)\}.$$

Note that these subsets $M_{E_i}(b)$ are not necessarily disjoint, as there may exist a triple $(x, y, z)$ where different entities take on different roles, resulting in overlaps between the subsets. If entity $E_1$ observes entity $E_2$, then Bit $(E_1, y, E_2)$ will belong to both $M_{E_1}(b)$ and $M_{E_2}(b)$, creating an overlap between these subsets.

An entity $E_i$ may assume one, two, or all three roles in a Bit $(p, q, s)$ that belongs to the Mode $M(b)$. Each case is examined separately below.

*Case 1: Entity as observer only.* When entity $E_i$ assumes only the role of observer in Bit $(p, q, s)$ the component $p$ falls within the Observerhood range $O^R_{E_i}(b)$, the set of possible observer roles made possible for $E_i$ by Bit $b$. It must fall within this range, as no observer roles for the entity $E_i$ can exist outside $O^R_{E_i}(b)$. Figure 4 illustrates how $p$ is drawn from the overall Observerhood range of $E_i$.

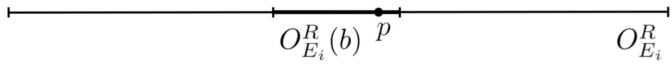


FIGURE 4. The Observerhood range $O^R_{E_i}(b)$ , a subset of the total Observerhood range $O^R_{E_i}$, shows how entity $E_i$, can take on specific observer roles, such as $p$ within Bit $b$.

*Case 2: Entity as observer and observed.* If the entity $E_i$ plays both the observer and the observed roles in Bit $(p, q, s)$, then $p \in O^R_{E_i}(b)$ and $s \in O^D_{E_i}(b)$. Figure 5 depicts this situation, showing how the interaction between the observer and the observed roles corresponds to the intersection of two ranges.

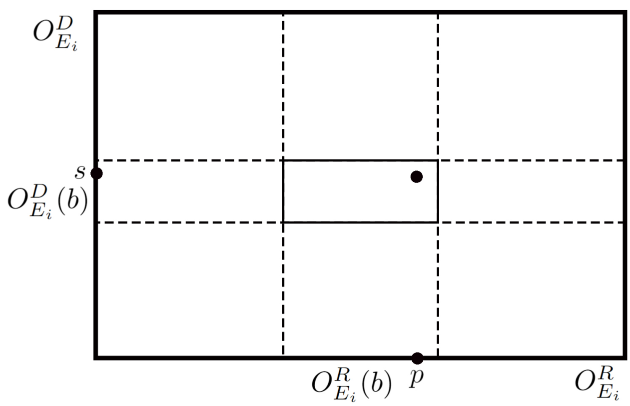


FIGURE 5. Illustration showing the overlap between Observerhood and Observedhood roles for an entity, highlighting how an entity can simultaneously observe and be observed.

*Case 3: Entity as observer, observing, and observed.* If the entity $E_i$ assumes the three roles of observer, observation process, and observed, the resulting range is the intersection of $O^R_{E_i}(b)$, $O^G_{E_i}(b)$, and $O^D_{E_i}(b)$, forming a cuboid as depicted in Figure 6.

Finally, the Mode $M_{E_i}(b)$ is decomposed into three subsets based on the roles the entity can play:

$$M_{E_i}(b) = M^R_{E_i}(b) \cup M^G_{E_i}(b) \cup M^D_{E_i}(b),$$

where:

$$M^R_{E_i}(b) = \{(x, y, z) \mid x \in O^R_{E_i}(b)\},$$
$$M^G_{E_i}(b) = \{(x, y, z) \mid y \in O^G_{E_i}(b)\},$$
$$M^D_{E_i}(b) = \{(x, y, z) \mid z \in O^D_{E_i}(b)\}.$$

These sets are not necessarily disjoint, as an entity can take on multiple roles in different Bits. As will be seen in later sections, Modes such as $M^R_{E_i}(b)$ play a critical

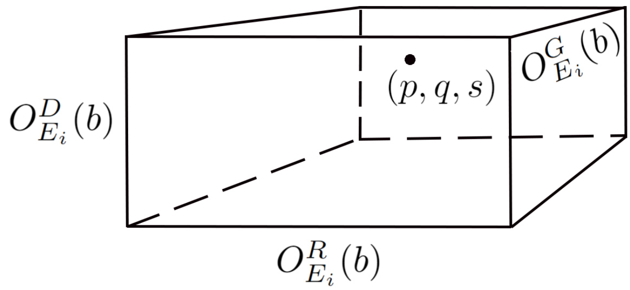


FIGURE 6. The cuboid visually illustrates the collection of Bits where entity $E_i$ assumes the roles of Observer, Observing, and Observed. Here, $(p, q, s)$ is one of the Bits in this collection.

role in the evolution of an entity. By combining these sub-modes, the Mode $M(b)$ can be represented as a matrix:

$$M(b) = \begin{pmatrix} M^R_{E_1}(b) & M^R_{E_2}(b) & \cdots & M^R_{E_k}(b) \\ M^G_{E_1}(b) & M^G_{E_2}(b) & \cdots & M^G_{E_k}(b) \\ M^D_{E_1}(b) & M^D_{E_2}(b) & \cdots & M^D_{E_k}(b) \end{pmatrix},$$

where the rows represent the Modes of different entities $E_1, E_2, \ldots, E_k$ made possible by Bit $b$, and the columns correspond to the roles played by each entity in the Bits of these Modes.

## 4. Can an entity be an observer in several Bits at the same time?

We now turn to the important question of whether an entity can be an observer in multiple Bits simultaneously. Can an entity participate in two Bits, $b$ and $b'$, at the same time, or is conscious experience restricted to a single Bit at any particular instant? To explore this further, it is essential to analyze both the multitasking limitations of the human brain and the potential for expanded consciousness in higher states of consciousness.

4.1. **The human brain and conscious experience: Multitasking Limitations.** Can an entity $A$ simultaneously be an observer in two Bits $b$ and $b'$? Research suggests that the human brain primarily supports single-tasking due to a central processing bottleneck, limiting the efficient simultaneous execution of multiple conscious tasks [3, 10]. Attempting to multitask causes rapid switching between tasks, incurring a "switching cost" that diminishes focus and attention [9].

In everyday life, apparent multitasking, such as checking a phone while conversing, actually involves rapid alternation between tasks rather than parallel processing. This switching introduces delays and reduces concentration, which in turn highlights the natural efficiency of single-tasking.

Although conscious experience itself remains singular, bodily processes such as breathing, heartbeat, and muscle movements occur concurrently through separate neural circuits, operating automatically and independently of conscious awareness. Routine tasks similarly transition from conscious control (prefrontal cortex) to automatic processing regions (basal ganglia), thus freeing cognitive resources [11]. Intelligence integrates these diverse automatic functions into a unified conscious experience.

Exploring this further, Nader [5] reflects on the Vedic symbolism of *Ganesha*, representing a balance between cognitive limitations and the transcendence achievable in higher states of consciousness. *Ganesha* acts as a symbolic bottleneck, analogous to the brain's processing constraints, ensuring that only manageable experiences are processed. This protective and regulatory mechanism serves to modulate experience in alignment with the capacity of the nervous system, preventing overload and stress. While each conscious experience has the potential to expand one's capabilities and awareness, excessive intensity can exceed one's integrative capacity and result in strain. In this way, *Ganesha* represents a threshold that evolves with the development of the nervous system—expanding as the system becomes more refined.

Specific structures of the human brainstem provide a striking physiological counterpart to *Ganesha*'s symbolic role. According to Nader [6], *Ganesha* corresponds to the *pons*, *medulla*, and *cerebellum*—together forming a gateway that regulates the flow of information into and out of the central nervous system. These structures filter sensory input, coordinate motor output, and integrate vital functions, mirroring *Ganesha*'s role as the remover of obstacles and guardian of transitions. As consciousness evolves—particularly in higher states—it is plausible that this inner gateway becomes increasingly refined, enabling more subtle experiences and deeper insights into the nature of reality to pass through without disruption. These symbolic and physiological correspondences offer meaningful conceptual bridges that enrich our understanding of conscious evolution.

The limitation of multitasking in the brain resembles a multitasking operating system on a single core processor, creating the illusion of parallelism by quickly switching between processes. The advent of multicore processors has enabled true parallel processing. Similarly, higher states of consciousness [7, p. 38] may allow for genuinely simultaneous conscious experiences, suggesting intriguing possibilities for future exploration.

This situation aligns with empirical models such as the *Global Workspace Theory (GWT)* [2], which proposes that conscious experience emerges when information is globally broadcast across the brain's processing modules. In this view, many unconscious processes occur in parallel, but the brain selects only one item at a time for conscious access. Researchers have compared this moment of integration to posting a message on a mental bulletin board, visible to the whole system. A *Bit of Consciousness* in our framework may correspond to such a globally integrated moment—selected from among the many potential Bits within a Mode, based on salience, relevance, emotional intensity, and prior experience. GWT thus supports the idea that only one Bit becomes active in awareness at a time, despite many being available in potential.

Having outlined multitasking limitations that define ordinary conscious experience, we next explore how higher states of consciousness might transcend these limitations, potentially expanding awareness and perception.

4.2. **Higher states of consciousness.** Researchers typically apply studies on single-tasking to ordinary waking consciousness, where attention is typically limited to processing one task or experience at a time. However, according to Maharishi Mahesh Yogi's teachings, higher states of consciousness—beginning with *Cosmic Consciousness*—transcend these limitations [7, p. 38]. In Cosmic Consciousness, the individual maintains simultaneous awareness of both external stimuli and the inner, unchanging field of Pure Consciousness. This expanded awareness not only enhances perception but also supports greater cognitive flexibility, creativity, and decision-making.

Even within ordinary waking consciousness, when sufficiently refined, a person may begin to experience the phenomenon of *witnessing*—a form of dual observation in which the individual perceives the outer world while simultaneously observing the process of perception itself. As described by Nader [7, p. 43], this dual experience can be represented as:

$$(x, u, z) + (x, v, (x, u, z)),$$

where $(x, u, z)$ denotes the experience of John seeing a flower, and $(x, v, (x, u, z))$ represents John's simultaneous awareness of having that experience.

In higher states of consciousness, this structure becomes further enriched. The observer not only sees the flower and knows that he is seeing it but is also aware of himself as Pure Consciousness at the same time. If we let $(x, w, x)$ represent this self-referral awareness—the observer observing himself—then the full witnessing experience can be written as:

$$(x, w, x) + (x, u, z) + (x, v, (x, u, z)).$$

This layered configuration illustrates how, in higher states, an entity can simultaneously participate as an observer in multiple Bits of Consciousness. The boundaries between observer and observed begin to dissolve and experience unfolds as a unified field of awareness that transcends the cognitive limitations of ordinary waking consciousness.

These higher states offer a compelling framework for understanding conscious evolution—not merely as a progression through sequential tasks, but as a transformation from fragmented, object-focused perception to integrated, multidimensional self-awareness. As entities evolve, the ability to consciously witness multiple Bits simultaneously may emerge, reflecting a shift toward greater freedom in action.

This unified perspective, integrating Observerhood, Observinghood, and Observedhood within a single Mode, provides a structured basis for understanding interactions and experiences within consciousness. Guided by Nader's foundational insights, we now examine how sequential experiences accumulate over time, shaping the evolutionary trajectory of an entity and progressively expanding its conscious potential.

## 5. Evolution of an entity

Many traditions view the pursuit of self-knowledge as a fundamental motivation behind human behavior to discover their identity and realize their potential. This pursuit is rooted in the ancient belief that self-knowledge unlocks understanding of both the world and the divine. Pythagoras stated, "Man, know thyself; then you shall know the universe and God." This resonates with Vedic wisdom from the Yajur-Veda, *Yathā piṇḍe tathā Brahmāṇḍe*—As is the atom, so is the universe; as is the body, so is the cosmic body [12, p. 237]. Building on Dr. Nader's theory, we now turn to examine the evolutionary process in more detail by breaking it down into its essential components and stages.

5.1. **Bits and the evolution of consciousness.** In the previous section, the Mode $M(b)$ of a single Bit $b$ was decomposed into its component parts corresponding to different entities. We now reverse the perspective to examine how a single *Entity* evolves across different Bits of Consciousness. The notation for an entity as introduced in [7] is as follows:

$$E = E[O_E^R, O_E^G, O_E^D],$$

where $O_E^R, O_E^G,$ and $O_E^D$ represent the properties that uniquely define an entity $E$. These properties encapsulate the total potential of *Observerhood*, *Observinghood*, and *Observedhood* that characterize Entity $E$ in its roles as observer, observing process, or object of observation [7, pp. 9, 10]. To emphasize that these represent the total potential of $E$, we introduce the notation $O_E$ to represent an aggregate of $O_E^R, O_E^G,$ and $O_E^D$:

$$O_E = [O_E^R, O_E^G, O_E^D],$$

and shortens the notation of an entity:

$$E = E[O_E].$$

A closer examination of *Bits of Consciousness* reveals that they are the fundamental units of evolution.

In a previous study, it was stated that "Reality (life and living included) is a sequence in time of real triples and separate triples that exist simultaneously in space" [7, p. 63]. In this framework, life can be understood as a sequence of Bits. Each Bit represents a distinct experience, and given the constraints of the human nervous system, *conscious experience* takes time to unfold [8, p. 3]. Let $N$ denote the total number of Bits experienced by an entity during its lifetime. The sequence of these Bits is represented as:

$$b_1, b_2, \ldots, b_{i-1}, b_i, b_{i+1}, \ldots, b_{N-1}, b_N.$$

The *Observerhood* range $O_E^R$ of an entity is the union of all Observerhood possibilities made available through each Bit encountered in life. This logic also applies to *Observinghood* $O_E^G$ and *Observedhood* $O_E^D$:

$$\begin{aligned} O_E^R &= O_E^R(b_1) \cup O_E^R(b_2) \cup \cdots \cup O_E^R(b_N), \\ O_E^G &= O_E^G(b_1) \cup O_E^G(b_2) \cup \cdots \cup O_E^G(b_N), \\ O_E^D &= O_E^D(b_1) \cup O_E^D(b_2) \cup \cdots \cup O_E^D(b_N). \end{aligned}$$

At each discrete moment, the Bit $b_i$ defines a specific *range of possibilities* for the entity $E$, and we represent it as:

$$O_E(b_i) = [O_E^R(b_i), O_E^G(b_i), O_E^D(b_i)].$$

As the entity experiences each Bit, its range of possibilities may expand, contract, or modify based on the gained conscious experience.

5.2. **The sequence of Bits and evolution.** Thus, the *evolution of an entity* follows a sequence of unfolding possibilities over time, as shown in Figure 7. Although each $O_E(b_i)$ initially takes the form of a cuboid (Figure 6), we simplify the representation by using rectangles, as in Figure 5.

$$O_E(b_1) \to O_E(b_2) \to \cdots \to O_E(b_{i-1}) \to O_E(b_i) \to O_E(b_{i+1}) \to \cdots \to O_E(b_N).$$

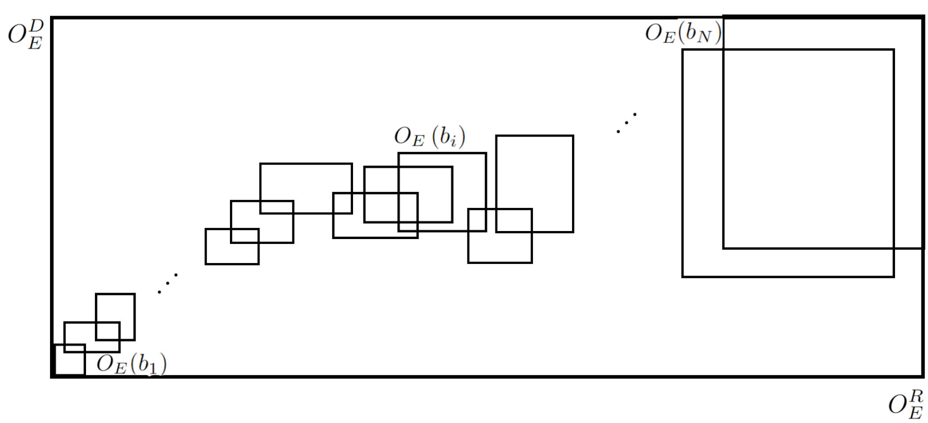


FIGURE 7. At each moment, an entity $E$ has a certain range of possibilities. The evolution of entity $E$ is described by the sequence of these ranges as they unfold over time.

The total range of possibilities of the entity $E$ at the end of its life is the cumulative union of all possibilities encountered throughout its life:

$$O_E = O_E(b_1) \cup O_E(b_2) \cup \cdots \cup O_E(b_N).$$

The experience associated with Bit $b_i$ updates the range of possibilities for entity $E$, forming its new $O_E(b_i)$. The entity may reshape its potential roles through this experience—its ability to observe, to be observed, or to function as the observing process, each represented by the length, width, and height of the cuboid in Figure 6. Depending on the nature of the experience, these dimensions may expand or contract, reflecting the evolving balance of the capacities of the entity. For example, the ability to function as an observer might increase, while the potential to serve as the object of observation may decrease. This is analogous to a scientist studying living organisms: as their capacity for observation refines, they may intentionally reduce their visibility, employing subtle methods to observe without being observed, thus maximizing their Observerhood while minimizing their Observedhood.

The following matrix summarizes the entity's evolution across Bits of Consciousness:

$$O_E = \begin{pmatrix} O_E^R(b_1) & O_E^R(b_2) & \cdots & O_E^R(b_N) \\ O_E^G(b_1) & O_E^G(b_2) & \cdots & O_E^G(b_N) \\ O_E^D(b_1) & O_E^D(b_2) & \cdots & O_E^D(b_N) \end{pmatrix}.$$

The columns in the matrix represent the ranges made possible by each Bit $b_1, b_2, \ldots, b_N$, whereas the rows indicate the roles—*Observer*, *Observing*, and *Observed*—that the entity assumes. This matrix provides a structured representation of all possible roles an entity can assume throughout its evolution from Bit to Bit, illustrating the interactions between Observerhood, Observinghood, and Observedhood.

Next, we examine the relationship between the sequence of Bits that constitute the "life" of Entity $E$: $b_1, b_2, \ldots, b_N$. How do these Bits relate to the evolution of the entity $E$? The following key statements from [7] provide insight into this relationship:

(1) "To have an 'experience' means to be conscious of something" [7, p. 10].
(2) "Observerhood ... is the ability to sense, detect, feel, witness—in short, to experience anything" [7, p. 11]. This implies that experience occurs only when taking on the role of the observer.
(3) "After John sees the flower, he is no longer the same John. He has had an experience and, to whatever extent that experience influenced him, he has changed" [7, p. 19]. This underscores that having an experience means "to be conscious of something," and by being the observer in a Bit, the range of John's possibilities is altered—he is no longer the same person after this experience.

From these points, we conclude that only the Bits where Entity $E$ plays the role of the observer provide *conscious experience* and influence the range of $O_E(b_i)$, thus contributing to the evolution of the entity. Any Bit in which the entity plays the role of an object, by contrast, acts merely as an external condition under which the entity's evolution occurs but does not directly affect its internal development.

The following consideration is important: since an observer can influence the observed object, thereby altering its range of possibilities, we must add an essential step to our reasoning. At some point, the observed object registers this influence and subsequently becomes an observer itself in another Bit of Consciousness, gaining conscious experience of this interaction. For instance, when sunlight reaches a person, the sun initially acts as the observer, and the person as the observed. However, as soon as the person consciously experiences warmth, the roles reverse: the person becomes the observer in a new Bit, and the sun's rays become the observed object.

The sequence of Bits $b_1, b_2, \ldots, b_N$, in which Entity $E$ acts as an observer, constitutes its conscious experiences. These experiences alter and expand the possibilities of the entity. All other Bits, where Entity $E$ is not the observer, simply form external conditions for its evolution. This sequence of Bits is intrinsically connected to the sequence of Modes $M_E^R(b_1), M_E^R(b_2), \ldots, M_E^R(b_N)$, which is now examined in more detail.

A key question arises: How are the terms of the sequence of Bits $\langle b_i \rangle$ related to the sequence of Modes $\langle M_E^R(b_i) \rangle$ where the Entity $E$ is the observer? To answer this, consider the transition between Bits over time.

When Entity $E$ plays the role of observer in Bit $b_i$ at time $t_i$, it gains a conscious experience. This experience modifies the entity's current ranges of possibilities and opens up new ranges $O_E^R(b_i), O_E^G(b_i), O_E^D(b_i)$, which contribute to the formation of the Mode $M_E(b_i)$ of Bit $b_i$. Bit $b_i$ then makes possible a set of potential Bits, its Mode $M(b_i)$ that only became accessible to the entity through the experience of $b_i$, as illustrated in Figure 8.

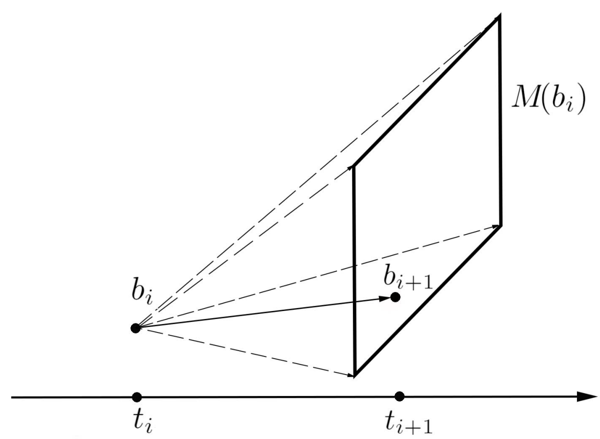


FIGURE 8. Bit $b_i$ at the moment $t_i$ makes possible its Mode $M(b_i)$ containing Bit $b_{i+1}$ at $t_{i+1}$.

Thus, based on the reasoning that only one Bit can be experienced at a time, it follows that:

$$b_{i+1} \in M_E^R(b_i), \quad i = 1, \ldots, N-1,$$

and

$$b_{i+1} \in M_E^R(b_i) \subseteq M_E(b_i) \subseteq M(b_i).$$

The entire sequence of life experiences for an entity $E$—with each bit contained within its corresponding mode—then appears as shown in Figure 9.

## 6. A Mode as a wave function

Further examination of *Bits* and *Modes* reveals that their behavior is fundamentally probabilistic, analogous to particle behavior described in quantum mechanics. This analogy suggests that quantum theoretical principles can meaningfully enhance our understanding of how conscious experiences evolve. Drawing parallels between the collapse of a quantum wave function and the selection of a single Bit from a Mode can help clarify the inherently probabilistic nature of future conscious experiences.

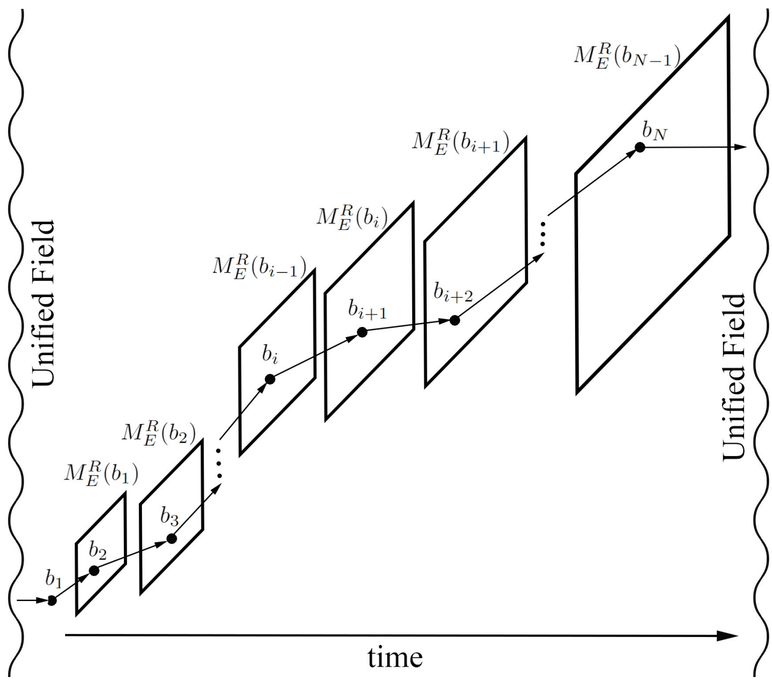


FIGURE 9. Lifetime of an entity consciously experiencing one Bit at a time. The Bits are shown along with their corresponding Modes.

6.1. **The quantum analogy of Modes.** The definition of a *Mode* implies that a Bit $b_i$ gives rise to a potentially infinite set of triples that make up the Mode associated with $b_i$. These triples may or may not occur within the lifetime of any given observer. Each triple has its own probability of being experienced as a Bit within the lifetime of an entity. Most of these triples may remain outside the scope of an entity's existence, while only a few will actually become part of the conscious experience of the entity. This inherent uncertainty, combined with the broad range of potential subsequent Bits, creates a *probability space* consisting of the set of possible Bits along with their associated probabilities.

This concept is analogous to the famous *double-slit experiment*, in which electrons exhibit wave-like behavior. Instead of having a definite position, each electron follows a *probability distribution*, meaning that each location has a certain probability of containing the electron. The *wave function* describes this behavior, and interference patterns confirm it.

Quantum mechanics provides the framework to understand these phenomena. Figure 10 illustrates how a wave function represents probability density, similar to how a Mode predicts the next Bit of Consciousness. In quantum mechanics, the position of an electron is not pinpointed but is represented by a wave function. The wave function represents a *probability amplitude*, with its square providing the *probability density* of locating the electron. When a measurement or observation is made in a quantum system, the wave function, which describes the probabilities of all possible states of the system, collapses. This collapse reduces the superposition of all possible states to a single state. As a result, a specific, localized position of the electron is obtained. Before measurement, the position of the electron is spread over a range of probabilities. However, the act of observation forces the electron to "choose" a particular position, making it observable and measurable at that specific point.

This framework can be seen to mirror the relationship between a *Bit* and its *Mode*. Consider a Mode $M(b_i)$ made possible by Bit $b_i$ associated with an entity $E$. This Mode $M(b_i)$ consists of a set of potential triples, one of which will eventually manifest itself as the next Bit experienced by the entity during its lifetime. However, which triple will be experienced is not predetermined; each Bit within the Mode has a certain probability of being experienced. Upon observation, similar to the wave function collapse in quantum mechanics, the Mode reduces to a single Bit, as shown in Figure 11.

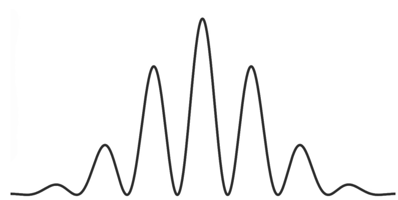

FIGURE 10. A probability density function. Determining the next Bit of Consciousness from within a Mode is similar to how an electron's position is predicted from the probability density function.

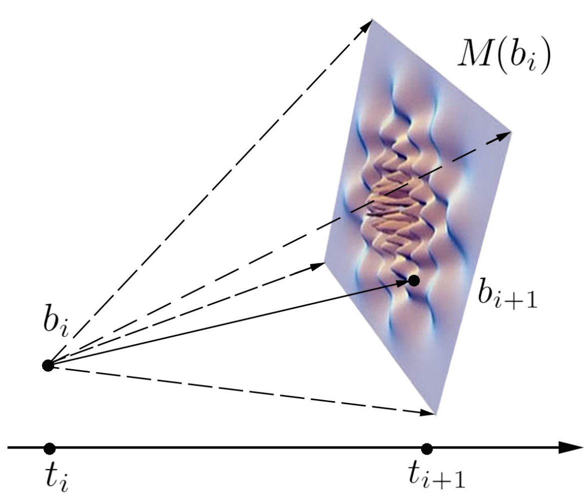


FIGURE 11. Mode as a Wave Function. Bit $b_{i+1}$ is the Bit following $b_i$.

Consider a traveler navigating a city grid. The presence of the traveler at a crossroad can be thought of as analogous to a *Mode*, consisting of multiple potential next steps (for instance, moving north, south, east, or west). A *Bit* corresponds to the act of moving along one of these paths until reaching the next crossroad. When the traveler chooses a direction and proceeds, that specific *Bit* is realized, while the other unselected possibilities disappear, much like the collapse of a wave function in quantum mechanics. Upon arriving at the next crossroad, a new Mode emerges, again offering multiple potential directions. This example effectively illustrates how each chosen Bit shapes the evolving sequence of experiences.

6.2. **Probabilistic nature of Modes and evolution.** Consider Bit $b_{i+1}$ within the lifetime of the Entity $E$. This Bit exists within the Mode of $b_i$, meaning it was made possible by Bit $b_i$. In turn, $b_i$ was made possible by the previous Bit, and this chain continues throughout the life of the entity. Bit $b_{i+1}$ depends on the entire sequence of preceding Bits, which collectively influence its manifestation. Each prior experience shapes the range of future possibilities, creating a probability framework similar to a chain reaction. Therefore, Bit $b_{i+1}$ is influenced by the entire sequence of previous Bits experienced by the entity. The current Bit can be understood as the cumulative result of all prior states, forming an interference pattern analogous to that observed in quantum systems. This interference pattern shapes the present situation for the entity.

Consequently, a Mode arises from the cumulative influence of all preceding Bits. While the next Bit is shaped by this history, some free will and variability remain. The occurrence of each next Bit is largely determined by this probability even though it is not strictly fixed.

In this context, a mathematician might note that if a sequence of points (Bits) exists, an *interpolation function* can pass through these points. By doing so, it is possible to *extrapolate* the function to estimate the next point or Bit. Similarly, a certain *wave function* can be envisioned that anticipates the next position of the system. This concept is aligned with Vedic Science, which teaches that past actions give rise to the situation in which one finds themself today. Furthermore, even these actions are, to some extent, shaped by the moment of birth, what might be called the *initial Bit*.

This process differs between various types of entities. For simpler entities such as a rock that lacks the ability to choose, life is more heavily predetermined. In contrast, entities like humans endowed with free will experience more variability in their evolution. Variability can differ even within entities of the same type. For example, in the case of humans, individuals can focus on their *self-development* and *self-knowledge* to varying degrees. The more deeply they engage with such aspects, the nature of the conscious experiences they accumulate tends to expand their capacity to perceive reality more broadly. As a result, their range of possibilities gradually expands over time, especially as they engage in the repeated experience of Pure Consciousness. As Nader explains, “These ranges of possibilities gradually expand as the experience of Pure Consciousness is repeated on a regular basis until the next higher state of consciousness is achieved” [7, p. 39].

Although the analogy of the wave function collapse provides insight into the probabilistic nature of individual experiences within consciousness, alternative interpretations can further illuminate this understanding. The *Many-Worlds Interpretation* of quantum mechanics posits that all possible outcomes of a quantum event actually occur, each in its own separate universe. Applied to the framework of Bits and

Modes, every potential Bit can be seen as manifesting in parallel realities. Exploring this interpretation within conscious evolution enriches the perspective on how consciousness navigates a vast landscape of potential experiences.

6.3. **The many-worlds interpretation and *Karma*.** The *Jyotish* section of the Vedas is a precise mathematical science of prediction, based on the motion of celestial bodies and their influence on human life. It incorporates probabilistic forecasting by identifying dominant tendencies during specific periods of an individual's life. This resembles solving a boundary-value problem with initial conditions, where the initial condition corresponds to the moment of birth, and the boundary conditions represent the external circumstances. As life progresses through conscious experiences, these boundary conditions evolve, either narrowing or expanding based on one's actions. Actions create ripples that spread throughout the universe and eventually return to shape future circumstances. This principle aligns closely with the concept of *Karma*—the law of action and reaction—which includes not only the actions themselves but also their outcomes. *Karma* governs the consequences of an individual's behavior, both positive and negative, determining the experiences of joy and suffering in life. These consequences, known as *Karma-phala*, extend beyond the present lifetime, encompassing influences from past and future existences.

While the wave function collapse analogy emphasizes the probabilistic nature of experience, the Many-Worlds Interpretation provides a broader perspective by suggesting that all outcomes simultaneously manifest in parallel universes. Within the framework of Bits and Modes, this implies that each potential future Bit exists simultaneously in separate realities, although only one path is consciously experienced. In the Many-Worlds Interpretation, the wave function never collapses; instead, a *Universal Wave Function* encompasses all quantum states, with every possible outcome realized in its own universe. Consequently, Modes do not collapse but persist, with all potential triples manifesting as Bits across parallel universes within an entity's lifetime [7, p. 33]. Although our perception is limited to a single universe, the existence of multiple universes should not be entirely discounted, despite their inaccessibility to direct observation.

In a sense, each individual lives in their own universe, shaped by a unique set of Bits and Modes, which defines their range of possibilities. People around us—our friends and loved ones—perceive us differently, forming their own version of us based on their own understanding; in their universe, we appear as an object of observation and their version of us is an approximation of our own true self. The closer someone is to us, the more accurate their approximation of us might be, yet it will never fully align with our own self-awareness. Thus, in the life of every person, we exist as if in a parallel universe, and this image of us in the eyes of others affects us since others build relationships with us based on how they see us and not what we really are. Not to mention the fact that we ourselves do not always really know who we are, which is determined by our level of consciousness. Only a person with a fully developed consciousness knows everything about themself and the world around them. So an alternative version of "myself" exists in parallel realities created in the minds of people around us and they interact with us, influencing our lives and the lives of others.

## 7. Conclusion

In this paper, we have extended the mathematical framework of consciousness presented by Nader [7], seeking to provide a deeper understanding of the evolution of an entity through conscious experiences. By introducing supplementary concepts and formalizing the interactions of Bits and Modes, we aim to have established a foundation for analyzing how entities evolve over time.

We have highlighted the probabilistic nature of future experiences, drawing an analogy between a Mode and a wave function in quantum mechanics. This analogy is intended to inspire further thought rather than assert a strict equivalence, emphasizing how each Bit of consciousness, influenced by prior experiences and potentialities, plays a role in the unfolding of an entity's evolution.

Furthermore, by integrating insights from Vedic philosophy, particularly the concepts of *Karma* and *Jyotish*, and the symbolism of *Ganesha*, we have connected modern mathematical concepts with ancient wisdom. This interdisciplinary approach seeks to enrich our understanding of consciousness and offers a holistic perspective on the mechanisms underlying evolution.

The enhanced framework presented in this paper may open new avenues for research in various fields. Future studies may explore the practical applications of this framework in neuroscience, psychology, and artificial intelligence, examining how evolution can be modeled and influenced. Furthermore, investigating higher states of consciousness and their implications for simultaneous experiences might provide further insights into capacities beyond ordinary cognition.

We hope that the interdisciplinary approach presented here will stimulate further research and dialogue across diverse fields, such as mathematics, neuroscience, physics, and philosophy, contributing to a deeper understanding of consciousness and its fundamental place in reality.

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## Appendix A. Correspondences of notations

Some notations from [7] have been changed in this paper to align with further development of the theory. These changes are made to ensure consistency and clarity as the framework evolves, making the notations more intuitive and easier to apply in expanded contexts. Table 1 outlines these notational correspondences for reference.

| **Original paper** | **Current paper** |
|---|---|
| $(O^R, O^G, O^D)$ | $[O^R, O^G, O^D]$ — square brackets are used for *ranges* to distinguish them from *Bits of Consciousness* |
| $O^{R_E}, O^{G_E}, O^{D_E}$ | $O^R_E, O^G_E, O^D_E$ — superscripts indicate the type of role, while subscripts indicate the *Entity* |
| $M_b$ | $M(b)$ — parentheses are used for *Bits of Consciousness* |

Table 1. Correspondences of notations with [7].

## Appendix B. Table of main notations

The following table summarizes the key notations used throughout the paper. These notations are fundamental for understanding the interactions of *Entities*, *Bits*, and *Modes* within the context of consciousness. The changes indicated in Table 1 have been incorporated.

| **Notation** | **Explanation** |
|---|---|
| $O_E^R, O_E^G, O_E^D$ | *Observerhood*, *Observinghood*, or *Observedhood* potential of an *Entity E* |
| $O^R(b), O^G(b), O^D(b)$ | *Observerhood*, *Observinghood*, or *Observedhood* made possible by the *Bit of Consciousness b* |
| $O_E^R(b), O_E^G(b), O_E^D(b)$ | *Observerhood*, *Observinghood*, or *Observedhood* potential of an *Entity E* made possible by the *Bit b* |
| $O_E(b)$ | Aggregate of $O_E^R(b), O_E^G(b)$, and $O_E^D(b)$ (e.g., total *Observerhood*, *Observinghood*, and *Observedhood* of *Entity E* for *Bit b*) |
| $O_E$ | $O_E(b_1) \cup O_E(b_2) \cup \cdots \cup O_E(b_N)$ — Represents the total range of *Observerhood*, *Observinghood*, and *Observedhood* for *Entity E* across all Bits |
| $M(b)$ | *Mode* of a *Bit of Consciousness b* |
| $M_E(b)$ | *Mode* of a *Bit of Consciousness b* where *Entity E* takes at least one role |
| $M_E^R(b), M_E^G(b), M_E^D(b)$ | *Modes* of a *Bit of Consciousness b* where *Entity E* plays the role of *Observer*, *Observing*, or *Observed* |

Table 2. Table of main notations used in the paper, adapted from [7, p. 58].

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# International Journal of Mathematics and Consciousness

In recent centuries, scientists have found that many phenomena in nature obey physical laws that can be expressed precisely in the language of mathematics. Their successes have led scientific inquiry beyond the physical world to include what was previously considered metaphysical or non-material. Today, an increasing number of scientists are examining the nature of consciousness and its relationship to the human brain.

While most models of consciousness propose that it is a product of chemical and electrical behavior within the brain, no current theory resolves the so-called "hard problem of consciousness"—how physical processes in the nervous system give rise to subjective experiences such as experiencing, thinking, feeling, analyzing, and creating. At the same time, it is undeniable that without awareness—without consciousness—we cannot think, perceive, dream, or love. On this basis alone, a scientific journal dedicated to exploring the nature of consciousness is timely and appropriate.

While consciousness can be studied within a variety of disciplines, mathematics especially lends itself to examine the relationship between consciousness and physical phenomena. Mathematics is precise and rigorous in its methodology, giving symbolic expression to abstract patterns and relationships. Although developed subjectively, using intuition along with the intellect and logical reasoning, mathematics allows us to make sense of our outer physical universe. Mathematics is the most scientific representation of subjective human intelligence and thought, formalizing how individual human awareness perceives, discriminates, organizes, and expresses itself.

The scientific consideration of consciousness by itself is a formidable challenge, for consciousness is a purely abstract reality. But the study of what we might call "consciousness at work"— how consciousness expresses itself in our daily activity of thinking, analyzing, creating, theorizing, and feeling—is inherently more accessible. For this exploration also, mathematics is the ideal tool, because its ability to express patterns of abstract human awareness helps us make sense of our physical universe. One could in fact argue that mathematics is the most scientifically reliable tool for the exploration of the dynamics of consciousness, for it alone can be seen as the symbolic representation of "consciousness at work."

***The International Journal of Mathematics and Consciousness*** will help to fulfill the need for a forum of research and discussion of consciousness and its expressions. The editors invite mathematicians, scientists, and other thinkers to present their theories of consciousness without restriction to proposed axioms and postulates, with the stipulation only that such theories follow strict logical argumentation and respect proven facts and observations. Articles that use factual or logical counterarguments to challenge commonly believed but not fully established facts and observations are also welcome.