Chapter

Nature of Temporal ($t > 0$) Quantum Theory: Part II

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Abstract

Since Schrödinger's quantum mechanics developed from Hamiltonian, I will show that his quantum machine is a timeless ($t = 0$) mechanics, which includes his fundamental principle of superposition. Since one of the most controversial paradoxes in science must be Schrödinger's cat. We will show that the myth of his hypothesis is "not" a physical realizable postulation. The most important aspect in quantum theory must be the probabilistic implication of science, a set of most elegant and simple laws and principles, which will be discussed. Since information and entropy have a profound connection, we will show that information is one of very important science in quantum theory, for which several significant aspects of information transmission will be stressed. Nevertheless, the myth of quantum theory turns out to be not Schrodinger's cat but the nature of a section of time Δt. Since time is a quantity that we cannot physically manipulate, we could change the section Δt but not the speed of time. Although we can squeeze a section of Δt, but we cannot squeeze Δt to zero. And this is the ultimate quantum limit of "instantaneous" response we can never be able to obtain. Since time traveling is one of the very interesting topics in science, I will show that time traveling is impossible even at the speed of light. Nevertheless, I will show quantum mechanics is a temporal ($t > 0$) physical realizable mechanics, and it should "not" be as virtual and timeless ($t = 0$) as mathematic does.

Keywords: quantum mechanics, Hamiltonian mechanics, timeless mechanics, temporal mechanic, temporal universe, timeless space, physical realizable, Schrödinger's cat

1. Introduction

Two of the most important discoveries in the twentieth century in modern science must be the Einstein's relativity theory [1] and Schrödinger's quantum mechanics [2]; one is dealing with very large objects and the other is dealing with very small particles. Yet they were connected by means of Heisenberg's uncertainty principle [3] and Boltzmann's entropy theory [4]. Yet, practically, all the laws, principles, and theories of science were developed from an absolute empty space, and their solutions are all timeless ($t = 0$) or time-independent. Since our universe is a temporal ($t > 0$) space, timeless ($t = 0$) solution cannot be "directly" implemented within our universe, because timeless and temporal are mutually exclusive.

Although timeless laws and principles have been the foundation and cornerstone of our science, there are also scores of virtual solutions that are "not" physical realizable within our temporal (t > 0) space.

Yet, it is the major topic of the current state of science, fictitious and virtual as mathematics is. Added with very convincing computer simulation, fictitious science becomes "irrationally" real? As a scientist, I felt, in part, my obligation to point out where those fictitious solutions come from, since science is also mathematics.

Since Schrödinger's quantum mechanics is a legacy of Hamiltonian classical mechanics, I will first show that Hamiltonian was developed on a timeless (t = 0) platform, for which Schrödinger's quantum machine is also timeless (t = 0); this includes his quantum world as well his fundamental principle of superposition. I will further show that where Schrödinger's superposition principle is timeless (t = 0), it is from the adaption of Bohr's quantum state energy E = hυ, which is essentially time unlimited singularity approximated. I will also show that nonphysical realizable wave function can be reconfigured to becoming temporal (t > 0), since we knew a physical realizable wave function is supposed to be. And I will show that superposition principle existed "if and only if" within a timeless (t = 0) virtual mathematical subspace but not existed within our temporal (t > 0) space.

When dealing with quantum mechanics, it is unavoidable not to mention Schrödinger's cat, which is one of the most elusive cats in science, since Schrödinger disclosed the hypothesis in 1935? And the interesting part is that the paradox of Schrödinger's cat has been debated by score of world renounced scientists such as Einstein, Bohr, Schrödinger, and many others for over eight decades, and it is still under debate. Yet I will show that Schrödinger's hypothesis is "not" a physical realizable hypothesis, for which his half-life cat should "not" have had used as a physical postulated hypothesis.

In short, the art of a quantum mechanics is all about temporal (t > 0) subspace, in which we see that everything existed within our universe; no matter how small it is, it has to be temporal (t > 0), otherwise it cannot exist within our universe.

2. Hamiltonian to temporal (t > 0) quantum mechanics

In modern physics, there are two most important pillars of disciplines: It seems to me one is dealing with macroscale objects of Einstein [1] and the other is dealing with microscale particle of Schrödinger [2]. Instead of speculating micro- and macro objects behave differently, they share a common denominator, temporal (t > 0) subspace. In other words, regardless of how small the particle is, it has to be temporal (t > 0), otherwise it cannot exist within our temporal (t > 0) universe.

As science progresses from Newtonian [5] to statistical mechanics [6], "time" has always been regarded as an "independent" variable with respect to substance or subspace. And this is precisely what modern physics has had been used the same timeless (t = 0) platform, for which they have treated time as an "independent" variable. Since Heisenberg [3] was one of the earlier starters in quantum mechanics, I have found that his principle was derived on the same timeless (t = 0) platform as depicted in **Figure 1**. And this is the "same" platform used in developing Hamiltonian classical mechanics [7]. Precisely, this is the reason why Schrödinger's quantum mechanics is "timeless (t = 0)" [8], since quantum mechanics is the legacy of Hamiltonian.

In view of **Figure 1**, we see that the background of the paradigm is a piece of paper, which represents a timeless (t = 0) subspace; it is "not" a physical realizable

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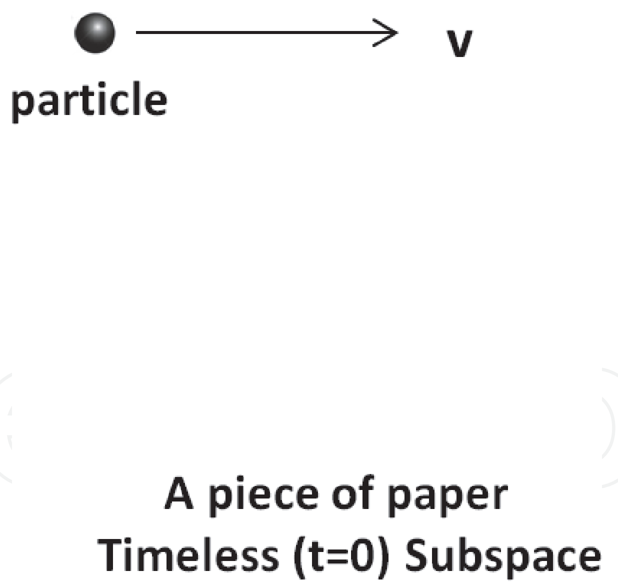

Figure 1.
A particle in motion within a timeless (t = 0) subspace. v is the velocity of the particle.

model since particle and empty space are mutually exclusive. Notice that total energy of a "Hamiltonian particle" in motion is equal to its kinetic energy plus the particle's potential energy as given by [7];

$$\mathcal{H} = \mathrm{p}^2/(2\mathrm{m}) + \mathrm{V} \tag{1}$$

which is the well-known Hamiltonian equation, where p and m represent the particle's momentum and mass, respectively, and V is the particle's potential energy. Equivalently, Hamiltonian equation can be written in the following form as applied for a "subatomic particle";

$$\mathcal{H} = -\left[\mathrm{h}^2/\left(8\pi^2\mathrm{m}\right)\right]\ \nabla^2 + \mathrm{V} \tag{2}$$

where h is Planck's constant, m and V are the mass and potential energy of the particle, and ∇^2 is a Laplacian operator;

$$\nabla^2 = \frac{\partial^2}{\partial \mathrm{xi}\ \partial \mathrm{xj}}$$

We note that Eq. (2) is the well-known "Hamiltonian Operator" in classical mechanics.

By virtue of "energy conservation", Hamiltonian equation is written as

$$\mathcal{H}\psi = \{-\left[\mathrm{h}^2/(8\pi^2\mathrm{m})\right]\ \nabla^2 + \mathrm{V}\}\psi = \mathrm{E}\ \psi \tag{3}$$

where ψ is the wave function that remains to be determined and E and V are the energy factor and potential energy that need to be incorporated within the equation. And this is precisely where Schrödinger's equation was derived from; by using the energy factor E = hυ (i.e., a quanta of light energy) adopted from Bohr's atomic model [9], Schrödinger equation can be written as [7]

$$\frac{\partial^2\psi}{\partial x^2} + \frac{8\pi^2\mathrm{m}}{h^2}(E - V)\psi = 0 \tag{4}$$

In view of this Schrödinger's equation, we see that it is essentially "identical" to the Hamiltonian equation, where ψ is the wave function that has to be determined, m is the mass of a photonic-particle (i.e., photon), E and V are the dynamic quantum state energy and potential energy of the particle, x is the spatial variable, and h is Planck's constant.

Since Schrödinger's equation is the "core" of quantum mechanics, but without Hamiltonian's mechanics, it seems to me that we would "not" have the quantum mechanics. The "fact" is that quantum mechanics is essentially "identical" to Hamiltonian mechanics. The major difference between them is that Schrödinger used the dynamic quantum energy E = hυ as adapted from a quantum leap energy of Bohr's hypothesis, which changes from classical mechanics to quantum "leap" mechanics or quantum mechanics. In other words, Schrödinger used a package of wavelet quantum leap energy hυ to equivalent a particle (or photon) as from "wave-particle dynamics" of de Broglie's hypothesis [10], although photon is "not" actually a real particle. Nevertheless, where the mass m for a photonic particle in the Schrödinger's equation remains to be "physically reconciled", after all science is a law of approximation. Furthermore, without the adaptation of Bohr's quantum leap hυ, quantum physics would not have started. It seems to me that quantum leap energy E = hυ has played a "viable" role as transforming from Hamiltonian classical mechanics to quantum mechanics, which Schrödinger had done to his quantum theory.

Although Schrödinger equation has given scores of viable solutions for practical applications, at the "same time", it has also produced a number of fictitious and irrational results which are not existed within our universe, such as his Fundamental Principle of Superposition, the paradox of Schrödinger's Cat [8], and others.

In view of Schrödinger's equation as given by Eq. (4), we see that it is a timeless (t = 0) or time-independent equation. Since the equation is the "core" of Schrödinger's quantum mechanics, it needs a special mention. Let me stress the essence of energy factor E in the Hamiltonian equation. Since Schrödinger equation is the legacy of Hamiltonian, any wave solution ψ emerges from Schrödinger equation depends upon the E factor. In other words aside the embedded subspace, solution comes out from Schrödinger equation whether is it a physical realizable; it depends upon the E factor that we introduced into the equation. As referring to the conventional Hamiltonian mechanics, if we let the energy factor E be a "constant" quantity that exists at time $t = t_0$, which is "exactly" the classical mechanics of Hamiltonian, this means that the Hamiltonian will take this value of E at $t = t_0$ and evaluates the wave function ψ as has been given by [7]:

$$\psi = \psi_0 \ \exp\left[-i\, 2\pi\, E(t{-}t_0)/h\right) \tag{5}$$

which is the Hamiltonian wave equation, where ψ_0 is an arbitrary constant, h is Planck's constant, and a constant energy factor $E(t - t_0)$ occurs at $t = t_0$. Although Hamiltonian wave equation is a time-variable function, it is "not" a time-limited solution, for which we see that it "cannot" be implemented within our temporal (t > 0) universe, since time unlimited solution cannot exist within our universe. This means that, wave solution ψ of Eq. (5) is "not" a physical realizable solution.

Then a question is being raised, why the Hamiltonian wave solution is time unlimited? The answer is trivial that Hamiltonian is mathematics and his mechanics was developed on an empty timeless (t = 0) platform as can be seen in **Figure 1**. Since it is the subspace that governs the mechanics, we see that particle-wave dynamics cannot exist within a timeless (t = 0) subspace. But Hamiltonian is mathematics and Hamilton himself is a theoretician; he could have had implanted a particle-wave dynamic into a timeless (t = 0) subspace, although timeless (t = 0) subspace and physical particle cannot coexist. Of which this is precisely all the scientific laws, principles, and theories were mostly developed on a piece or pieces of papers, since science is mathematics. This is by no means that timeless (t = 0) laws, principles, and theories were wrong [11], yet they were and "still" are the foundation and cornerstone of our science. However, it is their direct implementation within our temporal (t > 0) universe and also added a score of their solutions are irrational and virtual as "pretending" existed within our temporal (t > 0) subspace, for example, superposition principle of quantum mechanics, paradox of Schrödinger's cat, time traveling, and many others.

Nevertheless as we refer to **Figure 1**, immediately we see that it is "not" a physically realizable model that should be used in the first place. Secondly, even though we pretend that the particle in motion within can exist in an empty space, a question is being asked: how can a particle-wave dynamic propagate within an empty space? Thirdly, even though we assumed wave can be exited within an empty space, why it has to be time unlimited? From all these physical reasons, we see that time unlimited Hamiltonian wave equation of Eq. (5) is "not" a physically realizable solution, since it only existed within a timeless (t = 0) virtual mathematical space, which is similar within a Newtonian space, where time has been treated as an "independent" variable.

Since Schrödinger's mechanics is the legacy of Hamiltonian mechanics, firstly we see that Schrödinger's quantum "mechanics" is a solution as obtained from Hamiltonian's mechanics. Secondly, the reason why Schrödinger's quantum mechanics is timeless (t = 0) is the same reason as Hamiltonian, because its subspace is empty. Nevertheless, the major differences between Schrödinger's mechanics and Hamiltonian mechanics must be the name sake of "quantum", where comes Bohr's atomic quantum leap E = hυ, a quanta of light as shown in **Figure 2**, that Schrödinger has used for the development of his mechanics. This is precisely since Schrödinger's solution is very similar to Hamiltonian of Eq. (3) as given by [7],

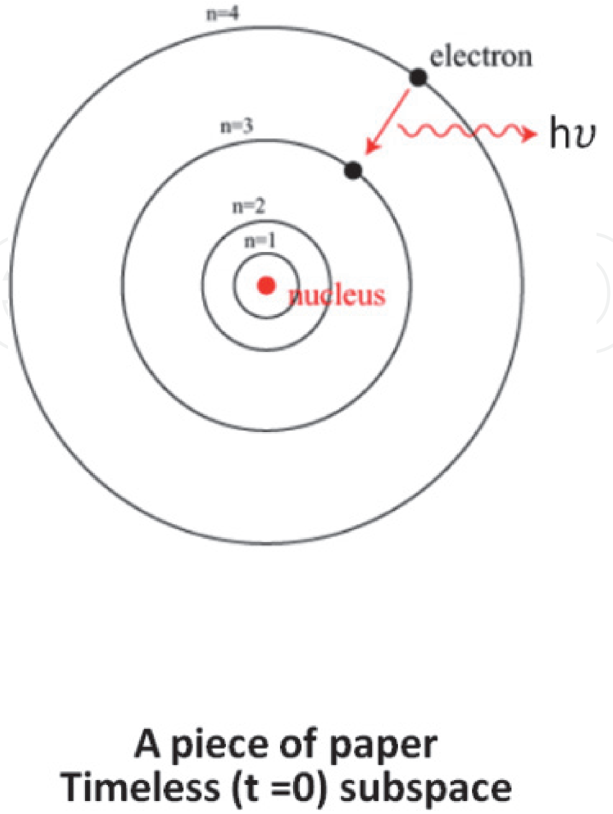

Figure 2.
Bohr atomic model embedded in a timeless (t = 0) platform (i.e., a piece of paper).

$$\psi(t) = \psi_0 \ \exp\left[-i\, 2\pi\, \upsilon\, (t\text{–}t_0)/h\right] \quad (6)$$

which is the well-known Schrödinger wave equation, where ψ_0 is an arbitrary constant, $h\upsilon$ is the frequency of the quantum leap, and h is Planck's constant.

As anticipated, Schrödinger wave equation is also a "time unlimited" solution with "no" bandwidth. For the same reason as Hamiltonian, Schrödinger wave equation is "not" a physically realizable solution that can be implemented within our temporal ($t > 0$) universe, since any physically realizable wave equation has to be "time and band limited". Yet, many quantum scientists have been using this time unlimited solution to pursuing their dream for quantum supremacy computing [12] and communication [13] but "not" knowing the dream they are pursuing is "not" a physically realizable dream.

Since quantum mechanics is a "linear "system machine, similar to Hamiltonian mechanics, for a multi-quantum state energies atomic particle, the energy E factor to be applied in the Schrödinger's equation is a "linear" combination of those quantum state energies as given by

$$E = \Sigma h\upsilon_{n,}\ n = 1, 2, \ldots N \quad (7)$$

where υ_n is the frequency for the nth quantum leap, and h is Planck's constant. Therefore, the overall wave equation is a linear combination of all the wave functions as given by

$$\psi_N(t) = \Sigma\, \psi_{0n} \ \exp\left[-i\, 2\pi\, \upsilon_n\, (t\text{–}t_{0n})/h\right], n = 1, 2, \ldots N \quad (8)$$

in which we see that all the wave functions are "super-imposing" together. This is precisely the Fundamental Principle of Superposition of Schrodinger. Yet, this is the principle that Einstein "opposed" the most as he commended as I quote: "mathematics is correct, but incomplete", published in The New York Times newspaper in 1935 [14]. And it is also the fundamental principle that quantum computing scientists are depending on the "simultaneous and instantaneous" superposition that quantum theory can offer to develop a quantum supremacy computer. But I will show that the superposition is a timeless ($t = 0$) principle and it does "not" exist within our universe.

Before I get started, it is interesting to show a hypothetical scenario of "superposition in life". If we assumed our life-expectancy can last for about 500 years, then we would have very good chance to coexist with Isaac Newton and possibly with Galileo Galilei somewhere in "time". Furthermore, if our universe is a "static" universe or timeless ($t = 0$), then we are also very likely to coexist with Galileo and Newton not only in "time" but superimposing with them everywhere in a timeless ($t = 0$) space. And this is precisely what "simultaneous and instantaneous" superposition can do for us, if our universe is timeless ($t = 0$) subspace.

As we understood from the preceding illustration, we know that any empty (i.e., timeless) subspace cannot be found within our universe. And we have also learned that within our universe, every quantum leap $h\upsilon$ has to be temporal ($t > 0$), that is time- and band-limited; otherwise it cannot be existed within our universe.

In view of Eqs. (7) and (8)), we see that they are time "unlimited" wave functions, and it is trivial to see that all of those wave functions, $\psi_N(t)$, n = 1, 2 … N, are superimposing together at all times. Similar to an example that I had postulated earlier, if our life expectancy can be extended to 500 years, we would be coexist with Einstein and may be with Newton somewhere in time, although 500 years of life-expectancy is time limited. But again, time unlimited wave function is "not" a physical real function, since it cannot exist within our temporal ($t > 0$) universe.

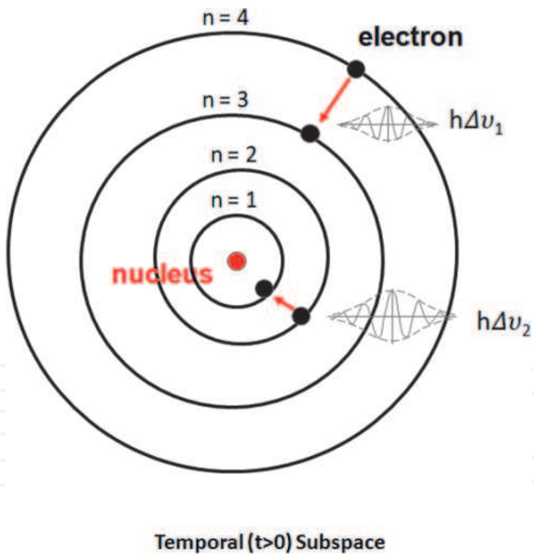

Figure 3.
A multi-quantum state atomic model embedded within a temporal subspace.

In order to mitigate the temporal (t > 0) requirement or the causality condition of those wave functions $\psi_N(t)$, we can "reconfigure" each of the wave function to becoming temporal (t > 0). In other words, we can reconfigure each of the wave function to "comply" with the temporal (t > 0) condition within our universe. For example, as illustrated in **Figure 3** we see that each of the quantum leap hΔυ is represented by "time limited" wavelets.

by which it can be shown that "reconfigured" wave functions are approximated by

$$\psi\ (t) = \Sigma\, \psi_{on}\ \exp\ \left[-\alpha_{on}\ (t - t_{on})^2\right]\ \cos\ (2\pi\upsilon_n t), t > 0, n = 1, 2, 3. \qquad (9)$$

$$\psi\ (t) = 0, t \leq 0 \qquad (10)$$

where t > 0 denotes equation is subjected to temporal (t > 0) condition, in words exited only in positive time domain. In view of these equations we see that the packages of quantum leaps are "likely" temporal separated, in which we see that all the wavelets are very "unlikely" to be "simultaneous and instantaneous" superposing together. Once again, we have proven that Schrödinger's fundamental principle of superposition "fails" to exist within our temporal (t > 0) universe.

3. Timeless (t = 0) space do to particles

On the other hand, if we take the preceding physical realizable wave functions of Eq. (9) and implement them within a timeless (t = 0) subspace, then it is trivial to see that how a timeless (t = 0) subspace can do to all the wave-particle dynamics within a timeless (t = 0) subspace. Since within a timeless (t = 0) space it has no time and no dimension, all wave-particles (i.e., package of wavelets) will be collapsed at t = 0, as can be seen in **Figure 4**.

Before this goes on, I would say that the wave-particle duality is a "nonphysical" reality assumption to "equivalence" a package wavelet of energy to a particle in motion, which is strictly from a statistical mechanics point of view, where momentum of a particle p = h/λ is conserved [7]. However, one should "not" be treated wave or a package of wavelet energy hΔυ as a particle or particle as wave. It is the package of wavelet energy "equivalent" to particle dynamics (i.e., photon), but they are "not" equaled [15]. Similar to Einstein's energy equation, mass is equivalent to energy and energy is equivalent to mass, but mass is not equal to energy and energy is not mass, for which quanta of light $h\Delta\upsilon$ or a "photon" is a "virtual" particle, in which we see that a photon has a momentum $p = h/\lambda$ but no mass, although many quantum scientists regard a photon as a physical real particle.

In view of **Figure 4** we see that within a timeless ($t = 0$) space, it has no time and no space; every particle exists anywhere within a timeless ($t = 0$) space but only exited at $t = 0$. This is precisely what the "simultaneous and instantaneous" superposition of Schrödinger's principle is anticipated for, since this is the fundamental principle that quantum scientists are aiming for, to build a quantum supremacy computer. This is as well applied to quantum entanglement communication, but unfortunately, the "simultaneous and instantaneous" superposition does "not" exist within our universe, of which we have had shown that superposition principle exists "if and only if" in a mathematical virtual timeless ($t = 0$) space, and it cannot exist within our temporal ($t > 0$) universe.

The reason that superposition principle "fails" to exist is coming from a nonphysical realizable paradigm used in the analysis, which can be traced back to the development of Hamiltonian mechanics, since quantum mechanics is an extension of Hamiltonian. I have found that it is the background subspace (i.e., a piece of paper) used in quantum mechanical analysis. Since the background represents an "inadvertently" empty timeless ($t = 0$) subspace, where a photonic particle in motion was embedded, it is also that piece of paper that Bohr's atomic model was used, added his quantum state energy $h\upsilon$ is not a time limited physical reality.

Aside the substance and emptiness are mutually excluded; it is the subspace that governs the behavior of each wave functions $\psi_n(t)$. In which within a timeless ($t = 0$) subspace, we have shown all the wave functions $\psi_N(t)$, regardless time limited or time unlimited, collapse all together at $t = 0$. In other words, all the quantum state wavelets superimposed at a "singularity" $t = 0$. This is the reason that superposed quantum state energies can be found anywhere and everywhere within a virtual mathematical timeless ($t = 0$) space, since a timeless ($t = 0$) space has no distance.

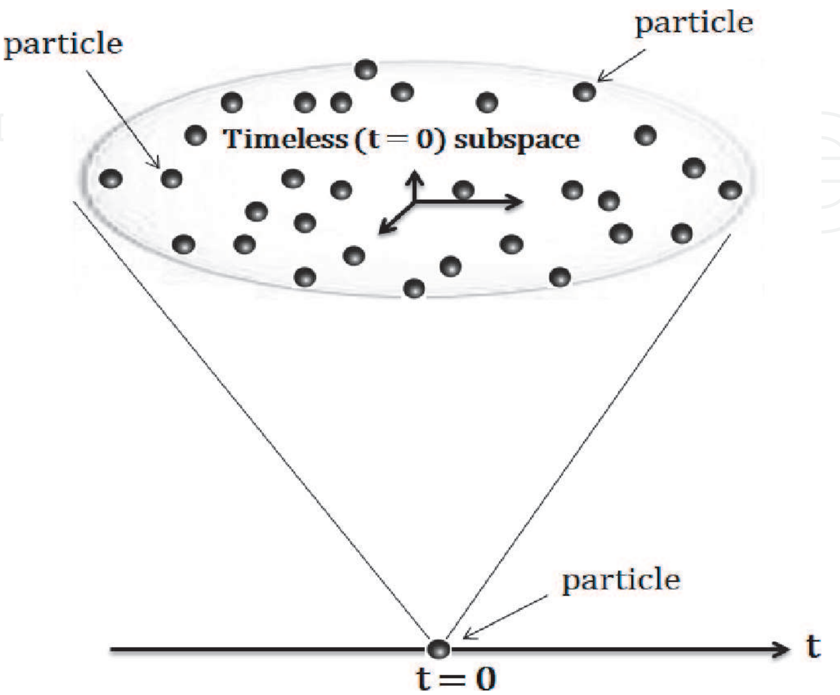

Figure 4.
All the particles within a timeless ($t > 0$) subspace actually have done; converges all the particles at $t = 0$.

From this illustration, we have shown once again that; it is not how rigorous the mathematics is, it is the physical realizable paradigm determines her analytical solution is physical realizable or not? For which we see that; the wave functions as obtained from Schrödinger equation is virtual as mathematics is, because Schrödinger's quantum mechanics was developed on an empty subspace platform, the same platform as Hamiltonian classical mechanics.

4. Schrödinger's cat

When we are dealing with quantum mechanics, it is inevitable not to mention Schrödinger's cat since it is one of the most elusive cats in the science since Schrödinger's disclosed it in 1935 at a Copenhagen forum. Since then his half-life cat has intrigued by a score of scientists and has been debated by Einstein, Bohr, Schrödinger, and many others as soon as Schrödinger disclosed his hypothesis. And the debates have been persisted for over eight decades, and still debating. For example, I may quote one of the late Richard Feynman quotations as: "After you have leaned quantum mechanics, you really "do not" understand quantum mechanics … ".

It is however not the art of the Schrödinger's half-life cat; it is the paradox that quantum scientists have treated it as a physical "real paradox". In other words, many scientists believed the paradox of Schrödinger's cat actually existed within our universe, without any hesitation. Or literally "accepted" superposition is a physical reality, although fictitious and irrational solutions have emerged; it seems like looking into the Alice wonderland. In order to justify some of their believing some quantum scientists even come up with their believing; particle behaves weird within a microenvironment as in contrast within a macro space. Yet, some of their potential applications such as quantum computing and quantum entanglement communication are in fact in macro subspace environment. Nevertheless, I have found many of those micro behaviors are "not" existed within our universe; and the paradox of Schrödinger's cat is one of them, as I shall discuss briefly in the following:

Let us start with the Schrödinger's box as shown in **Figure 5**; inside the box we have equipped a bottle of poison gas and a device (i.e., a hammer) to break the

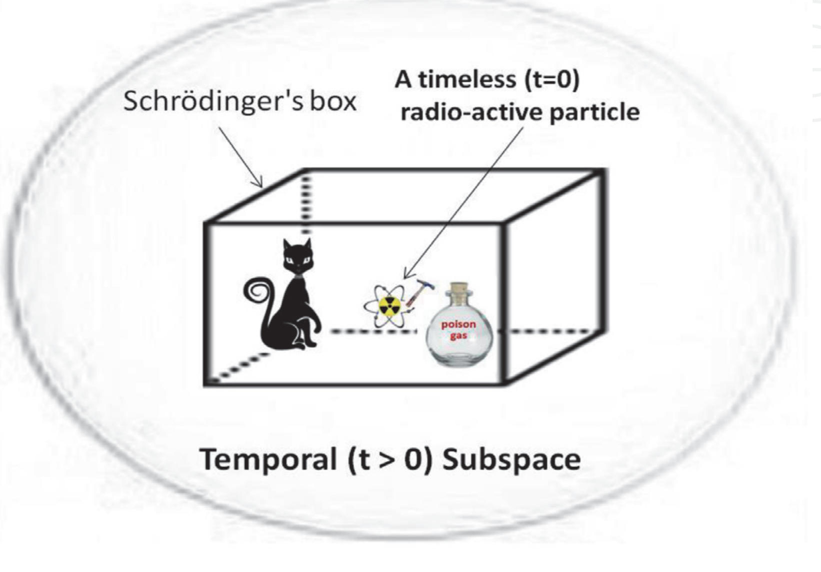

Figure 5.
Inside the box we equipped a bottle of poison gas and a device (i.e., hammer) to break the bottle, triggered by the decaying of a radio-active particle, to kill the cat.

bottle, triggered by the decaying of a radio-active particle, to kill the cat. Since the box is assumed totally opaque of which no one knows that the cat will be killed or not, as imposed by the Schrödinger's superposition principle until we open his box.

As we investigate Schrödinger's hypothesis of **Figure 5**, immediately we see that; it is "not" a physical realizable postulation at all, since within the box it has a timeless $(t = 0)$ or time independent radioactive particle in it. As we know that; any particle within a temporal $(t > 0)$ subspace has to be a temporal $(t > 0)$ particle or has time with it, otherwise the proposed radioactive particle cannot be existed within Schrödinger's temporal $(t > 0)$ box. It is therefore, the paradox of Schrödinger's cat is "not" a physical realizable hypothesis and we should "not" have had treated Schrödinger's cat as a physically real paradox.

Since every problem has multi solutions, I can change the scenarios of Schrödinger's box a little bit, such as allow a small group of individuals take turn to open the box. After each observation, close the box before passing on to the next observer. My question is that how many times the superposition has to collapse? With all those apparent contradicted logics, we see that Schrödinger's cat is "not" a paradox after all! And the root of timeless $(t = 0)$ superposition principle as based on Bohr's quantum leap $h\upsilon$, represents a time "unlimited" radiator, which is a singularity approximated wave solution. For which we should "not" have treated quantum leap $h\upsilon$ a physical real radiator, since any quantum leap has to be time and band limited within our universe.

Finally I would address that; all the laws, principles, theories and paradoxes were made to be broken, revised and replaced, it is not they were all approximated, because they all changes with time or temporal $(t > 0)$. Yet, without approximated science, then there would be no science in which we have shown that a simple hypothetical paradox takes decades to resolve! And this is the nature of quantum mechanics and is all about temporal $(t > 0)$ subspace.

5. Nature of Δt

Since our universe was assumed created with a huge energy explosion with time situated within a "non-empty" space. Every subspace "no" matter how small is created by an amount of energy ΔE and a section of time Δt for which every subspace is temporal $(t > 0)$ (i.e., existed with time).

In view of modern science, there is a set of simple, yet elegant laws and principles that are profoundly associated with a unit of $(\Delta E\ \Delta t)$. The objective of this section is to explore the relationship between these laws and principles as related with the unit of $(\Delta E, \Delta t)$. Since time is a dependent forward variable moves at a constant speed, we see that Δt is one of the most "esoteric" variable existed within our universe. We will show that once a moment of Δt is used, we "cannot" get it back although ΔE and Δt can be traded. In which I will show that; there it is a physical limit for Δt to approaching to "none" (i.e., $\Delta t \longrightarrow 0$), that "prevents" us to reach; even though we have the all the price to pay. And this must be the nature of Δt?

Nevertheless, there is a set of "simple and elegant" laws and principles that are profoundly associated with a section of time Δt. These are laws and principle of entropy of Boltzmann [4], information of Shannon [16], uncertainty of Heisenberg [3], relativity of Einstein [1] and temporal $(t > 0)$ universe [17]. Each of them has associated with a section of time Δt which changes naturally with time. And all these evidences tell us science has to be temporal $(t > 0)$ and dynamics, which cannot be "static" or timeless $(t = 0)$. In other words, if there has no time, then there has no science. Nevertheless, science is a law of "approximation", as in contrast

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with mathematics, which is an axiom of "certainty", of which I state these laws and principles "approximately" as follows:

Law of entropy; entropy within an enclosed subspace increases naturally "with time" or remains constant.

Theory of information; the higher the amount the information, the more uncertain the information is.

Principle of uncertainty; uncertainty of an isolated particle increases naturally "with time".

Theory of special relativity; when a subspace moves faster "relatively" than the other subspace; there is a "relativistic" time speed between them, although time speed within the subspaces remains the same.

Nature of universe; every isolated subspace was created by amount of energy ΔE and a section of time Δt and it is a dynamic temporal (t > 0) stochastic subspace changes naturally with time.

Nevertheless, it is easier to facilitate these laws and principles in mathematical forms, since mathematics is a "language", as given by

$$S = -k \ \ln \ p \tag{11}$$

$$I = -\log_2 p \tag{12}$$

$$\Delta E \ \Delta t \geq h \tag{13}$$

$$\Delta t' = \frac{\Delta t}{\sqrt{1 - v^2/c^2}} \tag{14}$$

$$U : \Delta E \ \Delta t \geq (\Delta mc^2)\Delta t, \ \Delta E \ \Delta t \geq h \tag{15}$$

where S, I, and U are entropy, information and universe respectively, k is the Boltzmann's constant, h is the Planck's constant, p is the probability, Δt is a section of time, Δt' is the dilated section of time, v is the velocity, m is the mass and c is the speed of light. k = 1.38×10^{-16} ergs per degree centigrade and h = 6.624×10^{-27} erg-second.

In this we see that our universe was created by means a "huge" amount of energy ΔE and a "long" section of time Δt. And Δt is "still" extending rapidly, since the boundary of our universe is still expanding at the speed of light [17].

In view of these laws and principles, they must be the most "elegant and simple" science equations that existed today in which these equations either attached or associated with a section of time Δt, except Eq. (12) since information theory is mathematics. But as soon information is recognized as related to entropy, information is equivalent to an amount of entropy; this makes an amount of information a physical quantity which is acceptable in science. For which we will show that a section of Δt will be associated with the theory of information, otherwise information will be very difficult to apply in science. Since Δt is coexisted with ΔE, we will further see that; every bit of information takes an amount of energy ΔE and a section of time Δt to transmit, to create, to process, to store, to process and to "tangle".

As we got back from Eq. (11) to Eq. (15) we see that; they are all point-singularity approximated; otherwise it will be very difficult to write in simple mathematical forms. As the laws and principles stated, there are all associated with time, by which they are all space-time variable laws and principles, since time is space and space is time within our temporal (t > 0) universe. In short, they are all connected to a unit of (Δt, ΔE) which is the basic building blocks of our universe. For which I envision that; every existence within our universe has a beginning and has an end. But it is time; it has "no" beginning and has "no" end!

Since our temporal ($t > 0$) universe was created based on a commonly accepted Big Bang Theory [17], we see that our universe as is a temporal ($t > 0$) dynamic "stochastic" subspace [18]. The boundary of our universe increases at the speed of light, we see that; every subspace within our universe is a "nonempty" temporal ($t > 0$) stochastic subspace. By the way, any one or two dimensional subspaces "cannot" be existed within our universe, since one or two dimensional subspaces are volume-less for which any independent Euclidian subspace "cannot" be simply applied to describe a temporal ($t > 0$) subspace. Because all the dimensional coordinates (e.g., x y z coordinates) of a temporal space are all "interdependent" with time, where time is a forward variable with respect to the subspace. In other words, every substance no matter how small it is, has to have time and temporal ($t > 0$).

In view of the time dilation of Einstein's relativity of Eq. (14) and Heisenberg's uncertainty principle of Eq. (13); we see that they are associated with a section of time Δt; which represents a "temporal ($t > 0$)" subspace, as given by;

$$\Delta r = c\ \Delta t$$

where r is the radius of a spherical subspace and c is the velocity of light. In which we see that subspace enlarges rapidly as Δt increases is given by

$$V = (3/4)\ \pi\ (c\ \Delta t)^3 \tag{16}$$

This shows precisely our universe is expanding with a section of time Δt. Since ΔE is a physical quantity equivalent to a subspace that "cannot" be empty and coexisted with Δt, then every unit (ΔE, Δt) is a temporal ($t > 0$) subspace, in which we see that time and space "cannot" be separated. In other words, time and space are "interdependent" although ΔE is a physical quantity but Δt is an invisible "real" variable.

6. Entropy and information

As we look back at Boltzmann entropy Eq. (11), we see that it is a typical timeless ($t = 0$) point-singularity approximated equation. But the law described; entropy increases with "time", implies that entropy is associated with a section of time Δt, although it is "not" shown in the equation. Nevertheless, law of entropy is essentially identical to the law of information as can be seen by their logarithmic expressions of Eq. (11) and Eq. (12), for which we have the following relationships as given by [19];

$$S = k\, I\ \ln\ 2 \tag{17}$$

where I is an amount of information in "bit" and k is Boltzmann's constant in which we see that, "every bit" of information is equal to an amount of entropy ΔS which is given by

$$\Delta S = k\ \ln\ 2,\ \text{per bit of information} \tag{18}$$

Although an amount of information can be "traded" for a quantity of entropy, but entropy is a "cost" in energy "equivalents" to an amount of information, but "not" the "actual" information. In other words, it is a "necessary cost" of an amount of entropy to pay for an amount of information in bits. For example, if an amount of entropy ΔS is equivalent to 1000 bits of information of a specific book. Then how many books have the same 1000 bits or how many different items has also 1000 bits? Similarly, an amount of information in bits is not given us the actual information, but it is a "necessary cost" but "not sufficient" to obtain the precise information. In which we see that; the amount of entropy ΔS is a "necessary cost" needed to obtain an equivalent number of information in bits.

Since entropy is a "physical quantity" similar to energy, as given by

$$\Delta S = \Delta E / T = h \Delta \upsilon / T \tag{19}$$

where $\Delta E = h\Delta\upsilon$ is the quantum leap energy and $T = C + 273$ is the absolute temperature in Kelvin, C is the temperature in degree Celsius. In which we see that; higher the thermal noise requires higher energy to transmit a of bit information.

$$\Delta E = T\,k\,\ln\,2 \tag{20}$$

Thus, we see that an amount of entropy is equivalent to an amount of information, but it is "not" the information. But an amount of information is equivalent to an amount of entropy that makes information a very "viable" physical quantity can be applied in science. In which we see that; information and entropy can be simply traded as given by

$$\Delta S \Longleftrightarrow \Delta I \tag{21}$$

Nevertheless, we have shown that; either information or entropy has to be a temporal $(t > 0)$ or time dependent law, as given by respectively;

$$I(t) = -\log_2 p(t), t > 0 \tag{22}$$

$$S(t) = -k\,\ln\,p(t), t > 0 \tag{23}$$

where k is the Boltzmann's constant. In which we see that either information or entropy "increases" with time, and $(t > 0)$ denotes imposition by temporal $(t > 0)$ constraint. The amount of entropy for $I(t)$ bits of information can be written as

$$S(t) = k\,I(t)\,\ln 2, t > 0 \tag{24}$$

where $I(t)$ is in bits and k is the Boltzmann's constant. In view of preceding equation, it shows that entropy increases as amount information increases. In which we see that "every bit" of information ΔI takes an amount of energy ΔE and a section of time Δt to "create" or to transmit as given by

$$\Delta I \sim \Delta E\;\Delta t = h, \text{per bit of information} \tag{25}$$

Since "every bit" of information is equivalent to an amount of entropy ΔS,

$$\Delta S = k\;\ln\;2, \text{per bit of information} \tag{26}$$

Thus, every quantity of entropy ΔS is "equivalently" equaled to an amount of energy ΔE and a section of time Δt to produce as shown by

$$\Delta S = \Delta E / T \tag{27}$$

where $T = C + 273$ is the absolute thermal noise temperature in Kelvin, C is the temperature in degree Celsius, h is the Planck's constant. Since ΔE is "coexisted" with Δt, it is reasonable to say that; every ΔS is also associated with a section of time Δt as given by

$$\Delta S \sim E\,\Delta t/T = h/T, \text{per bit of information} \tag{28}$$

In which we see that information is connected with the law of uncertainty, where "every bit" of information is profoundly associated with ΔE and Δt.

Since every subspace within our universe is created by an amount of energy ΔE and a section of time Δt, we see that; Boltzmann's entropy, Shannon's information, Heisenberg's uncertainty and Einstein's relativity has a profound association with a section of Δt and of ΔE since they are coexisted. In other words, all the laws, principles, and theories as well the paradoxes have to comply with the "coexistence" of ΔE and Δt, otherwise those laws and principles cannot guarantee to be existed within our universe.

Nevertheless, increasing entropy is regarded as a "degradation" of energy by Kelvin [19], although entropy was originated by Clausius [19]. But he might have intended it to be used as a "negative" of entropy (i.e., neg-entropy) in which we see that as entropy or amount of information increases means that there is "energy degradation". This is also meant that entropy or amount of information "degrades with time". Let me stress again "energy degradation" within our universe is due to boundary expansion of our universe at the speed of light [17]. For which I see it entropy increases with time is "no longer" a myth, as most scientists believed it is.

Since all the laws and principles are attached with a price-tag of (ΔE, Δt), but it is the $\Delta t \longrightarrow 0$ that "cannot" be reached, even though we assumed having all the energy of ΔE to pay for! This is precisely the "physical" limit of a temporal ($t > 0$) subspace, by which the "instantaneous" moment of time (i.e., $t = 0$) can be approached but can "never" be able to attend, regardless how much of energy ΔE we willing to pay for. And this is the nature of Δt!

7. Uncertainty and information

Every substance or subspace has a piece of information which includes all the elementary particles, basic building blocks of the subspaces, atoms, papers, our planet, solar system, galaxy, and even our universe! In other words, the universe is flooded with information (i.e., spatial and temporal), or information fills up the whole universe. Strictly speaking, when one is dealing with the origin of the universe, the aspect of information has never been absence. Then, one would ask: What would be the amount of information, aside the needed energy ΔE, is required to create a specific substance? Or equivalently, what would be the "cost" of entropy to create it? To answer this question is to let me start with the law of uncertainty, in equivalent form, as given by

$$\Delta \upsilon\ \Delta t = 1 \tag{29}$$

where υ is the bandwidth, in which there exists a profound relationship of an "information cell" [20], as illustrated in **Figure 6**. In which we see that, the shape of (Δυ, Δt) or equivalently (ΔE, Δt) can be "mutually" exchanged. Since every bit of information can be efficiently transmitted, if and only if it is transmitting within the constraint of the uncertainty principle (i.e., $\Delta\upsilon \cdot \Delta t \geq 1$). This relationship implies that the signal bandwidth should be either equal or smaller than the system bandwidth (i.e., $1/\Delta t \leq \Delta\upsilon$). In which we see that Δt and Δυ can be "traded".

It is however the unit region but not the shape of the information cell that determines the limit, as illustrated in **Figure 6**, we see that; within each unit cell, that is (Δυ, Δt) [or equivalently (ΔE, Δt)] can be mutually traded. But it is from Δυ

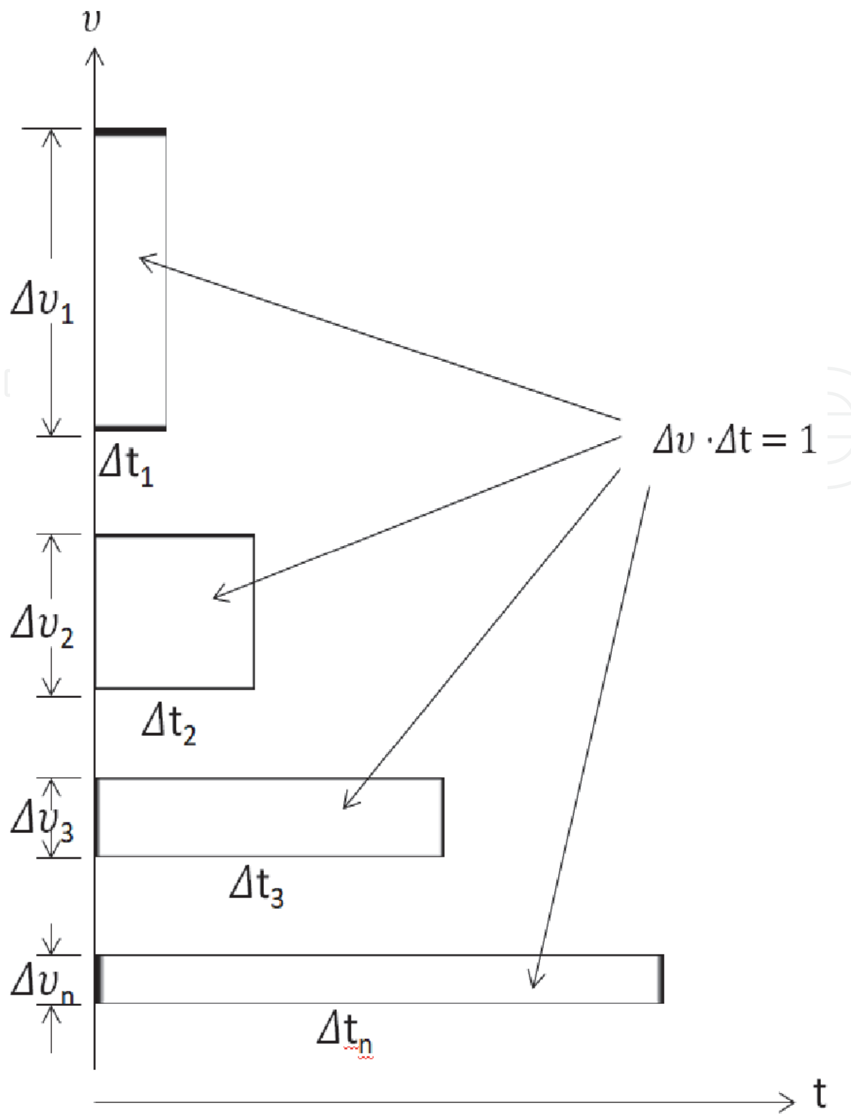

Figure 6.
Various (Δυ, Δt) information cells, where $\Delta\upsilon_n$ and Δt_n are the bandwidths and time-limited sections, and $\upsilon_1 > \upsilon_2 > \upsilon_3 > \ldots > \upsilon_n$ are the frequencies.

to Δt or from ΔE to Δt, since Δυ and ΔE are physical quantities. For which we see that; once a section of Δt is "used", we "cannot" get back the same moment of Δt, although we can create the same section of Δt, since time is a forward dependent variable.

Nevertheless, there are basically two types of information transmission; one is limited by uncertainty Principle and the other is constrained within the "certainty subspace". And the boundary between these two regimes is given by Δυ·Δt = 1 (or ΔE·Δt = h) as I called this limit a Quantum Unit [21]. In which we see that Δυ can be traded for Δt. But under uncertainty regime, information is carried by means of intensity (i.e., amplitude square) variation. Yet, information can also be transmitted within the certainty regime, such as applied to complex-amplitude communication [22, 23]. As limited by the law of uncertainty, a quantum unit subspace QLS, for (ΔE, Δt) and (Δυ, Δt), are shown in **Figure 7** for reference.

Since every subspace within our universe is a temporal (t > 0) subspace, the radius of any subspace can be described by a time-dependent variable as given by

$$r = c \cdot \Delta t \tag{30}$$

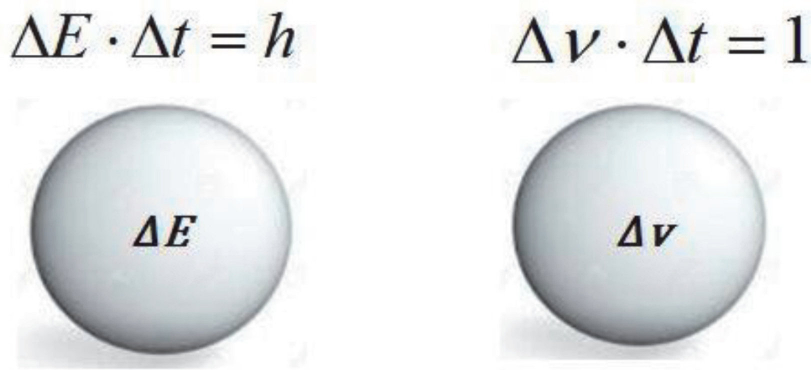

Figure 7.
A set of quantum limited subspaces (QLS). (a) Shows a ΔE limited subspace; (b) Shows a Δυ limited subspace.

where c is the speed of light, and Δt represents a section of time. In which we see that the size of the subspace enlarges rapidly as Δt increases as given by

$$V = (3/4)\, \pi\, (c\, \Delta t)^3 \tag{31}$$

Since the carrier bandwidth Δυ and time resolution Δt are exchangeable, we see that the size of the QLS enlarges as the carrier bandwidth Δυ decreases. In other words, narrower the carrier bandwidth Δυ has the advantage of having a larger quantum limited subspace for complex-amplitude communication as depicted in **Figure 8**.

In this we see that it is possible to create a temporal ($t > 0$) subspace within a temporal ($t > 0$) space (i.e., our universe) for communication. We stress that; it is “not” possible to create any time independent or timeless ($t = 0$) subspace within our temporal universe, since timeless ($t = 0$) or time independent “cannot” be existed within temporal universe. And this timeless ($t = 0$) or the “instantaneous limit” (or the causal condition) is the fact of physical limit (i.e., $\Delta t \longrightarrow 0$) within our universe. This limit can only be approached with huge amount of energy ΔE, but we can “never” be able to reach it?

Furthermore, let me note that; timeless ($t = 0$) or time independent subspace is “not” an “inaccessible” space as some scientists claimed, since inaccessible implies it existed within our universe. Nevertheless, one of the apparent aspects of using large

Figure 8.
A “very large” quantum limited subspace as depicted in (a) can be realized in practice within our temporal (t > 0) space, for example, such as applied to synthetic aperture radar imaging shown in (b).

quantum limited subspace is for complex information transmission, for example, as applied to complex wave front construction (i.e., holographic recording) [23], complex-match filter synthesis [24], as well as synthetic aperture radar imaging [22]. But there is an apparent price paid for using a "wider" section of time Δt; which "deviates" further away from real-time transmission.

8. Reliable communication

One of the important aspects of information transmission is that "reliable" information can be transmitted, such that information can be reached to the receiver with a "high degree of certainty". Let me take two key equations from information theory, "mutual information" transmission through a "passive additive noise channel" as given by [19]

$$I(A;B) = H(A) – H(A/B) \tag{32}$$

and

$$I(A;B) = H(B) – H(B/A) \tag{33}$$

where $H(A)$ is the information provided by the sender, $H(A/B)$ is the information loss (or equivocation) through transmission due to noise, $H(B)$ is information received by the receiver, and $H(B/A)$ is noise entropy of channel.

However, there is a basic distinction between these two equations: one is for "reliable" information transmission and the other is for "retrievable" information. Although both equations represent the mutual information transmission between sender and receiver; but their objectives are rather different. Example; using Eq. (32) is purposely designed for "reliable information transmission" in which the transmitted information has a high degree of "certainty" to reach the receiver. While Eq. (33) is purposely designed to "retrieve information" from "unreliable" information" by the receiver. For which we see that; for "reliable" information transmission, one can simply increase the signal to noise ratio at the transmitting end. While for "unreliable" information transmission is to extract information from ambiguous information. In other words, one is to be sure information will be reached to the receiver "before" information is transmitted, and the other is to retrieve the information "after" information has been received.

In communication, basically there are two orientations: one by Norbert Wiener [25, 26] and the other by Claude Shannon [16]. But there is a major distinction between them; Wiener's communication strategy is that; if the information is corrupted through transmission, it may be recovered at the receiving end, but with a "cost" mostly at the receiving end. While Shannon's communication strategy carries a step further by encoding the information before it is transmitted such that, information can be "reliably" transmitted, also with a "cost" mostly at the transmitting end. In view of the Wiener and Shannon information transmission orientations; mutual information transfer of Eq. (32) is kind of Shannon type, while Eq. (33) is kind of Wiener type. In which we see that; "reliable" information transmission is basically controlled by the sender; It is to "minimize" the noise entropy $H(A/B)$ (or equivocation) of the channel, as shown by

$$I(A;B) \approx H(A) \tag{34}$$

One simple way to do it is by increasing the signal to noise ratio, with a "cost" of higher signal energy (i.e., ΔE).

On the other hand, to recovering the transmitted information is to "maximize" H(B/A) (the channel noise). Since the entropy H(B) at the receiving end is "larger" than the entropy at the sending end; that is H(B) > H(A), we have,

$$I(A;B) = H(B) – H(B/A) \approx H(A) \tag{35}$$

Eq. (35) essentially shows us that; information can be "recovered" after being received, again with a price; ΔE and Δt. In view of these strategies; we see that the cost paid for using Weiner type for information transmission is "much higher" than the Shannon type; aside the cost of higher energy of ΔE it needs extra amount of time Δt for "post processing". Thus, we see that Wiener communication strategy is effective for a "none cooperating" sender, for example, applied to radar detection, and others. One the other hand, Shannon type provides a more reliable information transmission, by simply increasing the signal to noise so that every bit of information can be "reliably transmitted" to the receiver.

Therefore, we see that quantum entanglement communication [13] is basically using Wiener communication strategy. The price will be "much higher and very inefficient", such as post processing is one thing. And it is "illogical" to require the received signal be "more equivocal" (i.e., uncertain); the better the information recovery it can be received at the receiving end. In which quantum entanglement communication is designed for extracting information as Weiner type communication. However, it is "not" the purpose for reliable information-transmission of Shannon.

9. Relativistic transmission

One of most esoteric aspects in time must be Einstein's special theory of relativity [1] as stated approximately as follows: when a subspace moves faster than the other, there is a "relative" time speed between them, although time speed within the subspaces is the "same". In this we see that the "relativistic time" within a vast cosmological space may not be the same. Let me start with the relativistic time dilation as given by

$$\Delta t' = \frac{\Delta t}{\sqrt{1 - v^2/c^2}} \tag{36}$$

where Δt′ is the relativistic time window, as compared with the time window Δt of a standstill subspace; v is the velocity of a moving subspace; and c is the velocity of light. In which we see that time dilation Δt′ within a moving subspace, "relative" to the time duration of the standstill subspace Δt, appears to be wider as velocity increases.

In view of law of uncertainty limit as given by

$$\Delta E \ \Delta t = h \tag{37}$$

we see that every subspace is limited by ΔE and Δt. In other words, it is the h region, but not the shape of that determines the boundary of (ΔE, Δt). For example, the shape can be either elongated or compressed, as long as it is equaled to h region, as can be seen depicted in **Figure 6**.

Incidentally, the uncertainty limit of Eq. (37) is also the limit of "reliable" bit information transmission [16]. Nonetheless the connection with the special theory of relativity is that; subspaces near the edge of our universe will receive a "narrower" section of relativistic time (Δt') with respect to an standstill subspace, since relativistic dilation time window is wider Δt' > Δt. In which we see that; "relativistic" uncertainty within the moving subspace, as with respect to a standstill subspace, can be shown as given by

$$\Delta E\ \Delta t'[1-(\nu/c)^2]^{1/2} = h \tag{38}$$

Or equivalently we have,

$$\Delta \upsilon\ \Delta t'[1-(\nu/c)^2]^{1/2} = 1 \tag{39}$$

In which we see ΔE energy is "conserved". Thus a "narrower" time-window Δt can be squeeze as with respect to standstill subspace. This is precisely physically possible to exploit for "time-domain" digital communication, as from ground station to satellite information transmission.

One the other hand, as from satellite to ground station digital-transmission, we might want to use digital-bandwidth (i.e., Δν). This is a "frequency-domain" information transmission strategy, as in contrast with time-domain, which has "not" fully exploited yet. In which the "relativistic" uncertainty relationship within the standstill subspace as with respect to the moving subspace can be written as

$$\frac{\Delta E\ \Delta t}{\sqrt{1-\left(\frac{\upsilon}{c}\right)^2}} = h \tag{40}$$

Or equivalently we have,

$$\frac{\Delta \upsilon\ \Delta t}{\sqrt{1-\left(\frac{\upsilon}{c}\right)^2}} = 1 \tag{41}$$

In this we see that a narrower bandwidth Δv can be used for "frequency domain" digital communication.

Nevertheless, the essence of ΔE Δt = h (or Δυ Δt = 1) shows that ΔE and Δt or Δυ and Δt can be mutually traded. Again, trading from ΔE for Δt or equivalently from Δυ for Δt is physically viable, since ΔE and Δυ are physical quantities and Δt is "not". Since Δt is coexisted with ΔE (or equivalently with frequency Δυ), we can change Δt, but we "cannot" change the speed of time. In other words, it is time dictates the science but "not" science changes or "curves" the speed of time. In which we have shown that in principle, we can "squeeze" Δt as small as we wish with a huge price of ΔE, but we can "never" able to squeeze Δt to zero (i.e., Δt = 0). In which we see that; it is "not" possible to transmit a "bit" of information "instantaneously" (i.e., t = 0) within our temporal (t > 0) universe.

Since digital communication requires a "narrower" Δt for rapid transmission and complex amplitude communication needs a "wider" Δt for transmission, this is what communication between satellites and ground stations can do with the "relativistic" uncertainty principle. For example, using digital transmission from ground station to satellite stations has the advantage to squeeze the relativistic Δt somewhat at receiving satellite station. On the other hand, from a satellite station to ground stations, one might use wider relativistic Δt for digital frequency signal transmission. Wider Δt also offers a lager "certainty" communication space for complex wave front transmission [22].

Let me assume a "relativistic" communication scenario as depicted in **Figure 9**, in which we assume Q1 and Q2 satellite stations situated within two distinct

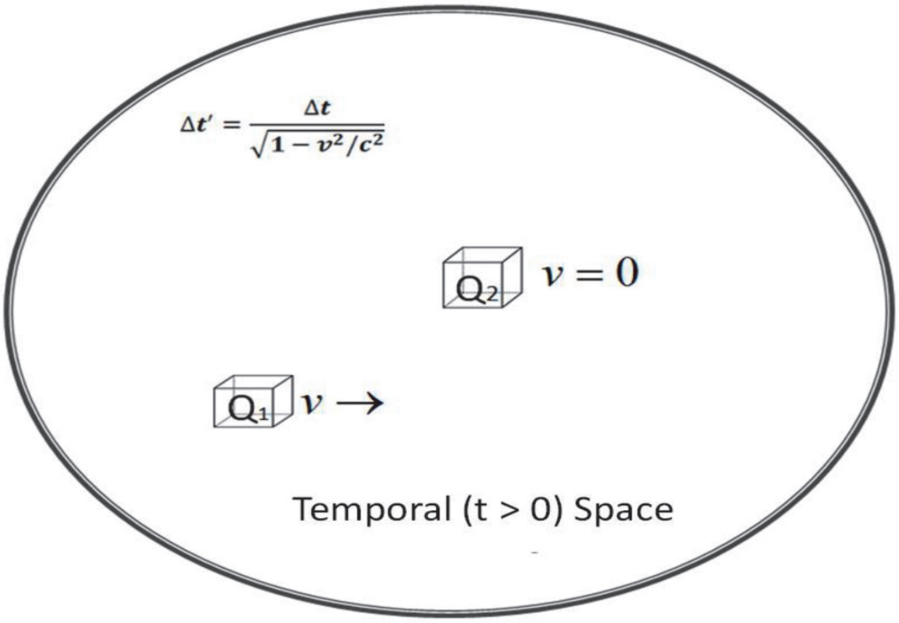

Figure 9.
Relativistic digital transmission within temporal subspace.

subspaces, one travels at a velocity v and the other is stand still. In view of this figure, we see that the hypothetical scenario is a "physical realizable" paradigm, since these two subspaces are embedded within a temporal ($t > 0$) space.

Now, if we let Q_1 station transmits a pulse signal with a duration Δt to Q_2 station. Assuming without any significant time delay, the digital pulse as received by Q_2 station appeal "wider" due to relativistic dilation as can be seen from Eq. (41). For instance, if we assume the time-dilation from Q_1 station relatively with respect to Q_2 station is two time wider (i.e., $\Delta t' = 2\Delta t$), then $\Delta t'$ is two times wider as received by Q_2; to complete for a bit" of information transmitted from Q_1, as depicted in **Figure 10**, where we see that the transmitted ΔE is "conservation". Needless to say that if the received pulse of Δt is transmitted back to Q_1 in motion; the receiving pulse width will be 2 time broader, as can be seen in the figure. In which we see that; one can exploits faster "time-digital" transmission from a static station Q_2 to a moving station Q_1. From Q_1 to Q_2 static station, one can take advantage for larger communication subspace, such as synthetic aperture radar imaging [22].

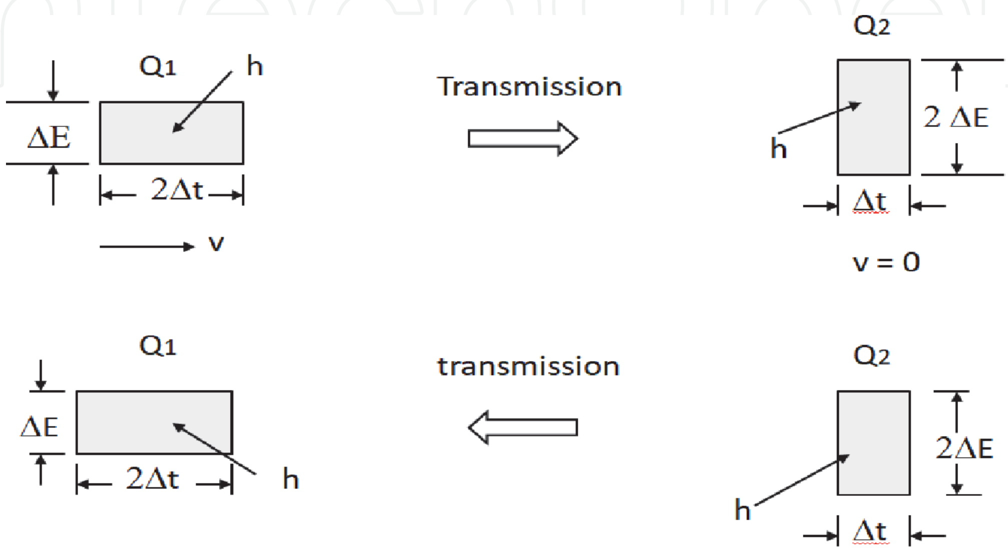

Figure 10.
A relativistic digital information transmission, $\Delta t' = 2\Delta t$.

As I see it; it is our universe governs the science and it is not the science dictates our universe. Within our universe every subspace is created by an amount of energy ΔE and a section of time Δt. Once a section of Δt has been used, it cannot bring it back, although we can create the same Δt at a different time. Although ΔE can be traded for Δt, but it is "impossible" to squeeze Δt equals to zero (i.e., t = 0), and this is the "temporal limit" of our universe. In this we see that there is "no" substance that can travel instantly (i.e., t = 0) within our universe. Even someday we may discover substance that travels beyond the speed of light, this is by "no" means that the substance can travel instantly (i.e., t = 0) within our universe.

Nevertheless, the nature of a section of time Δt is all about our temporal (t > 0) universe, in which time is space and space is time. I have shown that within our universe every subspace takes an amount of energy ΔE and a section of time Δt to "tangle"; by which ΔE and Δt cannot be separated. Although ΔE and Δt can be mutually traded, it is trading ΔE for Δt, or Δυ for Δt, but not trading for ΔE or Δt for Δυ since Δt is a real variable but "not" a physical quantity. But we cannot trade Δt for ΔE; once a section of Δt has been used, it cannot bring it back since time is a forward dependent variable. It is however, in principle, possible to trade ΔE (or Δυ) for a smallest Δt, but it is "not" possible to squeeze Δt to zero, no matter how much energy ΔE that one is willing to pay. Since Δt = 0 is the "instantaneous" response that "cannot" be reached within a temporal (t > 0) subspace, in which we see that Δt is lower bounded by Δt =0. But Δt = 0 exists only within a timeless (t = 0) space but not within our universe.

In view of the laws of entropy, information, uncertainty, relativity, and universe as given by

$$\Delta \mathrm{I} \sim \Delta \mathrm{E}\ \Delta \mathrm{t} = \mathrm{h}, \text{per bit of information} \tag{42}$$

$$\Delta \mathrm{S} \sim \mathrm{E}\ \Delta \mathrm{t}/\mathrm{T} = \mathrm{h}/\mathrm{T}, \text{per bit of information} \tag{43}$$

$$\Delta \mathrm{E}\ \Delta \mathrm{t} \geq \mathrm{h} \tag{44}$$

$$\Delta t' = \frac{\Delta t}{\sqrt{1 - v^2/c^2}} \tag{45}$$

$$\mathrm{U} : \Delta E\, \Delta t \geq (\Delta \mathrm{mc}^2)\Delta \mathrm{t},\ \Delta E\, \Delta t \geq \mathrm{h} \tag{46}$$

Notice that law of universe in Eq. (46) has a set of equations; one is for an isolated mass m and the other is for isolated photonic-particle, since photon is a "virtual" particle has no mass. Nevertheless, these laws and principles are profoundly associated with (ΔE, Δt), where unit (ΔE, Δt) is the "necessary" cost within our universe. We have shown that it is possible to "squeeze" Δt by widening ΔE. This corresponds to a higher energy of shorter wavelength λ. But it is "impossible" to trade for infinitesimal small section of Δt (i.e., t ≈ 0), which is physical limited as imposed by our temporal (t > 0) universe.

10. Time traveling?

One of the most interesting topics in science must be time traveling for which I assume a photonic traveler (i.e., a photon) is situated within subspace 1 at the center of our temporal universe in **Figure 11**. In view of this figure, the outward speed of subspaces 3 moves somewhat faster than subspace 2 (i.e., $v_3 > v_2$) toward the boundary of our universe since subspace 3 is closer to the boundary.

Now we let the photonic traveler start his voyage with a "narrow pulse" width Δt' from subspace 1 (i.e., very closed to our planet earth) to a distant subspace 3,

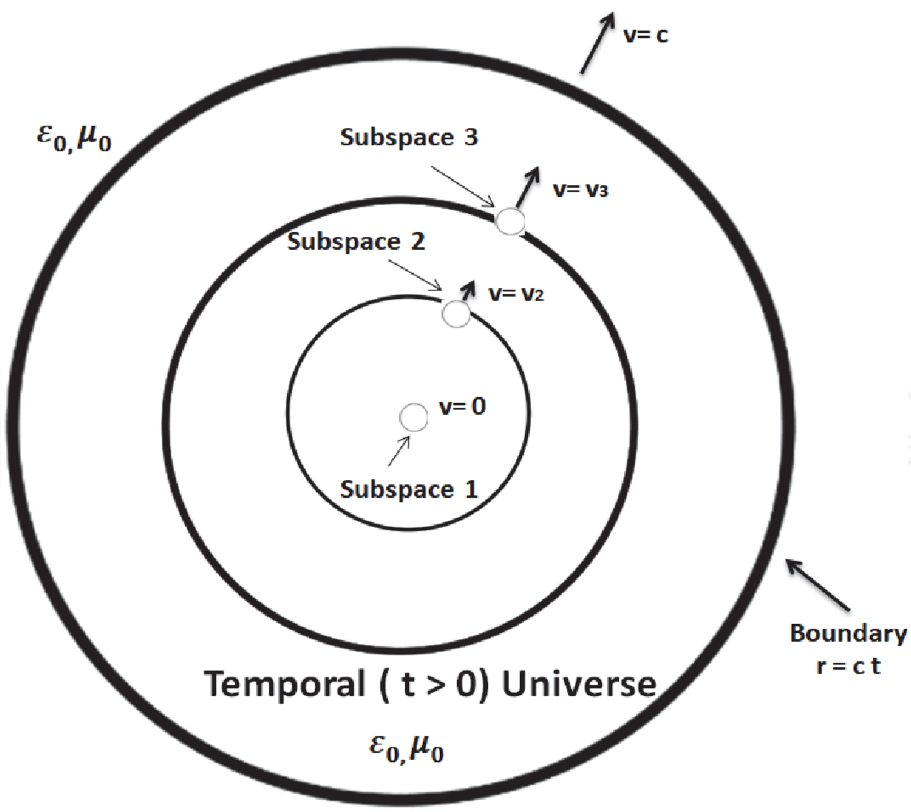

Figure 11.
A schematic diagram of our expanding universe. It shows our universe is a temporal (t > 0) dynamic stochastic universe; time and space are "coexisted." (μ_o, ε_o) are the permeability and permittivity of space.

which has an outward velocity of v_3. If the "relativistic" time dilation Δt' between these two subspaces is "two" times wider than the static sunspace 1 (i.e., Δt = 2 Δt'). Then velocity of subspace 3 can be calculated by means Einstein's special theory of relativity as given by

$$\Delta t' = \frac{\Delta t}{\sqrt{1 - v^2/c^2}} \tag{47}$$

For which the outward velocity V_3 is given by

$$V_3 = 0.87\ c = 0.87 \times 186,000 = 161,820\ \text{miles/s}$$

With reference to Hubble space telescopic observation [27], the boundary of our universe is about 15 billion light years away from subspace 1; for which Subspace 3 is estimated about 13 billion light years away from the center of our universe. Which will take the photonic traveler a 13 billion light-years and possible added another 13 billion light-years to catch-up to subspace 3, since subspace 3 has moved away as traveler's voyage started. For which the traveler will take about 26 billion light-years to reach subspace 3, at speed of light.

Nevertheless, as arrived at subspace 3, the traveler's pulse pulse-width reduces to about 1/4 the size. Which has a 3/4 "gain" in relative time-duration with respect to the static subspace 1 and the gain can be translated into "duration" of time that has been taken during the voyage. Since it took about a total 26 billion light-years journey to reach subspace 3, there is a "net gain"**of** about 19.5 billion light-years ahead "relatively" to the time duration that has gone by at the subspace 1. In other words; there is a total 19.5 billion light-years "relatively ahead" of subspace 1, after a total 26 billion light-years journey to subspace 3, as illustrated in **Figure 12**.

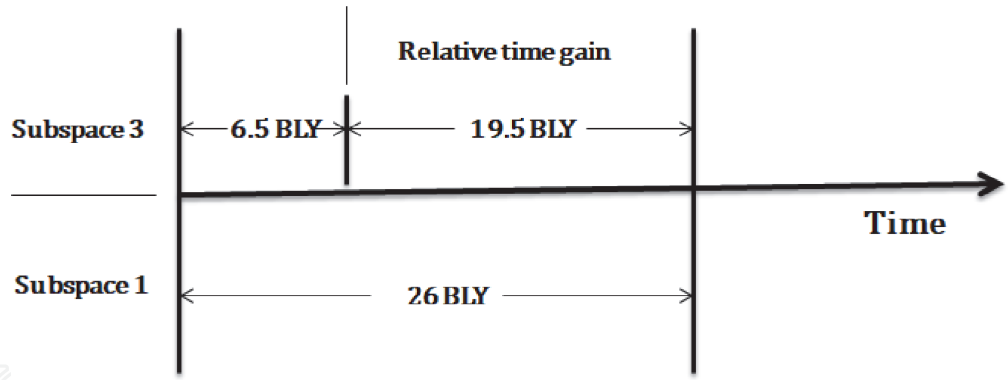

Figure 12.
The "relative" time gain as the traveler reached subspace 3. BLY represents billion light-years.

After the long journey arrived at subspace 3, the traveler is contemplating when he should return back. The "dilemma" is that if he waited too long, he may not be able to return home soon enough to enjoy some of his time-gained, since subspace 3 is moving even faster closer to the speed of light. For which he has decided to return right away, since is a longer journey of "more" than 26 billion light-years to cover, in view of an outward velocity of subspace 3 to overcome.

But as I see it; all the "relative" time-gained will be used up on his journey back home; it turns out the traveler will be home at precisely the same time of subspace 3 "without" any time gain. This part I will let you to figure out, since you have all the mathematics to play with. Yet the worst scenario is that; the traveler "cannot" find his home, since his home had been gone a few billion light-years ago after he had departed from subspace 1 to subspace 3.

On the other hand, if the traveler is "not" a cruising photonic particle, then the kinetic energy to reach a velocity of V_3 = 161,820 miles/s can be calculated as

$$K.E. = \tfrac{1}{2} m v^2 = \tfrac{1}{2} m (161{,}820)^2.$$

which is a price that "nobody" can afford, even just for one-way trip to subspace 3, where m is the mass of the traveler, in which we see that "time traveling" to the future is "unlikely", even assume we can travel at the speed of light.

Nevertheless, every subspace within our universe is always attached a price; a section of time Δt and an amount of energyΔE, although the unit $(\Delta E, \Delta t)$ is a "necessary" cost. For example the "cost" to create a golf ball; it need a huge amount of energy ΔE and a section of time Δt, but without an amount of information ΔI (or equivalent an amount of ΔS) it will not make it happen.

Another scenario is that traveling within "empty" space as depicted in **Figure 13**, as normally assumed. in spite it is a nonphysical paradigm; we see that traveler can reach subspace 3 instantly and return back as he wishes, since within a timeless $(t = 0)$ space it has "no" distance and no time, although the diagram shows it has. And this is precisely a virtual mathematical paradigm do to science, even though the subspace has no time and yet appears it has. For which I have found; practically all the laws, principles and theories of science were developed from the same empty space, which is "not" a physical realizable subspace.

Since science is a "principle" of logic, in which we see that a simple logic worth more than tons of mathematics. For example, as illustrated in **Figure 14**, if a time-traveler able to remove himself from current moment of 2020 and searching for last year of the same moment of 2019. The question is can he find it? The apparent answer is that; last year of our universe has been departed. Similarly, the traveler is wishing to visit next year 2021, but next year of our universe has not arrived yet.

In short, I remark that it is physical realizable science that "directs" the mathematics, but not the virtual mathematics that leads science, although science needs

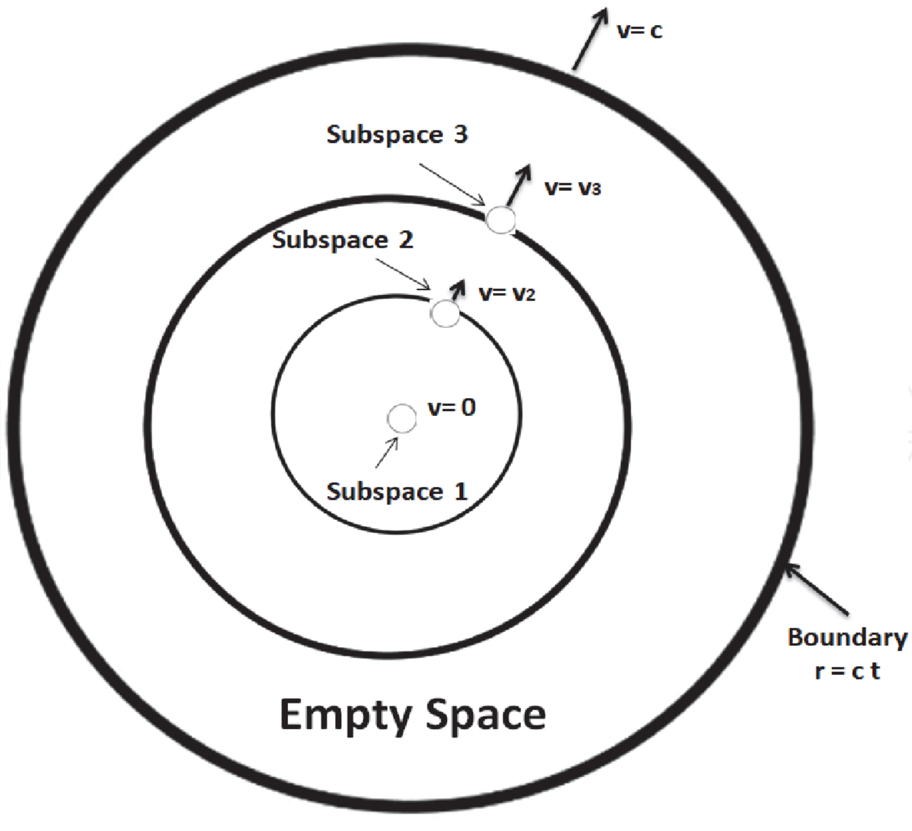

Figure 13.
Our universe model embedded within an empty space. This is a subspace that normally used since the dawn of science.

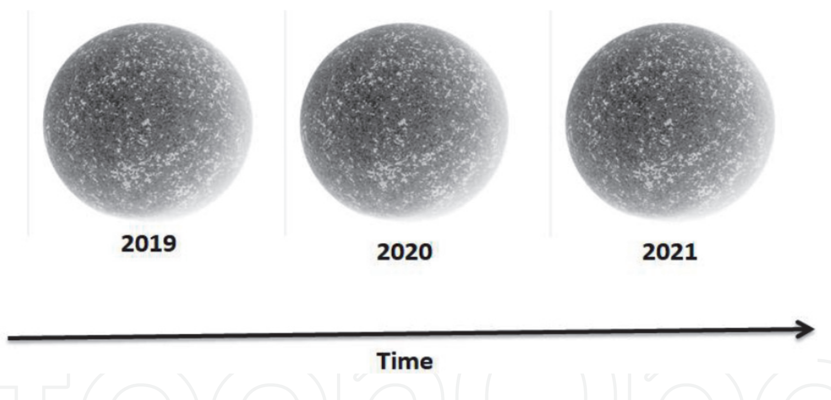

Figure 14.
A composited temporal universe as function of time. Notice that these temporal universes cannot be "simultaneous" existed as superposition principle of quantum mechanics.

mathematics. In which I note that; it is "not" how rigorous the mathematics is, it is the physical realizable science we embrace. Otherwise more and more virtual sciences will continuingly emerge. In view of relativity, we can "relatively" slow down the time somewhat, but we can "never" change the speed of time. It is you walk with time, and it is "not" time walks with you.

11. Conclusion

In conclusion, I would point out that quantum scientists used amazing mathematical analyses added to their fantastic computer simulations that provide very convincing results. But mathematical analyses and computer animations are virtual and fictitious, and many of their animations are "not" physically real, for example, the "instantaneous and simultaneous" superimposing principle for quantum computing did "not" actually exist within our universe. One of the important aspects within our universe is that one cannot get something from nothing there is always a price to pay an amount of energy ΔE and a section of time Δt. The important is that they are not free!

Any science that existed within our universe has time or temporal (t > 0), in which we see that any scientific law, principle, theory, and paradox has to comply with temporal (t > 0) aspect within our universe, otherwise it may not be a physically realizable science, as we know that science is mathematics but mathematics is not equal to science. In this we have shown that any analytic solution has to be temporal (t > 0), otherwise it cannot be implemented within our universe, which includes all the laws, principles, and theories.

Since Schrödinger's quantum mechanics is a legacy of Hamiltonian classical mechanics, we have shown that Schrödinger's mechanics is a timeless (t = 0) machine since Hamiltonian mechanics is timeless (t = 0). This includes Schrödinger's fundamental principle of superposition which is "not" a physically realizable principle. Since Schrödinger's cat is one of the most controversial paradoxes in modern history of science, we have shown that the paradox of Schrödinger's cat is "not "a physically realizable paradox, which should not have been postulated!

The most esoteric nature of our universe must be time, for which every fundamental law, principle, and theory is associated with a section of time Δt. We have shown that it is the section of Δt that we have used cannot bring it back. And this is the section of Δt that a set of most elegant laws and principles are associated with. In this we have shown that we can squeeze Δt approaches to zero, but it is "not" possible to reach zero even though we have all the energy ΔE to pay for it, in which we see that we can change the section of Δt, but we cannot change the speed of time.

Information is a very important aspect in science, since everything is a piece of information. Nevertheless, without the connection with entropy, information would be very difficult to apply in science. Since entropy is in energy form, but this is by "no" means that entropy is conserved implies that information is conserved since entropy is equivalent to an amount of information. We have shown; information has two major orientations; Shannon transmission is for "reliable" information while Weiner communication is for information "retrieval", for which we see that every bit of information takes an amount of energy ΔE and a section of time Δt to transmit, and it is not free.

Nevertheless, time traveling is a very interesting topic for all scientists, in which I have shown it is physically "not" realizable; it is simply we cannot "curve" a temporal (t > 0) space, since time in a "dependent" forward variable with space. It is science can change a section of time Δt but "not" change the speed of time. In other words, we walk on the street and it is not the street that walks on us. However, time traveling is possible if our universe is embedded within an empty space. But emptiness is a timeless (t = 0) space which is "not" exited within our temporal universe. And this is precisely most of the scientists uses this empty space for over a few centuries since the dawn of science. And this is precisely why all the laws, principles and theories are timeless (t = 0) or time-independent.

Overall, this chapter is to show that it is not how rigorous the mathematics is, it is the physically realizable paradigm that produces viable solution. If one used a nonphysical realizable model, it is very "likely" one will get a nonphysical realizable solution, virtual and fictitious as mathematics is.

Finally, I would stress that the nature of temporal (t > 0) quantum mechanics is all about the temporal (t > 0) universe, in which we have seen that it is our universe that governs our science; it is not our science that "curves" our universe. Although we can change a section of time Δt, we cannot change the speed of time. In short, it is the physically realizable science we value, but not the fancy mathematical solution we adored.

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