Article

Towards a Quantum Field Theory of Mind

Fred Alan Wolf

Abstract

I provide an historical account of my contributions to a theory of mind based on quantum physical consideration. In brief, mind appears to be a tachyonic (faster-than-light) and therefore atemporal field embedded throughout spacetime, which came into existence along with matter starting with the big bang and continuing to present day, in what makes up the sought-for Higgs field in particle physics colliders today. Consequently, I offer my speculations, based in quantum physics, on what we may call acausality and its intimate link to mind.

Key Words: Quantum physics, mind-field, consciousness acts, acausality, time order

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Introduction

Quantum physics provided a new paradigm that told us how mind and matter are correlated. It indicates that mind or consciousness plays a major role in the construction of reality because in it we have this facet of life that says, "Observation of objects in reality affects their reality." In other words, it isn't just a question of consciousness arising from particles banging into each other in your brain—which is the way many scientists tend to look at it—but it's more that what we imagine to be particles banging into each other is what gives rise to waves of possibilities. These waves indicate where and when these particles will appear, if at all and that the particles don't actually come into existence until a conscious observation occurs. Somehow, when you consciously observe something, a possibility becomes real and "out there." And the evidence seems to be pointing to the conclusion that there is only one true observer, one mind in this whole universe—a Mind of God, so to speak—for which each sentient life form plays a role making up what Jung may have deemed the "collective consciousness."

The best way I can describe this new paradigm is to speak of it in terms of what our own consciousness does during an observation. With the discoveries of quantum physics, we began to see this new role for consciousness—something that we know happens, but remained inexplicable until we began to realize that what we were talking about was the action of consciousness. So what I did in my earlier work (Wolf, 1984; 1986a; 1986b; 1989; 2004) was discover something I call a *fundamental act of consciousness*. I call it a *FAC*—please forgive the pun.

What is a *FAC*? It's an action in which something is perceived. Now, in ordinary physics, or in ordinary physiology, or in most of the classical realms of science, perception is something which is taken to be within the realm of physicality. In other words, if you visually perceive something (or use any other physical sense perception), you know that you see something and accordingly, *e.g.*, light will strike your retina, you'll get an idea, something will pop off in your brain, and all this takes place rather mechanically in a logical cause and effect order. We never get the notion that somehow the act of seeing something was affecting what was being seen

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either in memory or what was being looked at. But in quantum physics we've learned that when you're looking at very small objects, subatomic particles for example, the very action of looking at them disturbs them to such an extent that we never really get a complete picture as to what they actually are. Now, this has led me to think that a field of consciousness may be at the core of this problem. This field may explain how perception affects and changes reality, and that maybe what we're doing when we're thinking or feeling or sensing or even listening to a conversation, is creating a *FAC*. This creation suddenly alters the physical reality of both the human body and the object perceived in much the same manner as quantum physics indicates a particle suddenly arises in the quantum field that harbors it. Furthermore, a careful look at a *FAC* naturally brings into question the nature of time and mind: how events may affect each other in a time-reversed order in much the same manner that quantum field theory indicates a similar reversal of time order.

Most today believe in one-way causality—the past influences the present through the medium of an interaction that begins in the past and concludes in the future—what we call cause and effect. We have this idea from Newtonian mechanics. However, if we bring mind into mechanics—as we seemingly must through quantum physics—we find a new idea emerging: the future influences the present. Is such an idea just an idea that comes about through parapsychology or through mystical insight? A *FAC* says no, it says that there is a real mathematical basis showing that a future *FAC* (*fFAC*) can have an effect on the probability patterns that exist in the present and thereby create a new present *FAC* (*pFAC*). In other words, what takes places now, what choices are being made right now, may not be as free as you think they are. If you realized that a *fFAC* is having an effect on you now, then the reason for your present choices may not be as obvious. Quantum physics may be telling us that the usual $pFAC \rightarrow fFAC$ notion is incomplete and certain experiments in neurophysiology may be indicating time reversal, $fFAC \rightarrow pFAC$, occurs in the human brain and nervous system in all acts of sensory awareness in which we are usually unaware.

Quantum systems in the time interval between two events, so called two time observables (*TTO*), are known to behave in a manner quite differently from expectations based on initial value quantum mechanics (Aharonov and Vaidman, 1990). According to the transactional interpretation (*TI*) of quantum physics (Cramer, 1986), wave functions can be pictured as offer and echo waves, the offer wave passing from an initial event *pFAC* to a future event *fFAC* and the echo wave, the mathematically complex-conjugate of the offer wave, passing back in time from *fFAC* toward *pFAC*. The *TTO* and *TI* have been used to explain certain quantum physical temporal anomalies, such as non-locality, contra-factuality, and future-to-present causation as explicitly shown in Wheeler's *delayed choice experiment* (Wheeler, 1978)—an experiment wherein the history of the objects under scrutiny is not determined and is subject to change until the final observation. Experimental evidence involving neurological functioning and subjective awareness may be indicating the presence of the same anomalies.

To investigate these anomalies, I proposed (Wolf, 1998) a *FAC* model based on *TTO* and the *TI* wherein two neural events are ultimately responsible for backwards-through-time wave function collapse in the intervening spacetime interval. In brief we need two events to make a *FAC*. After providing a simple argument showing how quantum physics applies to neurological functioning and a simple demonstration of how the *TI* and *TTO* explain the delayed choice paradox, I showed how such pairs of causality-violating events must occur in the brain in order that a single experience in consciousness take place in the observer. Using this proposition I offered a quantum physical resolution—similar to that of the delayed choice experiment—of the "delay-and-antedating" hypothesis/paradox put forward by Libet *et al.* (Libet *et al.*, 1979) to explain certain temporal anomalies associated with a delay time, *D*, required for passive perception experienced by experimental subjects including the blocking of sensory awareness normally experienced at time *t* by a cortical signal at later time

t+k•D, (0<k<1) and the reversal in time of the sensory awareness of the events corresponding to cortical and peripheral stimuli. My model may be a first step towards the development of a quantum physical theory of subjective awareness and suggests that biological systems evolve and continue to function in accordance with *TTO* and consequently a causality-violating, two-valued, *TI* of quantum mechanics. The model successfully predicted and explained Libet's temporal anomalies and made a new prediction about the timings of passive bodily sensory experiences and imagined or phantom sensory experiences. The predictions of the model compared well with experimental data.

Brief Earlier History

To see how I came to this *TTO-TI* conclusion, perhaps a look at my earlier work is in order. In 1983, in preparing my book *Star*Wave* (Wolf, 1984) for publication, I had read John Cramer's interesting paper (Cramer, 1980) on the subject of a backwards-through-time quantum wave function[2], u^*, acting as a modulation of the normal forward-through-time quantum wave function, u, in standard nonrelativistic quantum physics. Cramer's account was a new way to interpret quantum physics and gave a plausible reason for calculating probabilities from the multiplication of u by u^*, a fact that previously had no explanation. In Cramer's account the forward-through-time u was considered as an *offer wave* initiating at a point i where an event had occurred. The backwards-through-time u^* was likewise an *echo wave* initiated by a final event f traveling backwards-through-time to the offer event and thus completing a cycle.

It seemed to me that one should know what takes place if both the initial and final events are determined. This led me to further investigate the connection between human consciousness and quantum physical probabilities. There were essentially three ideas I investigated:

(1) Self-observation—whenever atoms are arranged in a highly repetitive pattern, such as those found in crystals or in the long strands of molecular DNA, the quantum wave functions also take on a similar pattern. This pattern constitutes a continual kind of observation in which the quantum wave function, in a sense, is observing itself over and over again. Quantum waves and quantum wave functions can be imagined as constrained by such a pattern, which, in fact, gives the structure its stability—in brief, what you see is what you get.

(2) Experimental evidence—since there are actually two quantum wave functions involved in a quantum wave function transaction, u^* traveling backward through time may be able to be detected in a physical experiment involving our brains and nervous systems.

(3) Enhancement—because of the repetition of the DNA structure, the likelihood of a repeating u^*u pattern is highly enhanced, whenever the u^* involved propagates from a near future to the present. The signal from the near future is more or less the same as that from the past, and the pattern, consequently, tends toward stability. The more stable the pattern, the less likely that the distant future will disturb it.

From Then to Now: Mind—an Acausal Field

I shall go over these three ideas and summarize the results of my published investigations, (Wolf, 1984; 1986b; 1989; 1998; 2010). They show that acausality and mind are related and how mind can be accounted for in quantum physical terms.

Idea 1

Even though Cramer's account gave the correct mathematical calculation of the probability in quantum physics describing the probable causal connection between an initial event, i, and a final event, f, it in no way described how a particular and ultimately experienced sequence i to f was made into an actual pairing of two real events. If, for example, there were two possible final events f_1 and f_2 one would have both probabilities i to f_1 and i to f_2 to take into account without actually knowing which final event f_1 or f_2 actually occurred.

It seemed to me at the time that one should know what takes place if both the initial and final events are determined. This

[2] u^* stands for the complex conjugate of u. If u is a plane wave, *exp(ipx-iEt)* then u^* is *exp(-ipx+iEt)*.

led me to further investigate the connection between human consciousness and quantum physical probabilities.

Consequently when I finished writing *Star*Wave* I had included a discussion of Cramer's *transactional interpretation* (*TI*) as outlined in his paper as a possible mechanism for the way the mind works in relation to the brain.

A few years later I published *The Body Quantum* (Wolf, 1986b). In chapter 25 I once again looked into the *TI*. Then I described that whenever atoms are arranged in a highly repetitive pattern, such as those found in crystals or in the long strands of molecular DNA, the quantum wave functions also take on a similar pattern. Changes in those patterns of the quantum wave function, in my view, could take place through the making of a *FAC*. Consequently when an observations occurs, the quantum wave function "pops," and a pointlike atom, or part of an atom, is manifested for an instant. When no observation takes place, the quantum wave function "hangs around," like a ghost, in the same locale in which it first popped. This sequence is highly reinforced by the repeating structure. Habitual observation eventually becomes so reinforced that it becomes unconscious.

To try to imagine this concept is difficult because there are many atoms involved. The quantum wave functions, as I imagine them, are "resonating" with the structure of the molecules, so that each quantum wave function turns on and off with many oscillations. From the solid molecule's point of view, this corresponds to its own self-observation.

This viewpoint can be contrasted with a single atom's self-observation: It, too, can be thought of as being in a self-observation pattern, wherein its quantum wave function turns on and off. But being an isolated atom means that the pattern will display a higher degree of randomness. At the atomic level, this pattern appears as the atom itself, vanishing and reappearing in a sequence of random points, blurring, more or less, into a solid object.

Thus, each quantum wave function pattern is highly specific to the element it represents. A quantum wave function for the hydrogen atom is quite different in detail from the quantum wave function of a carbon atom. When, for example, a sugar-phosphate molecule repeats itself as an endless chain of snakelike strands, winding around each other much like a spiral staircase, an infinite hall-of-mirrors effect manifests itself, allowing the living, conscious molecule to appear. I am describing, of course, the molecule of genetic life, deoxyribonucleic acid, or DNA.

Idea 2

The second idea is even stranger and more speculative. Since there are actually two quantum wave functions involved in a quantum wave function pop, with the star quantum wave function, u^*, or *star wave* (Wolf, 1984) orientated backward in space-time, my speculation that u^* comes from the future, traveling backward through time, may be able to be justified by a physical experiment involving our brains and nervous systems.

I believed this idea was important because it could explain how the evolution of anything can take place—one needs both a flow of quantum wave function information from the past and the future to the present. My idea was similar to those that Sir Fred Hoyle discussed in his book *The Intelligent Universe* (Hoyle, 1984). Merely left to the odds, it is extremely unlikely that anything as orderly as a human being would arise at all simply from random processes. As I explained in Chapter 11, of *The Body Quantum* (Wolf, 1986b) there needs to be some form of intelligence involved. But the question is, how does that intelligence act? Of course, I could just postulate that there is a Supreme Intelligence and that this being can act in any way that it sees fit. As Niels Bohr once remarked to Albert Einstein, when he was trying to figure out how God did it, "Stop telling God what to do."

I certainly don't want to do that! But I do want to know how God does it. Yet, as a physicist, I am somewhat constrained: I can't postulate just any idea, because a scientific idea, in order to be considered valid, must fit with what we already know (or, at least, "think" we know) and have a means by which it can be experimentally falsified. As some quantum physics experiments confirm

(Wheeler, 1978), the idea that *u** comes from the future may just save the day, however. As Hoyle put it (Hoyle, 1984):

> If events could operate not only from past to future, but also from future to past, the seemingly intractable problem of quantum uncertainty could be solved. Instead of living matter becoming more and more disorganized, it could react to quantum signals from the future—the information necessary for the development of life. Instead of the Universe committed to increasing disorder and decay, the opposite could then be true (pg. 213).

In a highly organized material containing repeating patterns, the *u*u* content becomes highly repetitive, producing a probability pattern of reinforced strength. Thus, crystals of repeating materials, such as sodium chloride, carbon lattices (such as diamond), and other single crystals of metals and metals in combinations with other substances, possess great strength or other unusual properties.

In DNA we have a similar phenomenon of great repetition, with complex patterns of sugar-phosphate backbones interrupted by the much longer, seemingly random steps of *base pairs* linked together in complementary codes. These bases, you'll recall, include four types: *A, C, G, T*.

Idea 3

Here my third idea surfaces: Because of the repetition of the DNA structure, the likelihood of a repeating *u*u* pattern is highly enhanced, with the *u** involved propagating from a near future to the present. The signal from the near future is more or less the same as that from the past, and the pattern, consequently, tends toward stability. The more stable the pattern, the less likely that the distant future will disturb it. Again, the idea that there exists a resonance between the quantum wave function and its structure—involving both the past and the future—is at play here. Signals from the distant future do arrive, however; without them, DNA would never alter its patterns. But the more stable the reinforcement brought on by the repetition of the strand, the smaller the disturbance produced. It is the interplay of the endless crystalline repetition of the DNA strands, twisting in space and dancing in time as vibrations with the almost though not quite random patterns of *A, C, G,* and *T* bases, that produces stable animal and, yes, a kind of plant consciousness. Consciousness, as we commonly and humanly experience it, thereby emerges as a consequence of the quantum wave function's vibrational patterns associated with DNA; vibrational patterns repeating and resonating with both the future and the past.

Molecules of DNA within shouting distance of each other also vibrate, sending quantum semaphore messages back and forth, and in this manner a resonance arises between neighboring molecules. This resonance is much like any other resonance phenomenon, such as a building's vibrations in the wind or the rolling of a ship on the high seas. With energy being fed from one molecule to the other at just the right frequency to induce the other molecule to respond, the two resonate together. It is this resonance of waves in different cells that could result in the healing of the cells.

Illness could result from an opposite effect. When molecules are off-resonance, they fail to communicate with each other; such off-resonance could arise from atomic changes in the molecules or from subtle changes in the probability patterns of the quantum wave functions, possibly brought on by negative thinking. Influenced by such thinking, perhaps molecules tend to isolate themselves, forming self-contained units of limited capacity. Such molecular isolation can be understood in terms of our own behavior when we feel depressed or unduly anxious about something, and want to be alone in our misery.

Consequently, illness and possibly negative thinking could create molecular islands of separation within our cells. Healing energy counters this separation tendency by fostering correlations between molecules: One molecule "heals" another.

Acausality and Mind

A few years later I looked once again at this issue of acausality in my paper published in the *Journal of Theoretical Biology* (Wolf, 1989, pp 13-19) entitled "On the Quantum Physical Theory of Subjective Antedating." In

this paper, based on the work of Benjamin Libet (Libet *et al*., 1979; Libet, 1985), who discovered temporal anomalies in people's conscious awareness, I found that quantum physical probabilities could be related to these anomalies. In brief: a single conscious instant—one that registers as an event in our experience—requires both the occurrence of a past and a future event in the physical brain.

Libet discovered that before a conscious experience could take place the brain had to be sufficiently excited. He called this the achievement of neuronal adequacy. Assuming that neuronal adequacy and experience were one and the same, Libet (1985) pointed out the obvious discrepancy between the time of the experience of an event—the subjective referral—and the time of neuronal adequacy required to experience the event. I suggested an alternative proposal. Neuronal adequacy and subjective experience were not one and the same events. Neither were peripheral stimulation and subjective experience one and the same events, even though they seemed to be. The truth actually lies somewhere in-between. Both the stimulation and neuronal adequacy (two events) are needed for the conscious (one event) experience, even though the time of that experience is referred back to the peripheral sensation.

The events in question (stimulation and neuronal adequacy) are time-like separated. This means that any signal connecting the two events had to travel at lightspeed or less. Thus, according to the theory of relativity, there is no way that these two events could ever be simultaneously observable as was erroneously postulated by Snyder (Snyder, 1988). Hence his attempt to resolve the paradox was not tenable. However, the fact that the observer of those events sees them as simultaneous means that his mind acts like a kind of "time machine." That is, the experience of the event is "projected" back in time towards the occurrence of the sensation possibly via the $u^* \rightarrow u$ idea.

Libet had suggested that this may be an illusion, that the real "cognition" of the event only occurred later at the time of neuronal adequacy and that the subject "subjectively" and mistakenly remembered the event as having occurred earlier. Whether or not this is an illusion is at present not experimentally testable. In any case, one must wonder why subjects believe that their knowledge or cognition of an event is a simultaneous occurrence with the event if indeed the knowing and the stimulation are time-like separated.

I believed this backwards-in-time projection between a neural event and a stimulus can be consistently accounted for using Cramer's transactional interpretation (*TI*). In this case, the present event (the peripheral sensation), *S*, sends a forward-through-time probability offer wave to a future event (neuronal adequacy), *N*. Most likely, *N* lies on the area of the cortex normally associated with the sensation. The future event, *N*, sends a backwards-through-time probability echo wave to the present event, *S*.

According to the *TI*, the *S* to *N* offer wave stimulates the *N* to *S* echo wave. The *N* to *S* echo wave then carries a replica of the *S* to *N* offer wave back towards the original stimulation. The *N* to *S* echo wave arriving at the location of the source, *S*, multiplies or modulates the *S* to *N* offer wave and thus provides the probability for the correlation of the events. If the two waves "resonate," meaning that the probability for the *S* to *N* correlation is large, then a significant probability for the two events is achieved. In this manner, that which is significantly measurable—has the largest probability—is also that which is brought to conscious awareness. In my view then, all possible future events are in contact with a present event, however, the most probable future events are those that produce the largest value of u^*u, and consequently constitute an event in consciousness.

I offered the hypothesis that whenever two events are so correlated, i.e., the probability for the events is not *a priori* zero, they will be experienced as one and the same event. I suggested that this means, in general, that any two quantum physically correlated events separated in time or space will constitute a single experience.

Upon further thought I realized that although Cramer's hypothesis took care of providing a probability distribution surrounding the offer event in spacetime, it

by itself still did not account for which final event corresponded to human experience. Years later in 1998 I looked further into the work of Libet and his co-workers (Wolf, 1988). Aharonov and his coworkers (Aharonov *et al.*, 2007) had been working on a scheme to represent quantum physics in terms of two-time quantum wave functions—one that not only specified the initial condition of the quantum wave function but also its final state as well. Consequently, I based my new work on the work of Aharonov and his co-workers.

Here I offered a quantum physical resolution similar to that of the Wheeler delayed choice experiment in quantum physics of the delay-and-antedating hypothesis/paradox put forward by Libet *et al.* (1979) to explain the temporal anomalies associated with passive perception. I proposed a model, now enhanced by the work of Aharonov *et al.*, (2007) wherein indeed *two* neural events cause backward-through-time and forward-through-time neurological signaling in accordance with wave function collapse in the intervening spacetime interval. Pairs of causality-violating events must occur in the brain in order that a *single* experience in consciousness occurs. The model offered the next step towards the development of a quantum physical theory of subjective awareness and suggests that biological systems evolve and continue to function in accordance with a causality-violating, two-valued, transactional model of quantum mechanics. The model made a new prediction about the timing of passive bodily sensory experiences and imagined or phantom sensory experiences. The predictions of the model were compared with experimental data indicating agreement and new experiments are proposed testing the model.

In his book, Penrose (Penrose, 1989) poses the paradox of the relationship of awareness and physical events that elicit it as follows,

> Is there really an "actual time" at which a conscious experience does take place, where that particular "time of experience" must precede the time of any effect of a "free-willed response" to that experience?... If consciousness... cannot be understood... without...quantum theory then it might... be... that... our conclusions about causality, non-locality, and contrafactuality are incorrect (pg. 442).

Penrose believed that there are reasons for being suspicious of our physical notions of time in relation to physics whenever quantum non-locality and contrafactuality are involved.

I added that the same thing must be said with regard to consciousness. He suggests that *if,* in some manifestation of consciousness, classical reasoning about the temporal ordering of events leads us to a contradictory conclusion, then this is a strong indication that quantum actions are indeed at work!

In my 1998 paper I examined a quantum theory of the relationship between the awareness of timings of events and their corresponding physical correlates and showed that indeed not only are quantum actions at work, they are indispensable in explaining the temporal paradoxes inherent in the phenomena.

I concluded that when it comes to *time* in physics, we are somewhat at a loss. All of our equations are unique in one very real sense; there is no specific order to the sequences of events we label as the passage of time. Both Newtonian physics and quantum physics share this apparent fault in disagreement with our commonsense experiences. We could just as well write equations and set up appropriate spatial and temporal boundary conditions of retrodiction in place of prediction and feel equally satisfied that we had the correct equations. Indeed, if we do simple enough experiments we find that retrodicting is as good as predicting when it comes to determining what shall be happening in the next sequence of events either following or preceding.

In life, with all of its complexity and its ultimate human measure, *time* marches on. Fallen cracked eggs do not jump off the floor into our outstretched hands. Dead loved ones do not reconstitute themselves and resurrect. We grow older each day not younger. How are we to ever explain this scientifically and fundamentally? It would seem that we are missing something essential when it comes to time.

Two bits of data we know. Conscious experience of events and the second law of thermodynamics. The first bit is subjective in its context while the second is purely objective. We certainly know that we can think a thought, write a sentence, and find the words that are uniquely time ordered. We certainly know of the fact that hot bodies cool down and cold bodies warm up. Is there some connection between these data bits?

At this point in time we have no theory that connects them. While much as been done in the objective arena to connect thermodynamics and statistical mechanics to quantum mechanics, even some remarkably clever insights, we still do not have a fundamental theory connecting them.

In the world of subjective experience very little has been done by physicists and for probably very good reason; no one knows what to do, what to measure, or even if it is ethical to perform such measurements (usually involving probing of the human brain) even if we knew what we were looking for. Here Libet's remarkable experiments need special mention. At least in them we were provided with a clue concerning subjective time order. Perhaps there is something fundamental in the notion that our equations are not time order unique and the theory given here that according to subjective experience we need two or more separate events to have a single perception. Perhaps this theory that a perceived event requires information flowing from end points coming before it and after it, much like a stringed musical instrument requires information coming from its nodal end points to set up standing wave patterns of musical harmony is a fundamental requirement for both time order uniqueness and subjective experience.

It would seem to me that now we need to look toward altering our concept of time in some manner, not that this is an easy thing to do. Perhaps we should begin with the idea that a single event in time is really as meaningless as a single event in space or a single velocity. Meaningful relation arises as a correspondence, a relationship with some reference object. Hence an object's velocity is meaningfully measurable with respect to another object's velocity as the relative velocity between them. In a similar manner as I point out in this paper, the timing of an event is also only meaningful in reference to another timing event. When the end points or reference times for the events are not specified, then only the relative interval becomes relevant. When that interval lies within the limitation of quantum uncertainty, the event referred to within the interval must also lie within that uncertainty. Failure to note this leads to apparent timing paradoxes.

The resolution of temporal paradoxes particularly as they show themselves in future quantum physical objective experiments and in subjective timing experiments will continue to require a new vision of time.

A new hypothesis of mind and matter

Gaining new insight into how the universe came into existence, and in particular how it is that there is mind in it capable of knowing that fact is not an easy task, no matter which way you try to do this. For most of my life, ever since I was a college freshman (age 18), I have been interested in such questions and turned to physics, especially to study the behavior of light. I looked to physics to be my guide to learning how the universe works. Quantum physics and the many masters of the subject I have been privileged to study with have been great teachers. They initiated many changes to my earliest thinking, especially telling me that we really don't understand the universe without trying to understand how mind enters into it. Quantum physics tells us that mind must play a role (even though that role is far from clear) and that in some deep way mind is intimately connected to time. During my studies with David Bohm, he often brought this to my attention when I was a visiting professor at Birkbeck College in London.

There still remain some very interesting problems and worthwhile speculations to ponder over regarding how mind enters into the universe. In the game of quantum physics it plays a distinctive role: it acts as a cleaver seemingly making logical choices of event sequences by deciding which events occur. From a sea of possibilities something causes droplets to emerge and thus change into solid drops of actuality. We need to construct models that may show us

how mind enters the physical realm of existence. I really believe that it is possible to become better, more enlightened human beings provided we have a deeper understanding of how mind and matter interplay.

Today we are moving towards that goal; we have become immersed in what I call the *quantum age*—an era of technology based upon our grasp of the mini-worlds of nanotechnology. At present, atoms and molecules are at our fingertips and to some degree under our control, and we are embarking on the exploration of the processes that occurred in the universe at its very birth when time, space, and matter first emerged. Just as basic quantum physics was important in the current thinking of today's Western world, a new understanding of how these basic concepts—the cornerstones of physics itself—really work, is vital for tomorrow's whole planet. The future is now. We need to grasp a new vision of the basic building blocks of the universe if we are to survive. Our species survival may depend on our understanding nature at her deepest level.

Those who realize the steadily growing view that the classical dividing line between the observer and the object of his or her attention is blurry at best at our ordinary level of existence, are taking steps toward this new understanding of nature. Such a division may possibly not even exist at the deepest levels of reality. At the deepest level we know of, energy and time play a game of book-balancing of pluses and minuses. Light and matter act as game pieces zigzagging through the universe in continual eternal interaction with something called the Higgs field that changes *light* into matter[3] (which is currently the accepted view of quantum field theorists) and possibly changes light into mind.

What we finally come to understand about the world is that it is not at all as it seems to common sense, with a clear division in spacetime between observers or minds and the observed or particles. The Higgs field is believed to fill the vacuum of spacetime and provide the necessary matrix of interactions that bring matter into existence as particles of mass coming from light (spin ½ luxons). It also may provide a view of what we may call a logical universal mind—a field of consciousness that permeates the universe and uses the Higgs mechanism to generate thought as thoroughly as it generates matter with a unique direction and order of time.

The basic idea is that the Higgs field acts to make electrons zigzag though space at lightspeed thereby giving them mass and making them appear to move slower than lightspeed. Here I speculate: I propose that the Higgs field also acts to zigzag electrons through time as well and in so doing acts faster than light speed. In this way it accounts for the faster-than-light speed of the quantum wave function collapse and thus acts like mind. In effect memory would be contained within the field as a kind of back reaction in the Higgs field.

Spiritual hints: In the beginning there were two kinds of light

According to the opening lines of the Bible, in the beginning, God created the universe. We in modern science believe that this creation may indeed have occurred "in the beginning" of everything, including all matter and even the spacetime in which all of this came into being, not only making up a material universe but also setting it into motion with energy and telling us how that energy is to be put to use. Since we know about this, or think we know about it all, or at least are beginning to see clues about how it all began, it is of some interest to consider this big bang picture in both a physical and spiritual light—something I have been prone to do in my various musings and books.

Consider one of the Bible's famous passages—namely, the one in which God says simply, "Let there be light, and there was light." It is of interest to read this simple declaration in the original Hebrew, where it reads (with translation): "Va-Yomer (and spoke) Elohim (God), 'Yehy (Let there be) Aur (light) Ve-Yehy (and there is) Aur (light)'." In the ancient spiritual and mystical practice known as Qabala, one learns that each letter of the Hebrew

[3] I mean by "light" all massless particles that consequently move at lightspeed. I call such particles "luxons." Luxons includes massless spin ½ quarks and leptons as well as the spin 1 luxons we normally call "light." The half-spin luxons interact with the Higgs vacuum field and acquire mass.

alphabet is actually a word and therefore each letter has its own separate meaning.

Va-Yomer (and spoke, spelled Vav-Yod-Aleph-Mem-Raysh) means to make spirit and memory real through the whole universe. I think this really means the whole universe, and so it may be the Higgs field itself. *Elohim* (God, spelled Aleph-Lammed-Hay-Yod-Mem) is a kind of equation that means the spirit (Aleph) moves into the universe potentially enabling life to exist and at the same time to *resist* life through the creation of memory. *Yehy* (Let there be, spelled Yod-Hay-Yod), accordingly says, that once started, the universe itself will continue to generate life, enabling it to recur again and again by bringing *Aur* (Light, Aleph-Vav-Raysh) into existence. Light is an action of spirit propagating into spacetime: *Ve-Yehy* (And there is, spelled Vav-Yod-Hay-Yod) *Aur* (light, Aleph-Vav-Raysh).

The key here is the fact that light (*aur*) is mentioned twice in the same sentence, which according to qabalists such as Carlo Suarès (Suarès, 1970), indicates that there must be two forms of light in order for the universe to come into being, and that matter acts in resistance to the effect of the Higgs field by becoming inert. In a similar manner mind or memory acts in resistance to the Higgs field. Thus thought acts as an inertia to action.

Now when we look into quantum field theory we find that matter/energy is indeed made of two kinds of twisting light—a "bosonic" form emerging from the quantum field as photons and gluons that all have spin *1* and a "fermionic" form emerging as spin *½* leptons and quarks.[4] The universe of matter is then made from the interplay of these bosons and fermions and these in turn emerge as these two kinds of light: spin *1* and spin *½* luxons.

The Higgs field interacts with the spin *½* luxons, causing them to zigzag and change "handedness"[5] going from right-handed as they zig and then to left-handed as they zag through space, but always moving unidirectionally forward in time. In this manner, these luxons, on average, appear to slow down and can even appear at rest (zigzagging back and forth, even at lightspeed, means you go nowhere), thereby appearing with inertial rest masses, as assuredly as a snowball picks up snow when it rolls down a snow-covered hill. The snowball becomes more and more inert as it gains mass.

If on the other hand, these spin *½* luxons zigzag forward and backward in time as they move unidirectionally through space, they will move faster than light as tachyons and thereby constitute the framework for both annihilation and creation processes, as was so elegantly presented by Richard Feynman. (Feynman and Weinberg, 1987) If you have a tachyon moving between two events, say, *A* and *B*, its temporal sequence and consequent appearance will depend on the point of view of the observer of two events. One such observer may see *A* occur before *B* while the 2nd may see *B* occur before *A*. Faster-than-light sequences do not have unique time orders.

For example, two events in our universe that one observer observes simultaneously will be seen to happen in a particular order, say *A* following *B*, by another observer moving to the left of the *1st* observer. But accordingly, someone who is moving to the right of the *1st* observer would see the whole sequence happening in reverse order: *B* happening before *A*. It's as if time is going forwards for one but backwards for the other. So what we find with relativity is that there is no universal time order for events that happen simultaneously when seen by one observer: observers moving at different speeds don't necessarily agree on the order that such things happen.

Is the Higgs field the mind of God? A really big speculation about a mind field

There seems to be three kinds of matter: tardyons, luxons, and tachyons. Tardyons

[4] Boson includes all whole quantum number spinning particles, 1, 2, and so on, while fermion includes all half-odd integer numbers 1/2, 3/2, 5/2, and so on.

[5] Handedness refers to how a particle spins. Electrons and quarks come in two hands—right and left. Right-handed particles spin counter-clockwise; left-handed particles spin clockwise while moving in a given direction. If you examine your own hands you can picture a left-handed article's spin as the direction your fingers curl with the direction of motion as the direction in which your thumb points. A right-handed particle spins and moves as your fingers and thumb of your right-hand indicate. A left-handed particles spins in the opposite direction to a right-handed particle as your own hands can attest.

move at slower than lightspeed. Luxons move at lightspeed, and tachyons move faster-than-light. From Dirac's insight, luxons—spin ½ particles that move at lightspeed—could zigzag in spacetime. We now suspect that such motions occur because the luxons interact with the Higgs field. Here I want to suggest another way in which this Higgs field may act. This is certainly a speculative proposal. The proposal explains the emergence of a logical order of events that constitute the actions associated with mindful activity or the emergence of the logical order found in thought processes. To see this we need to go back to our quantum zig-zag.

Zigzagging in space, drifting forward in time

A zigzagging tardyon can change its speed in sudden discontinuous spasms at seemingly random instances. In Figure 1 we see an expanded view. We call a luxon going to the right a zig and one going to the left a zag. Zig luxons move toward the right with their spin anti-aligned with the direction of motion, while zag luxons move to the left with the spin axes aligned with the direction of motion. This rapid zigzagging appears as a solid straight line in the drawing and makes up a fundamental tardyon propagator. Spin ½ quarks and electrons all obey this dictum: they change hands when they interact with the Higgs field and thus acquire their so-called bare or rest masses. The zigzagging goes forward in time and as long as a zag interval is shorter than a zig, the effective movement will be toward the right as shown. If the zig and zag are equal in length, the resulting tardyon appears at rest and the tardyon trajectory runs along the timeline; if the zag is longer than the zig, the tardyon goes toward the left. Inspection of Figure 1 reveals the situation.

Zigzagging in time, drifting forward in space

On the other hand, according to the special theory of relativity no time actually passes for luxons; we could just as well take it that the zigzagging occurs both in the forward- and backward-in-time direction as shown in Figure 2. Here we have a "normal" forward-through-time long zig with an "abnormal" backward-in-time short zag, resulting in the motion shown by the solid straight line moving from left to right. Because the zag goes backward in time, the net result is a faster-than-light movement or a tachyon. A similar line of reasoning applies here. If the zig and zag are the same lengths, the particle moves along the space axis going nowhere in time—appearing as an infinite speed tachyon which according to the special theory of relativity has zero energy. If the zag is longer than the zig, the tachyon moves backward in time as it goes on moving from left to right.

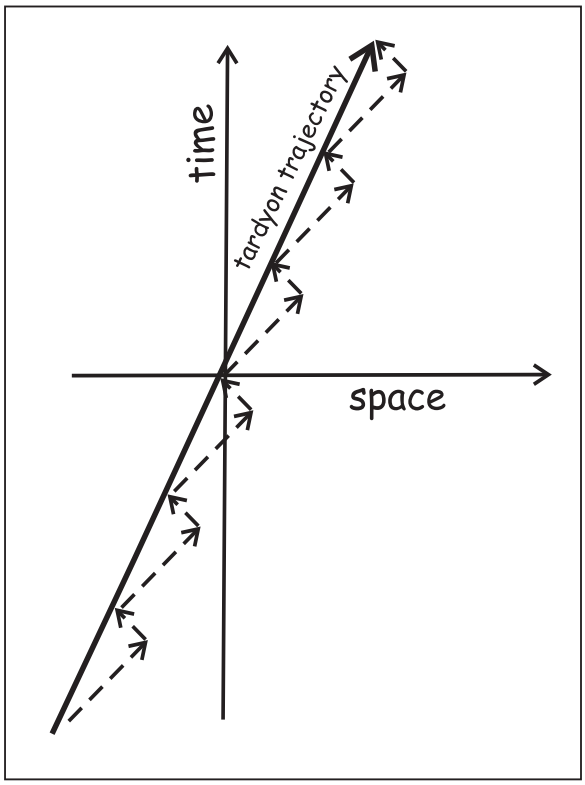

Figure 1. A tardyon propagates as a zigzagging forward-through-time luxon (From Wolf F.A. 2010).

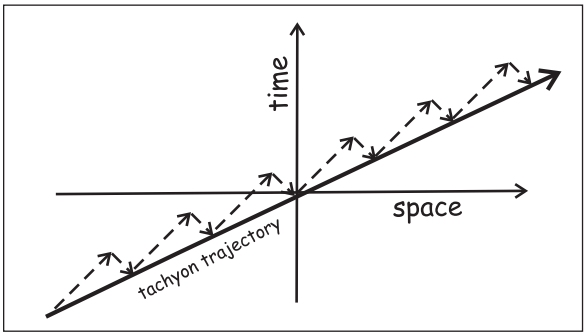

Figure 2. A tachyon propagates as a zigzagging forward-through-space luxon (From Wolf F.A. 2010).

Since tachyons can always be seen as moving at infinite speed, by at least one observer, they appear to be a good way of

dealing with the phenomenon of *spatial nonlocality* in quantum physics. That is, between two remote events describing the movement of so-called back-to-back particles in a coherent entanglement, if a measurement of one of the particles occurs, the other instantly appears to have been measured, resulting in a correlation between the two measurement events. Different observers moving relative to each other may see either event occurring before the other. This quantum physics atemporal entanglement factor appears to play a role in the organizational ability of events similar to the way a mind produces thoughts in a logical temporal order as I'll explain further on.

One more thing according to the special theory of relativity: tachyons have imaginary "rest" masses. Classically speaking of course, imaginary mass particles are known to have the speed of light at their lower speed limit and are called tachyons, while real positive mass particles have the speed of light as their upper speed limit and are called tardyons. Consequently, in the quantum field theory, the tachyonic fields are not assumed to be real (they don't generate real particles of matter); in fact, they may be thought of as generating imaginal mirror images represented by imaginary number masses. This characteristic is extremely important, both because of its imaginal or "mind-like"[6] quality and its ability to produce the logical temporal order of experience. Because such particles with imaginary masses are confined to speeds in excess of light, they may be seen to play a role in memory processes and a role in the feeling of intent following the orderly process of thinking. This tachyonic speculation may be important as a model for how a temporally ordered mind arises from tachyons interacting with tardyons by emitting light as they pass through or by an observer. It also indicates something else. Mind may not simply arise solely from the brain, but actually exists in the whole universe—the Mind of God, so to speak as a tachyonic mind field. Our brains are something like active radio transmitter/receivers that through our actions of intent simply tune in to this greater mind to produce our mundane and at time perhaps profound thoughts, feelings, intuitions, and even our five perceptive senses.

The key point here is that in quantum physics we know that observation changes whatever is observed. Observation is a mindlike event—no mind, no observation. We also know that observation instantly collapses the wave of possibility from a spectrum of many possibilities to an emergence of just one of them.[7] If we are to associate a field with this collapse, it must be a tachyonic field since this sudden event must occur in a spacelike manner—faster-than-light.

As you'll see in what follows, a sequence of collapse events produced by the interaction of a tachyon and a tardyon appears to follow a peculiar logical order that is similar to the way in which thought forms into a sequence of words. I must admit, I hadn't realized that a logical temporal order could arise in this tachyonic manner at first glance and was quite impressed that tachyons could be seen to create this order when they interact with tardyons via light signals. To keep this simple in what follows, I simply assume that all communication between tachyons and tardyons takes place via light signals—spin *1* bosons.

To see how temporal order arises from tachyons, let's consider something fairly well known called the Doppler shift. You are already familiar with this effect, even though you may not know its name. It occurs when you are listening to a train's whistle as the train approaches when you are stopped at a RR crossing. The train whistle's pitch rises as it approaches and falls as it moves away. The same thing happens with the frequency of light emitted from a moving source, but instead of a changing pitch we see a change in color—the color we see shifts toward blue as something approaches us and toward red when it recedes from us.

[6] Some may object here. I take it as a conjecture that mind is field outside of spacetime capable of acting within spacetime and hence has both imaginal and faster-than-light qualities.

[7] Many physicists believe that an additional ad hoc process called "decoherence" that has nothing to do with consciousness should be included in quantum physics resulting in superpositions suddenly or very quickly reducing to single realities on ridiculously short time scales.

Just as we also use our ears to sense when something is approaching or receding, we do the same thing with the light. Hence, we can determine from the blue-shifted light where and when the object emitted the light as it approached us, and from the red-shifted light where and when the object emitted the light as it flew away from us. Indeed from such a picture astronomers calculate the expansion of the universe and relative speeds of distant galaxies.

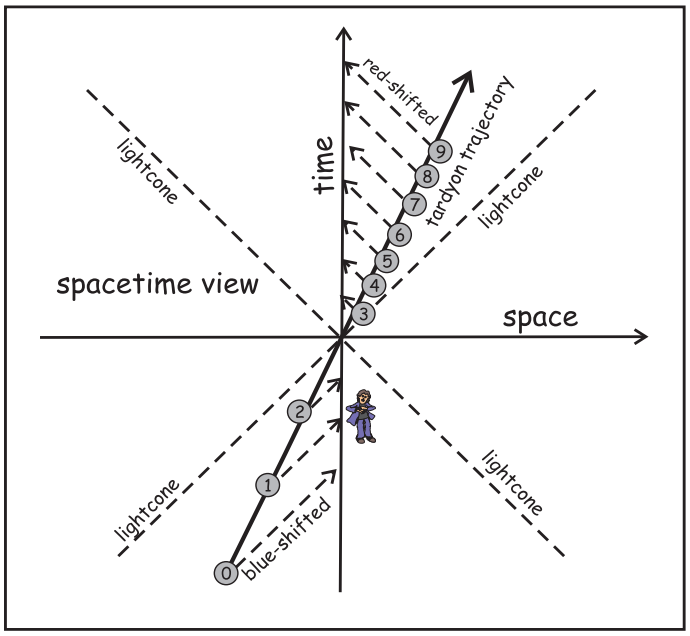

Figure 3. A tardyon communicating with an observer (From Wolf, F.A. 2010).

In Figure 3 we see a real object—a tardyon—speeding through the universe emitting light as it goes. We have placed an observer in this spacetime graph, and I show only the light the tardyon emits in his direction. Of course, as I have shown in my book (Wolf, 2010), both the tardyon and the observer move in this diagram as they both journey through time. The difference is that relative to the observer, the tardyon appears to move toward him and then away from him while emitting light as it goes. The observer sees the light as he make his journey in time and determines where the light is coming from and whether it is approaching him or receding from him. As the object approaches the light, rays appear bluer and as they recede they appear redder, just like the changes in the train whistle's pitch.

The observer is perfectly able to distinguish between the blue-shifted light emitted from the earlier events *0*, *1*, and *2* and the red-shifted light from the later events *3*, *4*, *5*, *6*, *7*, *8*, and *9* and can then tell how the tardyon is moving. In brief, he sees the tardyon generated blue-shifted light before he sees its red-shifted light. The order of the emission events, *0* through *9*, is matched by the order of the receptions. He sees the events in the temporal order *0* through *9* just as they occurred.

But what happens when an object moves faster than light? We might inquire as well about a similar phenomenon in sound and water wave transmission, when an object moves faster than any wave the object could produce in the medium through which it travels. For sound in air we have the sonic boom effect; in water we often see a boat speeding faster than the waves it makes can spread out from the boat. And in these cases the object makes the familiar boom or bow wave splash especially noticeable when we stand to the side and observe, as when a supersonic plane flies overhead or a motorboat zips past us on a pier sending a big wash over us.

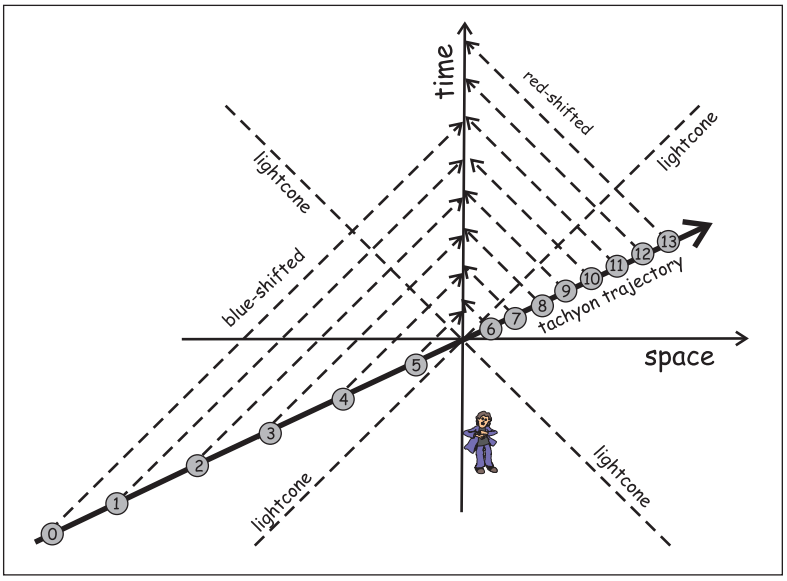

Figure 4. A tachyon communicating with an observer. (From Wolf, F.A. 2010)

In Figure 4 we see a tachyon speeding through spacetime. Look carefully and note that no light from the tachyon reaches the observer until the tachyon has actually crossed his path. Whereas for the tardyon shown in Figure 3 (slower than light speed particle), the observer sees light coming from the tardyon well ahead of when they cross paths. Note also that both the red-shifted and blue-shifted light are seen after the tachyon has crossed his path; so he sees the tachyon coming to him from past positions farther back in the past after they cross paths and later on in time. In the above sequence, he sees *5, 6, 4, 7, 3, 8, 2, 9, 1, 10, 0, 11*, and so on. Intermixed with the logical order of the red-shifted light sequence *6, 7, 8, 9, 10,* he sees the blue-shifted light signals coming from the past in the reverse order *5, 4, 3, 2, 1, 0*: in other words, it is like a watching a "blue" movie in reverse.

Hence the blue-shifted light appears to the observer, as he moves into the future, as a recording of the past positions of the tachyon (it looks like a tardyon going backward in space) with the red-shifted light appearing to be a record of its future positions (it looks like a tardyon going forward in space). Consequently, we also see that as the tachyon approaches the observer the earliest-emitted blue-shifted light arrives after the latest-emitted blue-shifted light. Thus, as time goes on, we see the blue-shifted light coming from farther back in time, appearing as if it was emitted from something moving backward from the crossing point. Since a tachyon moves faster than the speed of light, we cannot see it approaching or receding. So, after it has passed, we would only be able to see two images of it, appearing and departing in opposite directions.

Mind Order and Akashi speculations

As I explained earlier, tachyons are not physical particles simply because they move faster-than-light. Could the tachyonic mind field, which is non-physical and therefore not confined by movements in the material world, communicate with our brains using tachyons as carriers of information? As such, these tachyons are not limited in their direction through time—they can go backwards and forwards. I speculate that not only can we find the mind-matter interaction in this tachyonic/tardyonic interaction realm, we can find the source of all matter and energy put there as information or as an information field—the quantum field (possibly what the ancients call the Akashic records).

For those who may not know, *Akashic* is a theosophical term referring to a universal filing system that records every occurring thought, word, and action. The records are impressed on a subtle substance

called the *Akashi* (or ether). In Hindu mysticism this Akashi is thought to be the primary principle of nature from which the other four natural principles—fire, air, earth, and water—are created. These five principles also represent the five senses of the human being.

Some researchers compare the Akashic records to a cosmic or collective consciousness. These records have also been referred to by different names, including the Cosmic Mind, the Universal Mind, the collective unconscious, or the collective subconscious. Others think that the Akashic records make clairvoyance and psychic perception possible.

Perhaps what we call ghosts may have something to do with Akashic records. It may also explain what happens to us at the moment of death. This also may have a lot to do with how memory works. Tachyons racing through our brains may recall past events that appear as virtual images or flights of imagination. Perhaps at death or during an accident we have a quick flash of events occurring from a rush of tachyons. The red-shifted light in the brain registers an anticipation of the future, and the blue-shifted light records more and more of the past detail as time goes on. This may also indicate how we can form sentences.

Let me explain. A sentence or orderly thought consists of a logical array—a linear sequence of words or phrases. In Figure 4 we see the tachyon trajectory crossing the thinker's trajectory. I'll call the events occurring before the two trajectories cross the past and the events occurring after they cross the future. As the tachyon moves past the thinker as shown in Figure 4, blue-shifted light from the deepest past positions on the tachyon's trajectory arrive after the tachyon does. As the tachyon goes on by, red-shifted light arrives. The two signals, the past blue-shifted and future red-shifted light, form an intermixed sequence continually occurring as the thinker moves forward in time toward his future. Hence as time goes on new information from the future locations of the tachyon and old information from the past positions of the tachyon tend to intermix. Our thought processes may work this way: we think by looking at new information and comparing it with old information to see if the two streams of information gel or make logical sense. This tachyon-tardyon interaction model may also help us to understand how ordinary brain processes work according to similar atemporal processes, as indicated in the work of neural physiologist Ben Libet[8] (Wolf, 1998).

As I mentioned briefly, tachyon-brain interactions may indicate indeed how our thoughts form and how our minds may work. Let me explain this in some detail. As we ponder anything and put our words in order to form sentences, we need to not only see where we are going (the future of our thought), but we need also to constantly modify that future by reaching back to the past to see where such a word order may have arisen. Hence, if tachyons are interacting with brain tissue in this manner, we see that as our thought continues with more words and sentences coming into the picture, memory must play a continual role, allowing us to witness events or thoughts from the deeper past as our thoughts become more complex. Time order arising out of this atemporality is a key to understanding the process.

It may not seem to you that this is what we do in forming sentences. How do we formulate statements out of the raw material of our past linguistic and other experiences? We express new ideas and describe new experiences, by using and adapting the resources we have acquired so far. To do so, we need to go into our memory field, backward in time, so to speak and do this in a logical order. To express radically new ideas, do we need to use a kind of linguistic shock treatment to jolt ourselves into a new level of perception and/or understanding: a quantum leaps, so to speak? We may indeed need to do this. Such a jolt is the experience of the tachyon-tardyon interaction—the point where the tachyon and tardyon cross paths. As for

[8] Libet and his coworkers found experimentally that people project or refer backward in time to brain events in correspondence with their perceptions. They showed that events in the brain eliciting consciousness of passive sensory occurrences occur after the apparent awareness of these events and not before. They also hypothesize that a specific mechanism within the brain is responsible for or associated with the projection of these passive events both out in space (spatial referral) and back in time (temporal referral). Libet refers to this as the delay-and-antedating hypothesis/paradox. For more see F. A. Wolf, 1998.

instance, Joyce may have experienced with his stream of consciousness and wordplay, Garcia Marquez did with magic realism, and Kierkegaard did with existential challenges to conventional thinking, etc.

According to quantum field theory and the current search for the Higgs boson, we must have both tachyonic and tardyonic quantum fields present in our bookkeeping calculation as Feynman has shown (Feynman and Weinberg, 1987). Whether or not this is also true in nature remains a debatable question. My speculations here may certainly not be the current picture of nature as seen by many physicists. This prescription can be viewed as an interaction between the Akashi record of the tachyonic field and the tardyonic fields of matter, or, equivalently, a quantum field generator of a physical universe with different tardyonic masses. The big problem that the appearance of a tachyonic Higgs field may solve is not only how different masses come into existence, but also how a mind is there to know it. Again I caution the reader that this is speculation on how tachyon-tardyon interaction may explain thecollapse of the quantum wave function and the appearance of mind in nature.

Conclusion

I originated the idea that two events separated in time may be a necessary factor in determining the function of thought processes and normal brain functioning in my earlier publications (Wolf, 1989; 1998). Although we have known for perhaps close to 100 years that quantum physics really cannot be put into a mathematical logical format without realizing that the basic structure of quantum physics is probability theory, the relation between probabilities and physical events, although clear in quantum physics theory, is still fraught with many misunderstanding and perhaps needless philosophical meanderings as perhaps readers of this article may concur. The main culprit in all of this is the rather dogmatic insistence on temporal causality being a fundamental cornerstone of any physical theory. As time marches on we are beginning to see that causality is not in lockstep with temporal sequence—events that haven't happened yet will occur and will have an effect on events that are happening right now. We are not surprised that events that have occurred in the past—no matter how distant or close to the present moment—can and do affect the present. Even though logically the past is no more present than is the future, we might take it for granted that putting causality in lockstep with only a past to present one way flow relationship is merely an old prejudice, one that we have accepted for perhaps thousands of years and most likely caused by our human survival instincts and desire to have a rational universe.

In order to reach any logical form of causality within the range and environment of quantum physics thinking, it has become apparent that both events in the future and past do have a determining effect on the present. In essence the seemingly magical complex arithmetic of quantum physical calculations become real measureable predictions of the probabilities of events only when we are allowed to run the flows in both directions—from future to present and from past to present simultaneously, so to speak. It takes two events to make one conscious experience. This appears to be the direction we are taking to finally realize how mind and quantum physics are related.

Finally it is perhaps worthwhile to consider how such thinking may play a role in quantum field theory and the current search for the elusive Higgs field. With a new understanding of this field we may be seeing how mind and matter inter-relate.

About the author

Author of many books including *Taking the Quantum Leap, Parallel Universes, The Dreaming Universe, The Eagle's Quest, The Spiritual Universe, Mind into Matter, Matter into Feeling ,The Yoga of Time Travel: How the Mind Can Defeat Time*, and his latest book *Dr. Quantum Presents, A Little Book of Big Ideas.*

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In 1963, he received his Ph.D. in theoretical physics from UCLA and began researching the field of high atmospheric particle behavior following a nuclear explosion. Wolf's inquiring mind has delved into the relationship between human consciousness, psychology, physiology, the mystical, and the spiritual. His investigations have taken him from intimate discussions with physicist David Bohm to the magical and mysterious jungles of Peru, from master classes with Nobel Laureate Richard Feynman to the high deserts of Mexico, from a significant meeting with Werner Heisenberg to the hot coals of a firewalk.

In academia, Dr. Wolf has challenged minds at San Diego State University, the University of Paris, the Hebrew University of Jerusalem, the University of London, Birkbeck College, and many other institutions of higher learning. Wolf is best known for his contributions through technical papers and popular books, but he is frequently in demand as a lecturer, keynote speaker, and consultant to industry and the media.

Wolf is well known for his simplification of the new physics and is perhaps best known as the author of *Taking the Quantum Leap* which, in 1982, was the recipient of the prestigious National Book Award for Science.

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