ARTICLE

DNA
The Gateway to Time

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Abstract

The shape of DNA is fundamental to the nature of time. During a postsynaptic potential, positively charged ions flow towards the negatively charged phosphate groups in DNA molecules in brain cells. Due to the small size and unique geometry of DNA, this results in an interesting arrangement of electric and magnetic fields in space and time that assemble neatly to form, from scratch, new electromagnetic waves. The overall system of electromagnetic radiation surrounding DNA in this fashion possesses, due to the gyre of DNA, classical angular momentum. This angular momentum, when portioned off photon by photon, has the same magnitude as the intrinsic angular momentum of all photons. This astounding apparent coincidence results from the ratio of DNA pitch to radius. While ordinary photons can, in relativistic terms, be regarded as frozen at one point in time, existing and oscillating simultaneously at every point along their path in space, the newly formed electromagnetic radiation herein described comprises photons which can be regarded as the temporal analogue of ordinary photons, i.e. frozen at one point in space, but existing and oscillating "simultaneously" at every point along their path in time. Such temporal photons can couple with ordinary photons in satisfaction of Maxwell's equations to form spin-2 systems equivalent to gravitons, thereby unifying gravity and electromagnetism. The electric and magnetic fields surrounding brain DNA during a postsynaptic potential also form advanced Ψ functions responsible for observation induced wave function collapse. DNA geometry is correlated with time direction. The hypothesis is experimentally falsifiable.

Key Words: DNA, photon, virtual photon, biophoton, spin, graviton, nerve, soma, advanced waves, retarded waves, Schrödinger, state vector, Maxwell, electromagnetic waves, time

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1. Introduction

Maxwell's electromagnetic waves ("EM waves"), Schrödinger's probability waves (known as Ψ or the "state vector"), and DNA[2] all appear, superficially, to have similar geometries.[3] First, the two-dimensional projections of each appears to comprise two perpendicular sinusoids.[4] In the case of Maxwell's EM waves, these are the electric and the magnetic components; for Ψ, these are the imaginary and real components; and for DNA, these are the two phosphate-deoxyribose strands.[5] Second, each possesses

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[2] This paper is concerned with B-DNA, the most common form of DNA found in living cells.

[3] The author first noticed this similarity in or around 1995. While other commentators have independently noticed this similarity, to the best of the author's knowledge, no one has yet realized its significance.

[4] Strictly speaking, the electric and magnetic components of a Maxwell EM wave can be of any wave shape and need not necessarily be sinusoidal. As will be discussed, however, all wave shapes are merely combinations of sinusoidal elements.

[5] Although the geometries are similar, they are not identical. In particular, the relative phase of the two sinusoids in the EM wave is

some kind of intrinsic gyre. Maxwell's EM waves have polarization, the particles corresponding to Ψ have quantum spin, and DNA has a helical twist. For the reasons discussed below, it is the author's view that these similarities are not merely superficial but have important mechanical ramifications, particularly with respect to the nature of time and gravity and their connection to electromagnetism.

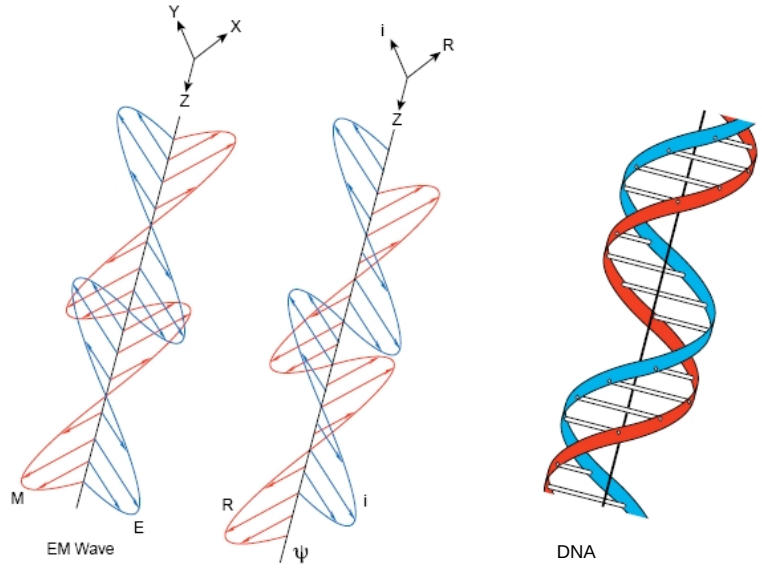

Figure 1. Geometric similarity in EM wave, Ψ function, and DNA.

1.1 Quantum Gravity and Organelles of Brain Cells – Penrose-Hameroff

Models linking quantum gravity to neuronal organelles have been suggested by other authors. Most notably Sir Roger Penrose and Dr. Stuart Hameroff have proposed that quantum coherent superposition occurs in the neuronal microtubules of conscious organisms.[6] By way of summary (albeit, a very crude summary), in that model, the superposed quantum states, each with their own space-time geometry are (abstractly speaking) separated to some degree. The degree of separation can increase only to a certain critical point at which quantum gravity renders the arrangement unstable, causing a collapse of the superposition and the manifestation of only one of the quantum states. Penrose and Hameroff attribute consciousness to this process.

Whereas Penrose and Hameroff were concerned with the internal quantum gravitational effects on superposition collapse mediated by microtubules in the brain, the present paper is concerned with the genesis of quantum gravitation mediated by DNA in the brain and its interface with the external world and correlation with wave function collapse of external systems.

Accordingly, although the hypothesis herein and the Penrose-Hameroff model are analogous in some regards, neither depends upon, nor contradicts, the other.[7]

1.2 Biphoton Emission from DNA – Popp

Dr. Fritz-Albert Popp's pioneering research on biophotons has revealed that biophotons originate from a coherent field which is likely produced in DNA.[8] The present hypothesis proposes simple mechanics on how DNA may serve as a template for the production of coherent EM radiation. Most interestingly, DNA has just the right ratio of pitch to radius (3.4 to 1) to facilitate the generation of classical angular momentum that eerily matches the intrinsic angular momentum of $h/(\pi\sqrt{2})$ possessed by all photons. The present paper extends the matter further by proposing that the arrangement of EM radiation surrounding DNA during a postsynaptic potential may serve as the temporal analogue of ordinary EM radiation. Finally, this paper proposes that DNA may also serve as the template for the complex conjugate of the Ψ function, thereby facilitating wave function collapse upon observation.

that of sine to sine, whereas the relative phase of the two sinusoids in Ψ and DNA is sine to cosine. The relevance of this is discussed below.

[6] Hameroff S, Penrose R. Quantum computation in brain microtubules? The Penrose-Hameroff 'Orch OR' model of consciousness. Philos T Roy Soc A 1998; 356:1869-1896; Hameroff S, Penrose R. Conscious Events As Orchestrated Space-Time Selections. J Consciousness Stud 1996; 3(1):36-53.

[7] However, it is the author's view that these two models may well compliment each other and that further investigation of same may lead to important insights in both the fields of quantum consciousness and external quantum phenomenon.

[8] See for example Popp FA. Consciousness as Evolutionary Process Based on Coherent States. NeuroQuantology 2008; 4: 431-439; Popp FA. Coherent Photon Storage of Biological Systems. Electromagnetic Bio-Information, 2nd ed. 1989; 144-167.

2. Observation

Before discussing the relevance of the similar geometries of Maxwell EM waves, Ψ, and DNA, it is instructive to consider the importance of observation in modern physics. The general consensus is that the two most important developments in 20th century physics were quantum mechanics and relativity. Although the two appear to have little in common (other than being profound), they both emphasized the importance of the observer.

2.1 Importance of the Observer in Quantum Mechanics

Quantum mechanics has shown us, most notably through "the double-slit experiment", also known as "the experiment with two holes"[9], that observation can cause something which would otherwise behave as a wave to instead behave as a particle. Other experiments have confirmed that, somehow, the mere act of observation changes the physical attributes of the thing being observed.

In an attempt to explain this bizarre phenomenon, some commentators have relied on philosophical arguments pertaining to the relationship between mind and reality. In the author's opinion, however, a more fruitful line of inquiry would be the physical mechanics of the brain[10] during observation.

2.2 Importance of the Observer in Relativity

One does not typically think of the observer altering reality in the context of relativity in the same sense as in the double-slit experiment. However, as the author hopes to demonstrate, one perfectly plausible interpretation of relativity is precisely that – at least insofar as relativity relates to light.

Relativity taught that things have different properties depending on the frame of reference in which they are observed. It demonstrated that as something, say a clock for example, moves faster relative to an observer, it becomes thinner in the direction of motion, it ages more slowly (i.e. the hands on the clock move more slowly), and it gains mass, as judged from the observer's frame of reference. Conversely, from the perspective of the clock it would appear as though the clock is at rest and that the observer is moving. The clock would "think" that the observer is becoming thinner in the direction of travel, moving slower in time, and gaining mass. All the while, the observer will not perceive himself to be any different than he was before.

All of this works fine for speeds lower than the speed of light, c, and it remains applicable to speeds arbitrarily close to c. The mass, rate of aging, and thickness of the clock (in the direction of motion), each have some finite value in the clock's frame of reference. In the observer's frame of reference, these finite values are *stretched* or *contracted* by a finite amount and consequently, have a different finite value in the observer's frame of reference.

However, *at* the speed of light, problems arise (and accordingly, physicists insist that light does not have a frame of reference). For example, relativity teaches that light has speed c in the frame of reference of a stationary observer, and precisely this same speed, c, in the frame of reference of an observer moving towards the light (at some speed less than c).[11]

[9] See Gribben J. Schrödinger's Kittens and the Search for Reality. New York: Time Warner Book Group; 1995 at 2 - 14 for a clear, lay-person's review of this experiment. There is also a very nice cartoon on the subjected titled "Dr. Quantum – Double Slit Experiment" available on Youtube.com at <http://www.youtube.com/watch?v=DfPeprQ7oGc>. To summarize, in this experiment, a single electron (the experiment has been done with electrons, photons, atoms, and even molecules with the same result) is ejected towards a screen. The screen has two holes in it through which the electron can pass. After passing through the screen, the electron will hit a photographic plate, leaving a mark at the point on the plate that the electron hit. After conducting the experiment a large number of times, a pattern appears on the photographic plate that is consistent with the electron being a wave (of some sort). When one of the holes is closed in advance, the pattern that appears on the photographic plate is consistent with the electron being a particle. However, when the experiment is done with both holes open, but with a detector in place to allow the experimenter to observe the electron while it passes through the screen (and to observe through which of the two holes the electron passes), the pattern that is left on the photographic plate is consistent with the electron being a particle. In other words, simply observing which hole the electron passes through causes it to behave as a particle, when it would have otherwise behaved as a wave.

[10] As will be discussed later, organisms that do not have brains, such as single celled organisms, have an equivalent mechanism to that of the human brain.

[11] The equation used for this calculation is:

$$w' = \frac{(w - v)}{(1 - wv/c^2)}$$

where v is the velocity of the 2nd observer, w' is the velocity of the thing being observed in the frame of reference of this 2nd observer, and w is the velocity of the thing being observed in the frame of reference of the 1st stationary observer. If the thing being observed is light (with velocity c) and the 2nd observer is also moving at velocity c, one is left with the expression 0/0.

However, if one were to calculate the speed of light in the (fictitious and physically impossible) frame of reference of an observer who was moving at speed c himself, one would not get the value c. Instead, one would get the mysterious expression 0/0. This expression is mathematically indeterminate and physically meaningless.

As another example, if light were capable of observing itself, it would not experience the passage of time – it would not be temporally extended. That is to say, it would exist at every point along its spatial path all in a single instant of time, namely the instant of time in which it was emitted, as a standing wave in space. The light would be unaware of all the things that have changed in the universe since it was emitted.

Yet, in the frame of reference of anyone who observes a photon, the photon has a non-zero temporal extension, i.e. it existed for a certain number of seconds, say, that is greater than zero. This is problematic because no amount of "stretching" can make something with a value of zero acquire a finite value. Mathematically, the amount of this time stretching (determined by the Lorentz factor) becomes infinite at the speed of light – which is physically meaningless.

Likewise, the rest mass of a photon is zero, and a photon would not experience its own mass or gravitational attraction. However, from the perspective of an observer, the photon has a "relativistic mass", resulting from the fact that it travels at the speed of light, and is thus subject to gravitational attraction like any massive object. Again, no physically meaningful amount of stretching can cause a zero rest mass to become a finite relativistic mass.

The observation of light somehow gives light something from nothing – in particular, relativistic mass from zero rest mass and finite temporal extension from a state of timelessness.

This is true whether the observation is direct, as when photons make direct contact with our sensory organs, or when the observation is indirect, as when photons are absorbed by a photographic plate and the observer subsequently looks at the plate – just as the wave function at issue in the double-slit experiment would (theoretically) collapse regardless of whether the observer senses the particle directly, or observers it indirectly by looking at the pattern it left on a photographic plate.

Note that, unlike matter, once a photon is observed, it ceases to exist. For example, you do not "see" light until after it is absorbed by your eyeball (or until after is absorbed by a photographic plate and you look at the plate); you do not "feel" radiation until after the radiation is absorbed by your skin, and so on. The same is true of every living organism of which we are aware.

Therefore, the author proposes that one valid interpretation of relativity, as it applies to light (and other EM radiation), is to say that the act of observing a photon bestows upon the photon a temporal extension and (relativistic) mass - attributes which the photon would not (and could not) have if left to its own devices. Given that a photon does not have a frame of reference of its own, and given that a photon does not exist after it is observed in any event, this interpretation does not contradict the principles of relativity. Further, this interpretation – that it is observation itself that gives observed photons their sense of time and gravitational mass – is not merely philosophical, but leads to useful application and important insight into the nature of time, gravity, and even consciousness, and their connection to electromagnetism.

Against this backdrop, this paper will review closely some of the physical processes associated with observation. As we will see, an investigation into the nature and mechanics of observation yields some unexpected results that directly affect the external world.

2.3 The Nature of Observation

From what we currently know, all observation requires a living creature. Even when an instrument is used to measure something, there is no observation unless a living creature sets-up the instrument to begin with and subsequently senses the reading of the instrument, either directly or indirectly.

All living things of which we are aware have certain attributes in common, including:

- DNA – all living things have DNA, and the phosphate-deoxyribose backbone of DNA in all living things, from the amoeba to human beings, has the same

geometry, diameter, pitch, composition, and chirality;

- Positively charged ions that flow, in the vicinity of the DNA, in response to stimulus – for human beings and animals, this follows the generation of postsynaptic potentials; however, even single-celled organisms respond to stimulus through the flow of positively charged ions in their cytoplasm.[12]

As far as we are currently aware, living things can only observe the physical world through five senses: sight, touch, sound, smell, and taste, or some variation on those five senses (as sonar, for example, is a variation on the sense of sound). For each of these five senses, the only thing that is observed directly is electromagnetic radiation, i.e. photons; everything else is inferred from the observation of the photons:

Sight: The sense of sight arises from the observation of light. When we observe matter, say a wall, what we are really doing is observing the light that bounces off the wall and from that observation inferring the existence of the wall.

Touch: When we touch the wall by hand, the electrons on the surface of our hand exchange (virtual) photons with the electrons on the surface of the wall. At all times, the hand and the wall are kept apart by electrostatic force, which is ultimately the exchange of electromagnetic radiation. The only thing that we actually "feel" is the photons, and from that, we infer the existence of the wall.

Sound, Smell, Taste: These three senses are variations on the sense of touch; again, the only thing that is directly observed is the EM radiation between the objects being sensed and the sensory organ.

The relevance of this will become clear after considering the mechanics of observation.

2.4 The Mechanics of Observation

Given that observation has been shown experimentally, through the double-slit experiment, to physically alter external reality, an investigation into the mechanics of observation may provide us with some insight as to why this is the case.

Let us consider a human observer who hears a noise. If the noise is loud enough and within a certain range of frequencies, a signal is sent from the sensory receptors in the observer's ear which ultimately reaches the brain.

In simplified terms, the signal starts at receptor cells in the ear, then propagates along an axon until reaching the synaptic knob before the synapse. The surface of the synaptic knob, (the presynaptic membrane) is then depolarized, causing neurotransmitters to cross the synapse and bind to the postsynaptic membrane on the other side of the synapse. This results in the flow of positively charged ions across the postsynaptic membrane and into a dendrite and ultimately the cell body of the nerve in the brain.

The cell body receives ion currents in this fashion from a large number of synapses, and the ion currents combine together in an additive fashion (i.e. "summation"). If the combined potential is high enough to exceed a particular threshold in the region of the cell body known as the axon hillock, another nerve impulse is triggered and the process repeats.

For the purposes of the present hypothesis, the exact mechanics of ion transport and the identity of the cations that flow into the cell body are unimportant. All that is required is that positive charges ultimately flow into the cell body in response to a stimulus, and that the positive charges subsequently exit the cell body, in some sort of periodic fashion.

The consensus is that it is in the cell body of the nerve (the "soma", or "somata" for plural) that, by some mysterious process, the signal is interpreted as sound by the observer. This in turn, allows for the generation of other signals that travel to other nerves, and so on.

The question arises, why the soma? What makes a soma different from other parts of the nervous system and other parts of the human body in general? Two properties which distinguish somata from all other cells are:

1) Positively charged ions (such as sodium, Na+) flow into a soma in response to stimulus.
2) They contain DNA which exists in a relatively uncondensed and uncoiled form, due to the fact that mature

[12] See for example Prusch RD, Hannafin JA. Calcium Distribution in *Amoeba proteus*. J Gen Physiol 1979; 74:511-521.

somata do not generally divide[13]. Therefore, the double helix of DNA in these cells is freely accessible, in all directions, by the cations that flow into the somata during a postsynaptic potential.

Relevant to the second property, Popp demonstrated experimentally that photon emission from DNA increases as DNA assumes an increasingly uncondensed conformation.[14] This provides support for the mechanics described herein.

Within somata (and most human cells), DNA is contained in the nucleus which is enveloped by the nuclear membrane. Although the nuclear membrane has been described as a "formidable diffusion barrier even for ions as small as Na+, K+ and Cl- " it is not an absolute barrier.[15] Accordingly, a significant percentage of the cations that flow into a soma as a result of a postsynaptic potential will diffuse across the nuclear membrane. The DNA molecule is loaded with negatively charged phosphate groups (PO_4^-) all along its double helical backbone. When the positively charged ions diffuse across the nuclear membrane, they will be attracted to the negative charges on the DNA double helix, and flow towards it. Experiments have shown that when DNA is in a solution containing alkali-metal ions (i.e. ions such as Na+ and K+), the ions interact with DNA in an electrostatic fashion. The ions "form an ionic cloud around the lattice of negatively charged groups", with the ions remaining "highly mobile".[16] As one research article states:

> It is possible that a small fraction, not more than 1%, of the population in the ionic cloud approaches the DNA molecule more closely… The life-time of this interaction is 5.5 nanosecond or shorter. Thus, if there is any specific binding of alkali ions to DNA involving severe restriction of motional freedom, it must be very weak and of a very short duration.[17]

Therefore, once the cations flow across the nuclear membrane, they will be attracted to the DNA and move towards it as a result of electric attraction; however, despite this attraction, they will remain unbound and highly mobile, capable of flowing back outside of the cell nucleus as the ions are pumped out of the cell upon completion of that particular signal.[18] This results in some interesting electromagnetic geometries, as explored below.

2.4.1 Flow of Positively Charged Ions towards DNA during a Postsynaptic Potential

Let us consider one phosphate group of DNA and the surrounding portions of the helix on which it lies. Once the positively charged ions cross the nuclear membrane[19] they will approach the negatively charged phosphate group from all directions, unless the path of the ions is obstructed somehow.

Classical electrodynamics tells us that an accelerating charge will emit EM radiation (i.e. Photons) perpendicular to the direction of motion of the charge. Quantum electrodynamics tells us that this charge will also emit "virtual photons" in the direction of motion[20]. Although the geometry of the real EM radiation is fascinating in itself, this paper is concerned primarily with the geometry of the virtual radiation.

The photons are called "virtual" because they exist over only short intervals of space and time, having energy "borrowed" from the universe within the limits of the uncertainty principle, and cannot be directly detected; they can only be detected as forces. However, they

[13] Kandel E, Schwartz JH, Jessell TM. Principles of Neural Science, 4th ed. New York: McGraw-Hill; 2000 (at 89).

[14] Popp FA. Coherent Photon Storage of Biological Systems. Electromagnetic Bio-Information, 2nd ed. 1989; 144-167 (at 152 – 153).

[15] Loewenstein WR, Kanno Y. The Electrical Conductance and Potential Across the Membrane of Some Cell Nuclei. J Cell Biol 1962; 16:421-425.

[16] Reuben J, Shporer M, Gabbay EJ. The Alkali Ion-DNA Interaction as Reflected in the Nuclear Relaxation Rates of ^{23}Na and ^{87}Rb. P Natl Acad Sci; 72 No. 1:245-247.

[17] *Ibid*.

[18] One concern that arises is that the presence of cations near DNA may impair the ability of DNA to repair itself after transcription. However, Wang et al. have shown that the presence of Na+ and K+ inhibits transcription in uncoiled DNA (and, as discussed, DNA in somata exists in a relatively uncoiled state). While further research is needed on this point, it would seem reasonable that transcription would be briefly halted or reduced during a postsynaptic potential until the cations are pumped back out of the cell.

[19] It is conceivable that positively charged ions may be attracted to the DNA molecule even before crossing the nuclear membrane; however, to err on the side of caution, the author will only consider the flow of the ions after crossing the nuclear membrane.

[20] and the charge to which it accelerates reciprocates by emitting virtual photons towards the first charge which, rather than cancelling out the first stream of photons, somehow compliments it to result in an attractive force.

are photons nonetheless and are (generally) subject to the same equations as real photons. The dimensions of DNA are small enough that the very brief intervals of space and time in which the virtual photons exist are nonetheless significant in terms of their interaction with the DNA. As with real EM radiation, virtual EM radiation comprises an electric field component oscillating in one plane, and a magnetic field component oscillating in a perpendicular plane.

As the ions approach the phosphate group through electrical attraction, they will emit virtual photons which propagate towards the phosphate group. If two antiparallel paths towards the phosphate group are equally unobstructed, the resulting net virtual electromagnetic fields from each path will cancel out – the net virtual EM field at the phosphate group will be zero.

However, one prominent obstruction in the flow of ions is the portion of the helix immediately behind the phosphate group. As a result, ions can approach the phosphate group in a direction tangential to the helix only "upward" in the 5' **à** 3' direction (i.e. the direction in which the ion will encounter the phosphate group before encountering the obstruction), but not "downward" in the 3' **à** 5' direction (for the other strand of the double-helix, the phosphate groups "point" in the opposite direction, and therefore, the ions can only approach "downward" rather than "upward" – more on this later).[21]

Therefore, there will be a non-zero net virtual electromagnetic field generated in the direction of the helix at the point of that phosphate group. The same would occur at every other phosphate group along the helix. The result will be a helical arrangement of a stationary virtual EM field.

Now, one can imagine drawing lines tangential to the DNA which extend from the DNA all the way to the inner surface of the cell nucleus.

Virtual EM fields propagating along these tangential lines will, due to the obstruction discussed above, not cancel out. At the point where these tangential lines touch the DNA,

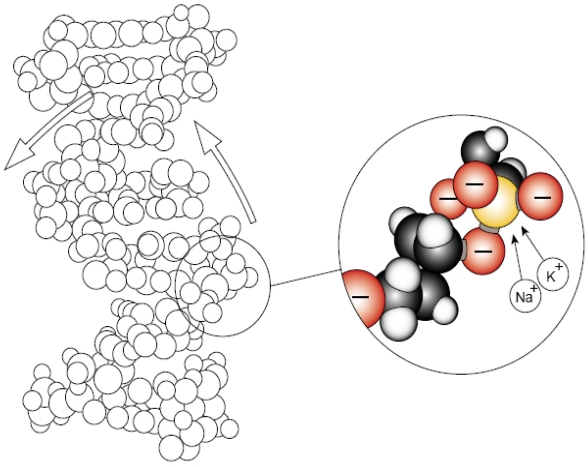

Figure 2. Ions can approach the phosphate group in a direction tangential to the helix only "upward" for one strand and only "downward" for the other. Movement of ions in the opposite direction is blocked by the portion of the helix immediately behind each phosphate group.

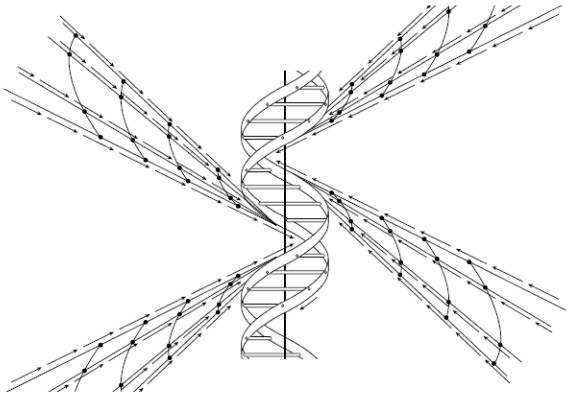

Figure 3. Ions flowing along lines tangential to the strands of DNA will result in the formation of EM helical segments surrounding the DNA molecule. The further one moves away from the DNA molecule, the larger the pitch and radius corresponding to each helical segment becomes. However, all such helixes maintain the same ratio of pitch to radius, i.e. 3.4 to 1.

there will be a resulting virtual EM helix that has the same dimensions as the DNA itself – i.e., the virtual EM helix will have the same radius (approximately 1 nm) and pitch (approximately 3.4 nm) as DNA. As one moves outwardly away from the DNA molecule along one of the tangential lines, one will find a portion of a larger helix along which there will be virtual EM radiation that does not cancel out. The diameter of the virtual EM helical segment at that point will be larger, as will the pitch. However, these larger virtual EM helix segments will have the same proportions as DNA (i.e. the ratio of their pitch to radius will continue to be approximately 3.4 to 1).

[21] The direction of ion flow is opposite the direction that the DNA template strand is read during transcription.

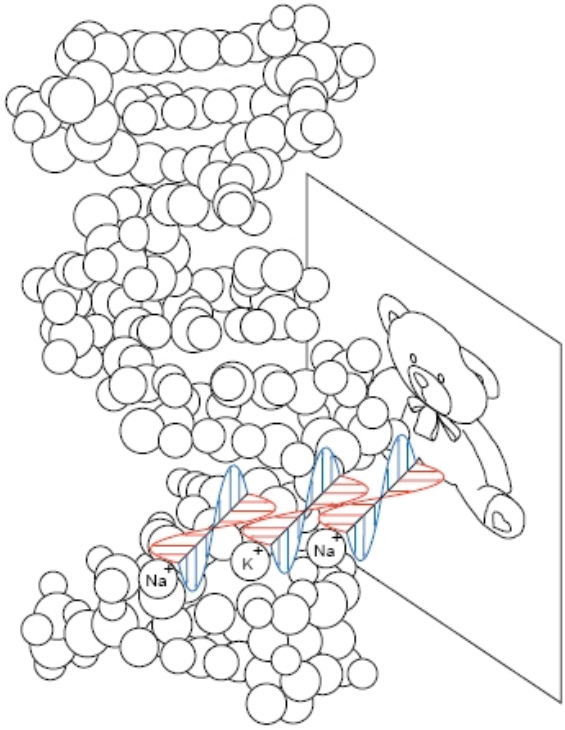

Figure 4. A two-dimensional teddy bear relegated to a plane adjacent the DNA molecule "watches" as EM radiation is exchanged between positively charged ions and the DNA. In reality, the wavelength of the EM radiation would be orders of magnitude larger than the pitch of DNA, contrary to what is shown here.

Now imagine drawing a plane along the length of the DNA and touching the outer periphery of the DNA at a point where there is a phosphate group. Relative to this plane, the magnitude of both the electric and magnetic components of the virtual EM field vary sinusoidally along the length of the DNA as a result of the DNA helix falling away from the plane on each side of the phosphate group.

By way of illustration, imagine that there is a two-dimensional creature living on this plane. As this creature is not really living, but is just a pedagogical device to help us visualize the phenomenon, let us represent him with a teddy bear – and let us call him "Teddy". Teddy would detect an electric field of a certain magnitude at the phosphate group. As Teddy moves up in his plane, away from the phosphate group, he would detect that the magnitude is decreasing (due to the fact that the DNA molecule is rotating away from his plane).

The further up he goes in his plane, the more the magnitude of the field would decrease. Teddy would note that the rate of change of field magnitude is sinusoidal, with a maximum magnitude at the phosphate group and a minimum at the point on his plane that corresponds to one quarter rotation of the DNA molecule. Conversely, if Teddy were closer to the bottom of his plane and moving upward towards the phosphate group, he would detect that the magnitude of the electric field is increasing in a sinusoidal fashion. That is, Teddy would detect this phenomenon as a standing electric wave in space extending lengthwise along his plane and existing, simultaneously, at every point along the length of his plane. The magnetic component of the EM field is present at every point along the DNA helix at which the electric field is present, but perpendicular to the electric field. Accordingly, Teddy would observe that the magnitude of the magnetic component of the EM field also varies sinusoidally as he moves along his plane, in the same fashion that the magnitude of the electric component varies. In other words, Teddy would detect a standing magnetic wave in space extending lengthwise along his plane, and at each point, perpendicular to the standing electric wave described above.

Meanwhile, the number of ions flowing into the soma, and therefore into the nucleus, varies with time in a period fashion. Therefore, the magnitude of the electric and magnetic components of the EM field measurable by Teddy will also vary in time according to such a periodic function. Using the Fourier series, any periodic function can be written as a sum of sines and cosines. Putting all of this together, Teddy will observe a standing sinusoidal EM wave extending along space in the direction of the length of the DNA, but frozen at a single point in time. At every point along Teddy's plane in which there is an EM field, Teddy will also observe the sum of several sinusoidal EM waves propagating in time, but frozen at a single point in space, namely the point along Teddy's plane in question. The relevance of this arrangement of EM fields in space and time will become apparent upon a review of the properties of Maxwell's EM waves.

2.5 Maxwell's EM Waves and Relevance to Arrangement of EM fields generated in Vicinity of DNA during a Postsynaptic Potential

A Maxwell EM wave comprises an oscillating electric field and an oscillating magnetic field oriented perpendicular to each other and to the

direction of wave propagation. If a snapshot is taken of an EM wave as it moves from say the Sun to the Earth, both the electric and magnetic components would look like standing waves in space, each extending from the Sun to the Earth. If we consider only a specific point along the path of the EM wave, we see that the electric and magnetic components vary in time in an oscillatory fashion. In this sense, an EM wave can be thought of as comprising a spatial component and a temporal component, as is the case with any (non-standing) wave phenomenon. (Note that Maxwell's equations do not merely describe EM waves, but can also describe individual photons.[22])

However, unlike classical wave phenomenon, because the EM wave travels at the speed of light, it only "experiences" the spatial component – as mentioned above, it is as though the temporal component is somehow bestowed upon the EM wave by an observer in a different frame of reference.

As an important side note, the argument that light does not experience time is based on deduction rather than observation (of course, it would be impossible to demonstrate this by observation as a photon does not have a frame of reference and as it would be impossible in any event to travel at the speed of light). Conversely, Maxwell's equations were based on the behaviour of *observed* light. Physicists have historically assumed that observed light behaves the same as unobserved light; however, as the double-slit experiment has shown us, we cannot so summarily dismiss the effect of observation.

A Maxwell EM wave must satisfy the following conditions:

$$\frac{\partial \mathbf{E}}{\partial x} = -\frac{\partial \mathbf{B}}{\partial t} \qquad (1)$$

$$\frac{\partial \mathbf{B}}{\partial x} = -e_0 m_0 \frac{\partial \mathbf{E}}{\partial t} \qquad (2)$$

That is to say, that the rate of change of the electric field with respect to space is equal but opposite to the rate of change of the magnetic field with respect to time. Likewise, the rate of change of the magnetic field with respect to space is proportional, but opposite to, the rate of change of the electric field with respect to time (the constants $\varepsilon_0\mu_0$ arise because the magnitude of the magnetic field is 1/c the magnitude of the electric field when SI units are used).

Returning now to our friend Teddy, we see that he observed phenomenon which accords with the two conditions above. Teddy observed an electric field weakening sinusoidally in *space* as he moved up along his plane while experiencing a strengthening of the total EM field, including the magnetic component, in *time* in a fashion that is the equivalent of the sum of sines and cosines. Likewise, teddy observed a magnetic field (which, in the usual course, was 1/c the magnitude of the electric field) weakening sinusoidally in space as he moved up along his plane while experiencing a strengthening of the electric component in time in a fashion that is the equivalent of the sum of sines and cosines. This suggests that the EM phenomenon observed in the vicinity of the DNA molecule during a postsynaptic potential could be the equivalent of a Maxwell EM wave (with wavelength equal to the pitch of the helix). That is, the bits and pieces of EM field arising from the exchange of photons between the ions and the DNA molecule assemble neatly in space and time so as to form, from scratch, a new EM wave!

However, for this to be true, the precise rate of change on the left hand side of equations (1) and (2) above (i.e. rate of change with respect to space) would need to accord with the precise rate of change on the right hand side above (i.e. rate of change with respect to time). As will be demonstrated below, this condition is satisfied.

First, considering the spatial components of our proposed newly minted EM waves, recall that as we move away from DNA along tangents drawn from the DNA towards the inner wall of the nucleus, the diameter and pitch of the EM helix segments increase in a proportionate manner. There is a continuous spectrum of EM helix sizes. The minimum size is that of the DNA

[22] Raymer MG, Smith BJ. The Maxwell Wave Function of the Photon. SPIE conference: Optics and Photonics, Conference number 5866, "The Nature of Light: What is a Photon?", San Diego, August 2005, online: arxiv.org <http://arxiv.org/ftp/quant-ph/papers/0604/0604169.pdf> (submitted to arxiv.org April 24, 2006).

molecule itself, i.e. with a pitch of 3.4 nm and a radius of roughly 1 nm. This corresponds to an EM wave with wavelength 3.4 nm (i.e. in the range of x-rays). The maximum is dictated by the size of the cell nucleus, which varies from cell to cell and organism to organism. In human cells, the diameter of the nucleus is normally around 6 μm [23] – i.e. approximately 2,000 times the pitch of DNA. This corresponds to EM waves with wavelengths in the infrared range. Accordingly, as long as the temporal components of our new EM waves have wavelengths somewhere within this very large range of wavelengths, Maxwell's equations are satisfied.

To determine the wavelength of the temporal components, we need to write the periodic function corresponding to the flow of ions into the cell body during a postsynaptic potential as a Fourier series:

$$g(x) = \sum_{n=0}^{\infty} A_n \pi^{1/2} \sin(nx) + \sum_{n=0}^{\infty} B_n \pi^{1/2} \cos(nx)$$

Where g(x) is the said periodic function (which can be any periodic function),

$$A_n = 1/\pi^{1/2} \int_{x=0}^{2\pi} g(x)\sin(nx)dx,$$

and

$$B_n = 1/\pi^{1/2} \int_{x=0}^{2\pi} g(x)\cos(nx)dx.$$

We see that the above expression includes discrete values of n rather than continuous values (resulting from the fact that it uses a summation rather than integration). This means that the sinusoidal components of our periodic function must be of certain specific values. However, we also see that n can be anywhere from 0 to infinity, while still having significant values for the constants A and B. Thus, although only specific wavelengths fit within our periodic function, there is an endless spectrum of allowed wavelengths.

Therefore, where the flow of ions into the soma spans say 1 millisecond, the periodic function corresponding to same can be broken down into an infinite number of sinusoidal elements, the sinusoids varying in temporal "wavelength" anywhere from approximately 1 millisecond (the span of the impulse as a whole) to a wavelength that approaches zero. This, in turn corresponds to EM radiation ranging from radio waves (i.e. waves with periods in the range of milliseconds) all the way down to gamma rays (and beyond).

Accordingly there is a very large range of overlap between the allowed temporal wavelengths determined by the flow of ions into the soma and the spatial wavelengths determined by DNA and the distance from DNA. This overlap takes place beginning at the infrared range of the EM spectrum down to the x-ray range. The author proposes that, within this range, the temporal components combine with the spatial components in satisfaction of Maxwell's equations so as to yield, from scratch, fresh EM waves. As will be shown below, these fresh EM waves also satisfy the mathematically derived value of photon spin.

2.6 Photon Spin

All photons have intrinsic angular momentum, called "spin", of magnitude $h/(\pi\sqrt{2})$, where h is Planck's constant, regardless of wavelength. The direction of the angular momentum can be either positive or negative. The mechanism described above results in the generation of angular momentum which, when portioned off photon by photon, is found to agree with the mathematically derived value of plus or minus $h/(\pi\sqrt{2})$ or approximately +/- 0.225 h.

Recall that the virtual photons exchanged between the ions and the DNA molecule are moving tangential to the DNA molecule. The strands of DNA, in turn, are helical such that if several photons were to move along one strand or the other, the total system of EM radiation would possess angular momentum as measured from the centreline of the DNA molecule. Classically, the angular momentum of a particle is defined as:

$$L = r \times p$$

Where L is the angular momentum, r is the position vector of the particle from the

[23] Alberts B et al. Molecular Biology of the Cell. 4th ed. New York: Garland Science; 2002 at 198.

origin, p is the linear momentum of the particle, and x denotes the cross-product.

In our case, the origin is at the centreline of the DNA molecule and the magnitude of r is the radius of the DNA molecule. The angular momentum can be found by taking the component of the tangential momentum of the photons that is in the plane that lies perpendicular to the centreline. We then simply multiply this value by the magnitude of the position vector to obtain the magnitude of the angular momentum.

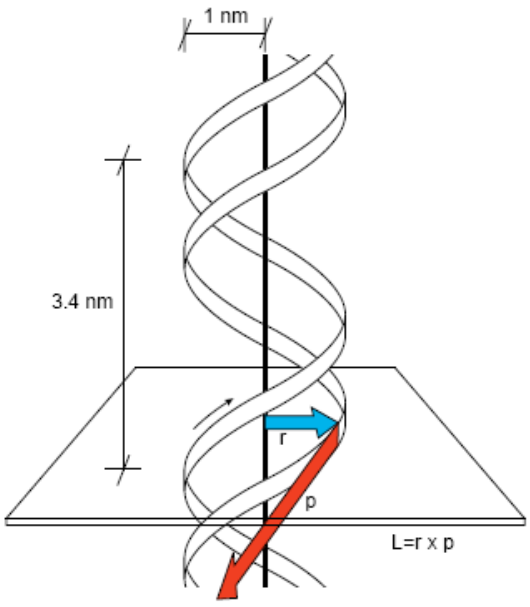

Figure 5. A photon having momentum p moves tangentially to a strand of DNA. The position vector, r, is in a plane running along the cross-section of the DNA molecule, extending from the centreline of DNA to the location of the photon.

The magnitude of the tangential momentum of the photons is found using the following equation:

$$p = h/\lambda$$

Where λ is the photon's wavelength.

Let us imagine our newly formed EM waves as comprising photons, like any other EM wave (more on this later). Let us further consider one photon among those closest to the DNA molecule. Its wavelength will be the pitch of the DNA molecule itself. According to Watson and Crick, the scientists who determined the geometry of DNA, the pitch of DNA is 34 A (i.e. 3.4 nm).[24] As for the radius, "[t]he distance of a phosphorus atom from the fibre axis is 10 A [i.e. 1.0 nm]".[25]

Therefore, the wavelength of the photon will be 3.4 nm, and the tangential momentum will have magnitude h/3.4 nm. The position vector of the photon will have a magnitude of 1.0 nm (plus a small additional amount to account for the oxygen groups that extend from the phosphorus atom).

Therefore, the component of the tangential momentum that is in the plane perpendicular to the centreline is the tangential momentum multiplied by a factor of 1.0/1.31244. This follows from simple application of Pythagoras' Theorem given that the radius of DNA is 1.0 nm and the length of a ¼ rotation is 0.85 nm. Putting it altogether, the angular momentum is:

$$\frac{(h/3.4\text{nm})(1.0\text{nm})(1.0\text{nm})}{1.31244\text{nm}} \approx 0.224h$$

This value 0.224h is eerily close to the mathematically derived value of 0.225h.

In order to get the precise value of $h/(\pi\sqrt{2})$, the radius need only be increased by approximately 0.003 nm, i.e. so that the total radius of DNA is 1.003 nm instead of 1.0 nm (this is, incidentally, comparable in magnitude to the amount of additional extension that an atom of oxygen would cause).

Considering that the dimensions of DNA above were given to only two significant figures, and considering that DNA, as it exists in living cells, is not completely rigid, it is reasonable to assume that the proportions of its pitch and radius vary about a range of values, such that the angular momentum calculation above would yield a (very small) range of values with $h/(\pi\sqrt{2})$ being somewhere in the middle of the range. A significant portion of the EM phenomenon so produced during a postsynaptic potential would, therefore, satisfy the spin constant and have the potential to be proper EM waves.

[24] Watson JD, Crick FHC. Molecular Structure of Nucleic Acids: A Structure for Deoxyribose Nucleic Acid. Nature 1953; 4356:737-738 at 737.
[25] *Ibid*.

Now, recall that as we move along lines tangential to the DNA which extend from the DNA all the way to the inner surface of the cell nucleus, we find virtual EM fields arranging themselves in helical segment configurations, each such helix having the same proportion of pitch to radius as DNA itself. Accordingly, these larger helixes would also satisfy the spin calculations above, and yield the same magnitude of angular momentum, despite the fact that the wavelength corresponding to these larger helixes would be larger.

Regarding the direction of angular momentum, recall that the strands of DNA "point" in opposite directions such that the flow of ions towards each strand during a postsynaptic potential will be in opposite directions at any given point along the molecule. This, in turn, causes the resulting virtual EM radiation exchanged between the ions and the strands of DNA to have opposite gyre. Therefore, one can (arbitrarily) assign the angular momentum from one strand a direction of + and the other a direction of -, just as photon spin can be either + or -.

The significance of all of this is discussed in the next segment.

3. Time EM Waves and Time Photons

What does all of this mean? Although the EM waves formed in the fashion described above have a spatial component, they do not *propagate* in space. Rather, they are frozen in their position in space around the DNA. Their only direction of propagation is forward in *time*, resulting from the flow of ions into the cell nucleus over time.

From a different perspective, one can imagine dividing these EM waves into new photons – not the virtual photons that we started with, but a different kind of photon. These new photons are relegated to only one point in space, i.e. the photon's specific location along the length of the DNA molecule, and never exist at any other point in space. The wave as a whole extends along several points in space only because it is the combination of several photons, side-by-side (just as an ordinary EM wave can be the combination of several photons emitted at different points in time one after another). Each of these photons, which is frozen at a specific point in space, propagates (and oscillates) in time due to the influx of ions during a postsynaptic potential. Further, each such photon can be viewed as a wave-packet, i.e. a combination of sinusoids of varying wavelength, varying again due to the periodic nature of the flow of ions into the soma. This is akin to ordinary photons, which also exist as wave-packets, but with the dimensions of space and time reversed (that is, ordinary photons are each frozen at the point in time at which they were emitted, but propagate and oscillate in space).

In this way, we see that these new EM waves and photons have their own intrinsic sense of time, without the need to be observed. They can be thought of as orphaned time components of a Maxwell EM wave – just as an (unobserved) ordinary EM wave or photon can, from its own perspective, be regarded as an orphaned space component of a Maxwell EM wave.

For lack of a better term, the author will refer to the new EM waves as "time EM waves" and to the photons which the waves comprise as "time photons". According to this terminology, an ordinary EM wave (prior to observation) can be thought of as a "space EM wave" comprising "space photons". From the time EM waves surrounding DNA, it is reasonable to assume that there would be some ordinary biophoton "waste" within the meaning used by Popp:

> The photons which we have measured can be seen as a sort of "waste" from a virtual electromagnetic field with a high coherence.[26]

This would be expected since all of the components necessary for photon emission come together from this virtual EM field: the spatial component of a Maxwellian EM wave based on the sinusoidal geometry of DNA, the temporal component of a Maxwellian EM wave based on the flow of ions over time, and the angular momentum, based on the helical gyre of DNA where the ratio of pitch to radius is 3.4:1.

However, even as these ordinary photons are emitted, the overall arrangement of field surrounding DNA continues to match that of a time EM wave frozen in space. It is

[26] Popp FA. Photon Storage in Biological Systems. Electromagnetic Bio-Information, 1st ed. 1979; 123 -149 (at 143).

somewhat analogous to Maurits Cornelis Escher's wood engraving entitled "Swans (White Swans, Black Swans)", where even as the individual birds are in motion, the overall figure 8 arrangement remains frozen in space.[27]

It is important to note here that the angular momentum discussed above only has classical meaning when one considers the total system of virtual photons flowing tangential to the DNA molecule. However, when this collective system of virtual photons is re-portioned into new individual time photons, the classical picture of angular momentum breaks down, and one is left only with some abstract sense of intrinsic angular momentum portioned off time photon by time photon.

The author proposes that the reason observation appears to bestow a sense of time and (and as we will see shortly, gravitational mass) upon light (and other EM radiation) during observation is because the spatially propagating ordinary EM waves couple with the temporally propagating time EM waves surrounding the DNA molecule during a postsynaptic potential. This coupling satisfies the apparent coupling of spatial and temporal components in Maxwell's equations.

For example, the real EM radiation emitted by the ions as they accelerate towards the DNA molecule can couple with time photons to result in the formation of a composite space-time structure within our brains (this composite structure is hereinafter referred to as a "composite space-time photon"). Additionally, external real EM radiation can couple with the time photons in a similar fashion. This coupling mechanism is elaborated upon below.

3.1 The Coupling of External Space EM Waves with Internal Time EM Waves

One question which arises is how do these time EM waves which exist within our brains affect the space EM waves that exist in our external world? Recall that the only thing that living creatures are capable of observing directly is EM radiation. Using once again the example of sound, when the medium, say air, carrying the sound wave makes contact with the sensors in the observer's ear, photons are exchanged between the air particles and the ear. This triggers a nerve impulse by the depolarization of the membranes of cells near the point of stimulation in the observer's ear. This in turn causes positively charged ions to flow across the membranes of neighboring cells in the attached axon, and into the cells themselves, thereby making the inside of these cells positively charged relative to the outside of the cells. The positively charged ions then begin to spread by diffusion laterally from their entry point, thus causing voltage-gated channels in the next cell along the axon to open, in turn causing ions to flood across the membranes of these cells, and so on down the nerve.[28]

As the ions flow across the cell membranes, they will emit (real) photons in the direction perpendicular to their flow, i.e. the photons will be emitted in the direction lengthwise along the axon.

The net flow of photons along the nerve is almost contiguous from the sensory cells in the ear all the way to the DNA within the nucleus of the soma. Although there are gaps along the way, most notably at the (chemical) synapse, such gaps are very narrow, being no more than a few nanometers in length. The photons (emitted from the ions) traveling along the nerve have wavelengths that are orders of magnitude larger than these gaps (they must be as a wavelength in the nanometer range would correspond to x-rays, which would destroy our nerves). Accordingly, the gaps are narrow enough relative to the wavelength of the photons that the photons can fairly easily tunnel across them.

Further, experiments have shown that when a photon travels through a medium, it is incorrect to say that it simply moves at the speed c until it collides with an atom in the medium, is absorbed by the atom, and then after a brief pause is re-emitted. Rather, the atoms in the medium form a collective behaviour with each other, and the photons that propagate through the medium interact with the medium as a collective structure.

Putting this together, the author proposes that the net EM radiation that propagates along the nerve from the ear to the DNA in the soma can be regarded as one continuous EM wave rather than simply a large

[27] This artwork can be seen at this link: http://escher.narod.ru/Images/Gallery/Pictures/swans.gif

[28] Campbell NA, supra note 17 at 969.

number of photons flying off in random directions. Further, this EM wave can be regarded simply as an extension of the EM radiation flowing between the air molecules that carry the sound wave and the observer's ear. In the end, we have the air molecules that hit the observer's ear connected directly to the DNA molecules in the observer's brain via a continuous EM wave.

The same would hold true of any observed object. For example, when you look[29] at the moon, a continuous EM wave spanning hundreds of thousands of kilometers through space, piercing your eyeball, extending along your nerve and ultimately reaching your soma, connects the moon directly to the DNA molecules in your brain; when you touch a sheet of paper, a continuous EM wave connects the paper directly to the DNA in your brain; and so on for all the ways that living creatures are able to observe anything. [30]

This continuous EM wave that extends along the nerve does not experience time of its own accord (unless and until it is observed directly or indirectly). It is, as described above, a space EM wave. However, because this space EM wave extends all the way to the DNA molecule, it can interact with the time EM waves surrounding the DNA. The author proposes that this interaction will allow the space EM wave to couple with the time EM waves surrounding the DNA to result in a composite space-time wave that satisfies Maxwell's equations.

The reason for the coupling follows again from equations (1) and (2) above. The space EM wave comprises electric and magnetic fields that change in *space*. The time EM wave comprises electric and magnetic fields that change in *time*.

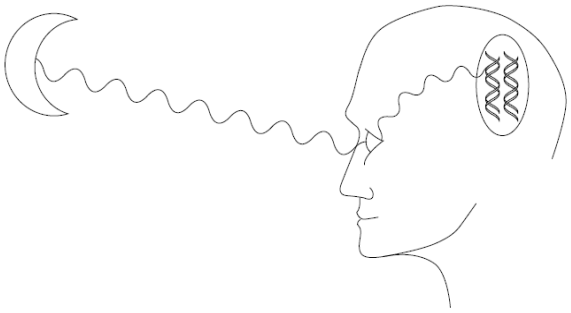

Figure 6. An observer looks at the moon. Light from the moon merges with the EM radiation resulting from the observer's nerve impulses and postsynaptic potentials. What results is something that is the equivalent of a contiguous EM wave connecting the moon directly to the DNA in the observer's brain.

Recall that there is a very large spectrum of "wavelengths" among the time EM waves. Therefore, it is reasonable to assume that some of these time EM waves will have precisely the correct rate of change of field in time to serve as the temporal counterpart of the space EM wave in agreement with equations (1) and (2).

Further, since space EM waves are infinitely compressed along their path, i.e. from their perspective, their start point is the same as their end point; this coupling will transform the entire space EM wave that extends from the thing being observed to the DNA molecule to such a composite space-time wave. Upon completion of this coupling process, the EM wave becomes temporally extended, with its initial point in time corresponding to the point it was emitted, and its final point in time corresponding to the point of interaction with the DNA. The amount of time along which the wave extends will depend on the length of its path, the longer the path, the greater the duration of its existence.

Depending on how the space EM wave meets the DNA, it may couple with the time EM waves surrounding one strand of DNA, or those surrounding the other. Each such coupling will result in a time component having opposite spin relative to the other. The author proposes that coupling occurs where the space component and the time component are of like spin (i.e. either both being +1 or both being -1), and thus the resulting composite space-time photon would have total spin of + or – 2 (more on this shortly).

Much of the time EM radiation surrounding the DNA will be duds. That is, they will not have the orientation, wavelength, or precise angular momentum necessary to serve

[29] The sense of sight is significantly more complex than that of touch or hearing and involves both the creation and disruption of nerve impulses, but the basic principle is the same.

[30] Further complexity arises where objects are perceived indirectly, for example, where light from the moon is received by a photodetector and the living creature subsequently observes the photodetector; however, the basic principle remains the same.

as the time component of an EM wave or to couple with the incoming space EM wave extending along the nerve – but, given how long the DNA molecule is[31], some will have these properties, resulting in important ramifications to what we know as time and mass.

3.2 Time Speed and Mass

Just as we think of an ordinary photon as having speed in a direction of space, so a time photon has something akin to speed in a direction of time. One way to think of ordinary speed is as a ratio of the number of units of spatial extension something has per unit of temporal extension – such as the expression "299,792,458 meters per second". Likewise, one can think of time speed as the ratio of units of temporal extension to some other unit. For example, we can simply reverse the units of speed and use "seconds per meter". Alternatively, we could invent some kind of pseudo-time and use the units "second per second". However, a simpler (and probably the most useful) way of doing this is to define time speed as "seconds per event".

Turning to our time photons, let us consider one "event" to be one complete cycle of the time photon. Accordingly, the speed through time that any time photon possesses would be the amount of time along which one complete cycle would extend – i.e. the temporal wavelength of the EM wave.

This is easier to interpret when considering the composite space-time photon described above. In order to satisfy Maxwell's equations, coupling can only occur where the temporal wavelength of the time photon matches the period of the space photon.

Thus, when considering composite space-time photons, those of large wavelength (and therefore large period) would have high time speed (i.e. extending further in time for a given cycle), and those with short wavelength, such as gamma rays, would have low time speed. The units of this time speed would be seconds per cycle. Since "cycle" is dimensionless, the units are reduced simply to "seconds", and a photon's "time speed" is equal to the composite space-time photon's period.

Now, when a time photon couples with a space photon in the fashion described above, something interesting happens. Recall that when left to its own devices, the space photon is timeless. According to relativity, an increase in temporal extension accompanies an increase in gravitational mass. In special relativity, an object that ages more slowly (i.e. that has greater time speed) will also gain gravitational mass. Likewise, in general relativity, the more massive an object is, the more slowly clocks tick in its vicinity (and this was proven experimentally).

What if we approached this phenomenon from the opposite direction? What if we were to, somehow, generate time speed first and worry about mass and gravity later? If we were to do this, we would create gravity and gravitational mass from the nowhere.

This is what happens upon the coupling of a space photon with a time photon. The photon acquires a temporal extension – i.e. it acquires a time speed. Therefore, if the author is correct, the space photon should, somehow, also acquire gravitational mass upon coupling with a time photon – and this is, indeed, what occurs as the photon acquires a "relativistic mass".

In other words, a gravitational field can be induced by an arrangement of electromagnetic fields – in particular, the coupling of a time EM wave with a space EM wave. *Gravity, electricity, and magnetism are all manifestations of the same force*.

3.3 Time Momentum

Just as we can define "time speed" as something akin to conventional speed, so we can define "time momentum". The magnitude of ordinary momentum, p, of an object, is calculated by multiplying its speed by its mass. In the case of a photon, its momentum can be calculated by multiplying its speed, c, by its relativistic mass. It's relativistic mass, M, in turn, is given by $h/(\lambda c)$ where λ is its wavelength.

By analogy, therefore, we can define the magnitude of time momentum of a composite space-time photon as the product of its time speed and its relativistic mass. That is, $p_t = [h/(\lambda c)]v_t$, where p_t is the time momentum of the composite space-time photon, and v_t is its time speed. When defined this way, all composite space-time photons have the same magnitude of time momentum, since M and v_t are inversely

[31] Estimates of DNA length typically vary from about 1 to 3 m – all crammed within a cell nucleus with a diameter approximately 1/1,000,000 this length!

proportional. As defined above, the time speed of a composite space-time photon is equal to its period, which is equal in turn to λ/c. Therefore, the magnitude of the time momentum of every composite space-time photon is a constant given by [h/(λc)] (λ/c), or simply h/c^2. That is,

$$p_t = h/c^2 \approx 7.37 \times 10^{-51} \text{ kg.s}$$

The above constant applies only where the event in question is one cycle of the photon. We could just have easily defined our event to be two cycles, 100 cycles, ½ a cycle, or any other number of cycles, each of which would yield a different value for the time momentum of a photon.

Just as an ordinary photon transfers ordinary momentum to an object that it collides with, so a composite space-time photon would transfer time momentum to an object that it collides with. In the everyday world, objects are bombarded with photons in every direction. Accordingly, the ordinary momenta of the photons cancel one another out, and the object's net increase in momentum is zero. However, unlike ordinary momentum, time momentum resulting from observation only points in one direction – forwards through time. Therefore, an object that is bombarded with composite space-time photons should move forwards through time. The more composite space-time photons that the object is bombarded with at any given instant, the faster the object should move through time (i.e. the greater the time dilation) for that instant, and the greater its mass should become for that instant.

3.4 Gravity and Electromagnetism

Let us take a closer look at the composite space-time photon:

- It is a spin-2 particle. As described, this particle is a system comprising two spin-1 particles, a space photon, and a time photon, with like spin direction;
- It has two possible spin states, either +2 or -2;
- It has zero rest mass, being a system of two photons, each of which in turn has zero rest mass;
- It travels in space at speed c, as governed by the ratio of its spatial extension to its temporal extension, said ratio according with Maxwell's equations;
- It increases the magnitude of the gravitational field while decreasing the rate of aging of an object that it makes contact with, as described above.

There is another particle with all of the above properties - *the graviton*. Accordingly, the author proposes that the graviton is a composite space-time photon, and that gravity is, therefore, a manifestation of the same interaction as electromagnetism. The graviton is currently classified as a hypothetical particle, having never been detected. It is theorized to be exchanged between massive objects thereby mediating the gravitational interaction. Based on the above hypothesis, a graviton can also result from observation of EM radiation. This renders the above hypothesis experimentally falsifiable (in principle), while also providing a means to experimentally (albeit indirectly) detect a graviton. (Throughout the remainder of this paper, the author will continue to refer to "composite space-time photons" on the understanding that these are also "gravitons").

3.5 Experimental Evidence

The author proposes the following experiments (described in qualitative terms only) to help prove or disprove the hypothesis herein.[32] Based on the above, an object, say a stone, should age more slowly and increase in gravitational mass (both extremely slightly) as the number of simultaneous observers of the stone increases.

The reason is that where there are more observers, there will be more coupling of the space photons reflected off of the stone with the time photons in the observers' brains; therefore, more composite space-time photons will be channelled to the stone. Assuming that time momentum works the same way as ordinary momentum, and given that observed objects can only move in one temporal direction, any momentum transferred to the stone would very

[32] The author has not conducted the experiments himself because, as will be appreciated from the nature of the experiments, he does not have access to the necessary equipment or resources.

quickly diffuse out to whatever is touching it (i.e. the stone would not store the momentum but would dispel it to its surroundings, causing its surroundings to gain time momentum, and so on). Therefore, all the observers must look at the stone at the same instant for there to be an increase in the stone's gravitational mass that exists when there is only one observer. The increase in gravitational mass would only exist during this "instant", and the breadth of this instant would be very brief, corresponding to the very short amount of time it would take the time momentum to diffuse out of the stone and into its surroundings.

Now, let us consider an ordinary photon that bounces off of our stone and towards an observer. That photon will transfer some ordinary momentum to the stone. Since the stone is being bombarded by photons from all directions, this ordinary momentum will end up cancelling with the momentum of another photon or photons. The ordinary photon, upon being observed, will couple with a time photon in the observer's brain. This, in turn, will give the (now composite) photon time momentum which will exist at every point along the photon's path, from the point of reflection off the stone to the vicinity of the observer's DNA. The effect will be as though time momentum is bestowed upon the photon retroactively at the point where the photon reflected off the stone.

Since the magnitude of the time momentum of a spatially propagating photon can only be one of two values – either h/c^2 in the case of a composite space-time photon, or zero in the case of an ordinary photon - and if we assume for now that the photon in question cannot go backwards in time, then the photon must stop in time once it strikes the stone and transfer all of its time momentum to the stone. This would cause the composite space-time photon to revert back to an ordinary photon at that point, thus avoiding any time paradox.

The above principles can be used to design various experiments to test the hypothesis herein. Two such experiments are proposed here, one to measure the effect of simultaneous observation on time dilation, and the other on gravitational mass.

3.5.1 Time Dilation Experiment – Observation of Atomic Clock

The less massive the stone, the more time speed it will gain from a composite space-time photon (since time speed is simply time momentum divided by mass). Accordingly, we should use as small a stone as possible to help the amount of time speed increase (i.e. time dilation) be large enough to be measured. Further, in order to measure the time dilation, the stone would need to have some sort of internal clock, capable of a high degree of precision.

Therefore, let us replace our stone with an atomic clock. The smallest atomic clock of which the author is aware has a volume of 9.5 mm^3 (about the size of a grain of rice), and is accurate to within 2.5×10^{-10} seconds.[33] Perhaps in a few years there will be atomic clocks that are still smaller and of greater precision. Quantification of the amount of time dilation that would result from observation is difficult since there is considerable practical uncertainty in 1) the number of photons that are exchanged between the atomic clock and any given observer, and 2) the duration of the very brief "instant" during which the photons from the observers would have a cumulative affect. Qualitatively speaking, however, if the atomic clock is observed simultaneously by a very large number of people, say 100,000 people in a large stadium, with the clock projected onto a large screen so as to be visible to all in the stadium[34], after a few minutes, its time reading should be (very slightly) behind the time reading of an identical atomic clock that is only observed by one observer.

3.5.2 Gravitational Mass Experiment – Observation of a Planet

The time dilation noted above should correspond to an increase in gravitational mass. From special relativity, we have the following equations:

$$\Delta t/\Delta t' = \gamma \qquad (3)$$

$$M = \gamma m \qquad (4)$$

[33] Knappe S et al. A Microfabricated Atomic Clock. App Phys Lett 2004; 85:1460-1462.

[34] Simple projection using light and lenses is to be used; electronic means, such as display on a large television screen, is to be avoided so as not to confound variables or unduly complicate the analysis.

Where Δt is the duration of a given event in the frame of reference having inflated time, Δt' is the duration of the event in a frame of reference having ordinary time, M is relativistic mass, m is rest mass, and γ is the Lorentz Factor. Accordingly, as the number of simultaneous observers of our hypothetical stone increases, the stone's relativistic mass should also increase. This experiment relates to the measurement of this increase in relativistic mass.

For any given composite space-time photon, the amount of increase in M will be the same regardless of the rest mass of the object. Although the increase in time speed varies inversely with the rest mass of the object, this amount of time dilation will then be multiplied by the rest mass of the object in order to yield the relativistic mass. In other words, the rest mass cancels out of the analysis.

Therefore, unlike the previous experiment, we are free to use objects of very large mass, such as planets. Planets have the advantage of having large radii. Accordingly, the time it would take for the increase in time momentum to diffuse out to the planet's surroundings (for example to ordinary photons that contact the planet) would be significantly greater than for the rice-sized atomic clock of the previous experiment. This, in turn, would allow the planet to "store" the time momentum longer, thereby allowing the effects of simultaneous observation to be more pronounced.

In this experiment, a telescope is to be used to observe a planet having greater rest mass than the earth. The eyepiece of the telescope should be replaced with some kind of projection screen so that a large number of people could observe it simultaneously.[35]

For a few hours, a single observer should look at the screen. Then for the next few hours, many observers should look at the screen simultaneously. All the while, detectors on the telescope should measure the mean wavelength of the light that propagates near the planet (and towards the telescope) during the respective periods of observation.

The author predicts that, provided the planet's rest mass is greater than that of the earth, the mean wavelength would be slightly larger where there are many observers since the planet's mean gravitational mass would be higher. This increase in gravity should result in the wavelength of light being shifted towards the red end of the spectrum to a greater degree than when the experiment is conducted with only one observer.

Note that these experiments are only examples of the type of experiment that could be conducted to verify or falsify the hypothesis herein. However, any such experiment would require an extremely high degree of precision, which for many (if not most) variations of these experiments, would exceed the capability of even our most precise instruments.

4. DNA and the Ψ Function

The discussion thus far has been restricted to Maxwellian EM waves. Now let us turn our attention to matter waves described by the Ψ function in the Schrödinger equation. As discussed at the beginning of this paper, the Ψ function which describes matter waves comprises two orthogonal sinusoids, one real, and the other imaginary. The arrangement is similar to that of the electric and magnetic fields in an EM wave, except that the real and imaginary components are out of phase by 90°. That is, they have the relation of sine to cosine rather than sine to sine. The arrangement of sinusoids in DNA is also roughly sine to cosine. Again, given that DNA in living cells is not entirely rigid, it is reasonable to assume that the relationship between the two strands spans a range of values with sine to cosine being somewhere in the middle.

Recall that as ions flow into the soma, imaginary photons are exchanged between the ions and the DNA molecule. According to Richard Feynman, the polarization of virtual photons is not restricted to the X and Y directions, but can also be in the Z and T directions. That is, the electric and magnetic fields may extend in the spatial dimensions perpendicular to the direction of propagation (as with ordinary photons) – but they may also extend in the direction of propagation itself (the "Z" direction), and more importantly, in the direction of time (the "T" direction).

[35] Again, the magnification of the image should involve simple use of lenses rather than a video camera or other electronic apparatus so as not to unduly complicate the analysis or confound variables.

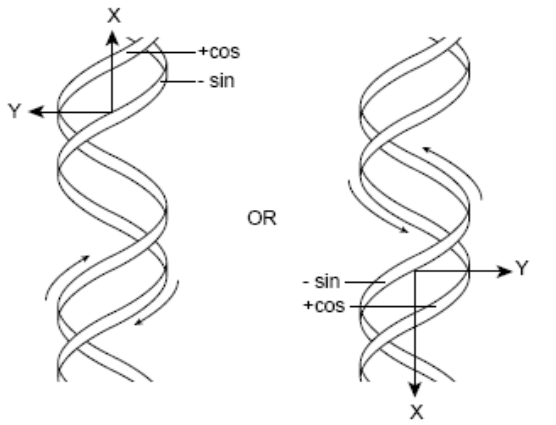

Figure 7. For "ordinary" (i.e. naturally occurring) DNA, where one strand is designated positive cosine, the other strand will be negative sine in relation to the first. Conversely, for hypothetical "backwards" DNA (i.e. DNA in which the direction of each strand is reversed), the second strand will be positive sine relative to the first strand.

If we consider that during a postsynaptic potential, some of the virtual photons flowing towards one strand of the DNA will be T polarized, and some flowing towards the other strand will be X or Y polarized, there will be points along the length of the DNA molecule in which the arrangement of the EM fields of the virtual photons will match the structure of a Ψ function – that is we will be left with one sinusoidal distribution of field which extends in a real direction (the X or Y) and a second sinusoidal distribution, out of phase from the first by 90°, which extends in an imaginary direction (the direction of time).

Recall further that, as defined herein, a time photon is relegated to only one spot in space; however, it *points* in a specific direction in space depending on which way the ions flow towards the DNA strand during a postsynaptic potential. This manifests physically as the difference between positive and negative spin.

If we designate the strand of DNA surrounded by the real EM field as the cosine, with the direction of the component of ion flow that runs lengthwise along the DNA as the positive x direction, then the other strand - the one surrounded by the imaginary EM field - will have the relationship of negative sine to the first strand. This is always true, regardless of which of the two strands is surrounded by the real EM field and regardless of which way the DNA molecule is oriented. If the direction of ion flow were reversed for each strand, the relationship between the strands would become positive cosine to positive sine. This arrangement of imaginary to real fields supports a modified version of Dr. John G. Cramer's transactional interpretation of quantum mechanics.

4.1 John Cramer's Transactional Interpretation of Quantum Mechanics[36]

Physicist, John Cramer proposed an interpretation of Quantum Mechanics to help explain, among other things, why changes in quantum events appear to occur instantaneously, in apparent contravention of the impossibility of faster-than-light communication. In the interest of brevity, a full review of his paper is not provided here. In simplified terms, Cramer proposed that Ψ is not merely an equation but that it has physical existence and travels at light speed.

The Ψ function is of the form $\cos(kx - \omega t) + i\sin(kx - \omega t)$. As Cramer observed, where the second term (i.e. the imaginary term) is positive, this corresponds to Ψ moving forwards in time. Where the imaginary term is negative, this corresponds to Ψ moving backwards in time. Further, Cramer observed that since the probability of a quantum event is determined by taking the absolute square of Ψ, that is by multiplying Ψ by its complex conjugate Ψ* (i.e. where the plus sign before the imaginary term is

[36] Cramer J. The transactional interpretation of quantum mechanics. Rev Mod Phys 1986. 58:647-688. Available from: URL: http://www.npl.washington.edu/ti/.

changed to a minus sign), what we are really doing when calculating probability is taking the product of Ψ and its time-reverse.

Cramer explained wave function collapse in terms of an "emitter", say an electron, emitting an ordinary Ψ function travelling forwards in time (which he calls a "retarded wave") meeting an "absorber", which could be another electron. Upon receiving the retarded wave, the absorber would emit a complementary Ψ* function travelling backwards in time (called an "advanced wave") towards the emitter. The imaginary components of the two Ψ functions would cancel, and for reasons that are not elaborated upon herein, one would be left with some real quantity of magnitude Ψ Ψ*, in agreement with the statistical interpretation of Max Born. Further, because the advanced wave travels backwards in time, this interaction would take place at the point in time at which the retarded wave was emitted, thus giving the appearance of instantaneous transmission of information and retroactive causality. However, Cramer did not explain why the absorber emits Ψ* in response to Ψ.

4.2 Observation Induced Transactional Interpretation

The arrangement of imaginary and real EM fields surrounding DNA during a postsynaptic potential could be the equivalent of Ψ*, that is Ψ moving backwards in time (recall that the relationship between the real and the imaginary fields surrounding DNA is cosine to negative sine). However because in this interpretation Ψ and Ψ* travel at the speed of light, we are left with the same dichotomy of the time component verses the space component of the wave as described previously in this paper with respect to light. In this case, the fields surrounding the DNA would be the time component of Ψ*, and this would need to couple with a space component from some external source.

Recall that when a living creature observes something, say the moon, light (or other EM radiation) propagates away from the moon, towards the observer, forming what the author proposed could be regarded as a continuous EM wave from the moon all the way to the DNA in the observer's brain. If this continuous EM wave could be described not just using Maxwell's equations, but also as Ψ (or as Ψ*), with a real and imaginary component, then this could serve as the missing space component of the Ψ* surrounding the DNA.

Whether light and photons can be described by a Ψ function is admittedly contentious. However, there is some support for this being possible.[37] If this is indeed possible, then the incoming EM wave from the moon could couple with the EM arrangement of fields around the DNA so as to form a composite space-time Ψ* function.

In so coupling, the direction of propagation of the incoming Ψ would reverse such that what was previously positive i sin would become negative i sin, thus transforming the incoming Ψ to Ψ*. As a result, the composite space-time Ψ* would propagate backwards through space (i.e. away from the observer and towards the moon), and backwards through time. Once it encounters the moon (in the past), it would interact with the moon's Ψ function in the same way as the advanced and retarded waves interact in Cramer's interpretation.

The difference is that here the moon's Ψ function (i.e. the retarded wave) does not propagate beyond the moon. It moves only as fast as the moon (not at light speed as proposed by Cramer) and does not travel towards the observer. However, the moon's Ψ function determines the properties of the photons that are reflected by it (or emitted by it if it were a light emitting object like the sun), and these travel at light speed. These photons, in turn, couple with the fields in the observer's brain to form an advanced wave. The advanced wave travels backwards in time towards the moon (and towards the moon's retarded wave) and meets the moon at the point in time at which the photons were first reflected off of it, thus collapsing the moon's wave function (and the advanced wave in the bargain).

5. Reversing the Arrow of Time by Reversing the Strands of DNA

If the above is correct, it would explain why living organisms can only move forwards through

[37] See for example Bialynicki-Birula I. On the Wave Function of the Photon. Acta Phys Pol 1994; 86:97-116. That paper proposes that a photon can be described by something equivalent to a Ψ function essentially in which there is an electric real component and a magnetic imaginary component.

time rather than backwards - it is the result of the position and orientation of one strand of DNA relative to the other, and the result of mass always being positive.

Our exclusive forward movement through time is an asymmetry in nature. It is reasonable to assume, therefore, that this is the result of (or corresponds to) other asymmetries in nature. For example, many physicists believe that the asymmetry in the expansion of space (i.e. that it is currently expanding only and not contracting) is related somehow to the asymmetry in our flow through time. The author proposes that the seed of our forward movement through time is the asymmetry in the DNA molecule, and the asymmetry in mass.

Theoretically, there is no structural reason why the strands of DNA cannot point in the opposite directions, i.e. with the "top" strand pointing "down", and the "bottom" strand pointing "up". However, we simply do not find this arrangement of DNA in living organisms.

Let us consider what would happen if the directions of the strands of DNA were reversed. First, as mentioned above, the Ψ function formed partly in the observer's brain would have the relation positive cosine to positive i sine rather than positive cosine to negative i sine; that is, it would be a retarded wave moving forwards in time rather than an advanced wave moving backwards in time. Accordingly, it would collapse wave functions as they exist in the future rather than the past. The result is that certainty would be in the future, and uncertainty would lie in the past – the opposite of our current state of affairs.

A second interesting difference would also arise. According to classical electrodynamics, the direction in which an EM wave propagates in space is the direction in which the Poynting vector points. The Poynting vector is defined as $S = (E \times B)/\mu_0$. It tells us that an EM wave will travel from left to right where the electric component points "up" and the magnetic component points "at" us, or alternatively where the electric component points "down" and the magnetic component points "away" from us. It travels in the opposite direction when the relative position of the electric and magnetic fields is reversed. This assumes that the EM wave must always point forwards in time – if EM waves were to travel backwards in time, these properties would be reversed.

Therefore, by analogy, the author proposes that the time EM waves discussed earlier in this paper would travel in the opposite direction in time if they were to point in the opposite direction in space, i.e. if the flow of ions were reversed. This would occur if the "upper" strand of DNA swapped position with the "lower" strand.

This, in turn, would cause the time photons to travel backwards in time rather than forwards, and thus the composite space-time photons to carry backward time momentum rather than forward, causing the objects that they collide with to acquire negative time momentum. Consequently, looking at the moon would decrease the time speed of the moon rather than increasing it as discussed previously while decreasing its gravitational mass. Similarly, the composite space-time photons in the observer's brain would cause the observer himself to age backwards (or reduce the extent by which he ages forwards).

These two effects together, the generation of retarded rather than advanced Ψ waves, and the generation of composite space-time photons with backward time momentum, would cause an observer's arrow of time to point backwards rather than forwards, in the absence of rest mass.

In the presence of rest mass, the observer would exist in a bizarre state of limbo. He would consider certainty to be in the future rather than the past; however the time momentum of the things he observes, and of himself, could go in either direction depending on the number of gravitons exchanged with the rest mass versus the number formed by observation.

5.1 Experimental Verification

The above is experimentally falsifiable (although practically difficult to do so).[38] The author proposes engineering an organism, say an amoeba, with the strands of its DNA reversed, but otherwise unchanged. Let us call such an organism a "backwards-body".

[38] Again, the author has not conducted the experiment because he does not have access to the necessary equipment or resources.

The backwards-body would age forwards in time due to the exchange of gravitons between its constituent molecules and its surroundings, in the usual course. However, if the hypothesis herein is correct, this forward aging would be counteracted, in whole or in part, by the reverse aging caused by the mechanism described above (likewise, its gravitational mass would be reduced, possibly to the point of becoming negative).

As a result, the backwards-body would exhibit one of two peculiar characteristics. If the extent of the forward aging exceeds that of the backward aging, the organism would age slower than a normal member of its species. Alternatively, if it ages backwards more than it does forwards, it would become anti-matter and annihilate with any matter it came into contact with. This, in turn, would result in gamma radiation measurable by a Geiger counter.

Further, the objects that the backwards-body observes would also experience slower, and possibly reversed, aging. Accordingly backward-bodies could be particularly useful in the medical sciences by, for example, slowing or reversing the growth of cancerous tumors, and of the aging process in general.

6. New Answers to Some Old Questions

Armed with the above hypothesis, we are now in a position to revisit some old questions:

6.1 What is gravity?

Gravity is a manifestation of the same interaction as electromagnetism[39]. The exchange particle of gravity is the composite space-time photon (which is the equivalent of the graviton). The exchange particle of electromagnetism is the uncoupled space photon. Electromagnetic effects arise when orphaned space photons couple with time photons. However, once the two combine into a composite space-time photon, electromagnetic effects are no longer exhibited by them. They are measurable only insofar as they increase the time momentum of the object they collide with, thus causing the object to age more slowly and increasing its gravitational mass.

Composite space-time photons can be generated by the observation of EM radiation by living creatures (thus coupling space photons with time photons). They can also be exchanged between massive objects.

6.2 Why does observation collapse wave functions?

Observation creates advanced Ψ waves, using DNA as a template, which interact with the retarded Ψ waves of the thing being observed, in accordance with Cramer's Transactional Interpretation of Quantum Mechanics.

6.3 Can computers and unintelligent organisms collapse wave functions?

Any organism can collapse a wave function, and it does not have to understand what it is observing in order to do so. All that is required is that it have DNA and the flow of ions towards the DNA in response to the stimulus of observation.

Presently, computers cannot collapse wave functions because they do not have charges flowing towards DNA (and if they did their status as "computers" rather than living organisms would immediately become questionable). At most, a computer may be able to alter the point in time at which an observation by a living creature is required (for example, by making a measurement after being set-up by a human to do so) – but the observation is ultimately that of the human (or other living creature).

6.4 Why is the speed of light relativistically invariant?

The speed of light is c for all observers regardless of frame of reference because the observer bestows upon light its temporal extension (in proportion to its spatial extension).

Generally speaking, speed is the ratio of spatial extension to temporal extension (e.g. "meters per second"). Photons extend in space of their own accord but acquire their extension in time from the observer. In order for the space and time components to couple, in accordance with Maxwell's equations, the magnitude of extension of the time component must be 1/c that of the spatial component. Since no single photon can be observed by more than one observer, there is never a contradiction in the

[39] And electromagnetism, in turn, is a manifestation of the same interaction as the weak nuclear force, as shown by Glashow, Salam, and Weinberg.

amount of temporal extension that is bestowed upon it.

6.5 How does the mind interface with the brain?

All mental events are rooted in virtual photons. Virtual photons are unlike ordinary photons in that the former exist on borrowed energy. These mysterious particles are continuously popping in and out of existence, everywhere, without violating any principle of physics.

A mental event can be of two forms: reaction to external processes, as with perception, and purely internal processes, as with thought. Above, the author described a mechanism whereby an external stimulus can trigger the flow of virtual photons around the DNA molecule. Due to the size and geometry of DNA, and the periodic nature of the flow of ions, this causes the virtual photons to align themselves in space and time so as to become the equivalent of coherent EM waves (and advanced Ψ functions). These EM waves can then trigger other nerve impulses, thus repeating the process in other brain cells, and creating a network of virtual photon interaction.

The author proposes that the opposite of this process leads to internal thought. That is, there is always spontaneous production of virtual photons in any portion of space. When this happens around the DNA molecules in our brains, these spontaneous and seemingly chaotic particles are organized, again due to the size and geometry of DNA, into coherent EM waves that are strong enough to trigger nerve impulses.

This explains how abstract urges translate to physical action (e.g. you have the urge to lift your arm and this urge translates to movement). The seed of the urge is in the virtual photon, which is inherently mysterious and spontaneous. However, DNA serves as the drill sergeant of the brain which organizes these rowdy, spontaneous virtual photons in a way that allows them to do physical work, i.e. by forming EM and Ψ waves.

6.6 Popp's Question: If the distances between the base pairs of DNA changed, would this impact the velocity of light?

In the last issue of *NeuroQuantology*, Dr. Popp asked the above question.[40] The present hypothesis would lead to the answer "yes". Light does not have "velocity" or "speed" of its own accord, it has only spatial extension. It acquires its temporal extension from the living observer. If the base pairs were a different distance apart, the ratio of DNA's pitch to radius would be different, and DNA could no longer serve as the template for the production of the temporal component of EM radiation. Therefore, light would not have any "speed" in the frame of reference of the observer (and the observer would not be able to "observe" the light in any event).

7. Conclusion

The flow of ions towards DNA, during a postsynaptic potential, following a nerve impulse, results in a unique arrangement of electric and magnetic fields in space and time. This arrangement of fields is the equivalent of EM waves extending in time and existing at only a single point in space. The total system of EM fields possesses angular momentum resulting from the twist of the DNA molecule. The magnitude of this angular momentum, when portioned off photon by photon is, astonishingly, $h/(\pi\sqrt{2})$ due to the ratio of pitch to radius of DNA being 3.4:1. This agreement between the magnitude of photon spin and the proportions of DNA is strong evidence in favour of the hypothesis herein.

The photons produced in this manner are the temporal compliment of ordinary photons, such that the two can couple, in accordance with Maxwell's equations, to result in a composite system. This composite system has the same attributes as the graviton, and the conclusion is irresistible that it *is* the graviton. If this hypothesis is correct, gravity is a manifestation of the electromagnetic interaction.

The flow of virtual photons towards DNA during a postsynaptic potential also results in an arrangement of field that is the equivalent of the advanced Ψ function described in Cramer's Transactional Interpretation of Quantum

[40] Popp FA. Consciousness as Evolutionary Process Based on Coherent States. NeuroQuantology 2008; 4: 431-439 (at 437)

Mechanics. This provides a mechanical basis for observer induced wave function collapse, rendering irrelevant philosophical arguments pertaining to the mind.

Finally, it was proposed herein that the arrow of time can be reversed by reversing the strands of DNA. If this is correct, it can have important consequences for medical science, as for example the possibility of reversal of tumour growth, and indeed, reversal of aging itself.

DNA is truly a remarkable molecule. The focus of the scientific community on DNA has thus far, unfortunately, been on the sequence of base pairs in DNA rather than its unique geometry. However, a logical application of Maxwell's principles on the interaction of ions with DNA during a postsynaptic potential leads to an appreciation of the importance of DNA geometry, not merely to biological systems but to the interface between organisms and their external world. It is the author's sincere hope that his paper will motivate research on the profound importance of DNA geometry.

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