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Spontaneous Photon Emissions in Photoreceptors: Potential Convergence of Arrhenius Reactions and the Latency for Rest Mass Photons to Accelerate to Planck Unit Energies

Michael A Persinger
Laurentian University, Sudbury, Ontario, Canada P3E 2C6
mpersinger@laurentian.ca

ABSTRACT

Spontaneous or phasic voltage shifts normally occur across the plasma membranes of photoreceptors without impingement from external photons on average once every ~38 s (26 mHz). There have been arguments that all living cells spontaneously exhibit Bokkon-type ~10^{-12} W·m^{-2} ultraweak photon emissions (UPE) independent of temperature-based Arrhenius reactions. However the non-Gaussian distribution of the phasic voltage-photon events can be accommodated by the results of accelerating mass equivalents of resting photons into the time frame of single electron orbits which would require ~38 s. This condition is strongly dependent upon the presence of free protons within Pollack's interfacial water states. The duration associated with the energy from the magnetic moment of a proton in a 1 nT magnetic field generated by 2 pA currents through channels across the membrane when divided into Planck's constant is ~38 s. Second shell activation energies (~10^{-20} J) that are correlated with proton movements within a human photoreceptor's volume of water result in a rate constant that is equivalent to energy within the range of Cosmic Microwave Background. One solution to accommodate the median emission of ~$2{\cdot}10^{-12}$ W·m^{-2} as a mass volume within a cell, the equivalent magnetic field strength of 1 nT, the interconnected 10^{-20} J and the diffusivity coupled to the hydrogen line suggests UPE may be reverse reactions from all living mass originating as Popp's primordial solar photon energy. If these convergence solutions are valid then non-local photon formation would be the source of these spontaneous shifts in photoreceptors that would be mediated by a plethora of local physical chemical manifestations.

Indexing terms/Keywords

spontaneous photon emission; Arrhenius equation; rest-mass photons; photoreceptors; interfacial water; trapped magnetic fields; UPE; CMB; Bokkon effect; Pollack phenomena

Academic Discipline And Sub-Disciplines

Quantum Physics, Photon-Electron Dynamics, Ultraweak Photon Emissions (UPE)

SUBJECT CLASSIFICATION

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TYPE (METHOD/APPROACH)

Quantitative Analyses; Convergent Operations

INTRODUCTION

The photon can be considered the central physical process by which the universe is integrated. If current values for the upper boundary of the rest mass of a photon (<$2{\cdot}10^{-52}$ kg) are assumed [1] in conjunction with the estimated mass of the universe (~$2{\cdot}10^{52}$ kg) which converges from a variety of approaches [2], there would be ~10^{104} photon equivalents per 10^{78} m^3. This results in ~1 photon per 10^{-26} m^3. The linear distance would be between 1 nm and 10 nm. These two values are frequently encountered as the width of ion channels within the plasma membranes of cells and the widths of the plasma membrane, respectively, as well as the monomers that compose microtubules [3,4]. There are now numerous experimental demonstrations [5-7] and theoretical considerations [8] that photons are emitted from the membranes of cells through a variety of physical chemical mediators [9, 10]. As stated by Gurwitch [11] and demonstrated brilliantly by Popp and his colleagues [12, 13] all living systems exhibit biophotons or ultraweak photon emissions (UPEs). One classical enigma in photoreceptor cells is the occurrence of voltages shifts comparable to photon impingement when there are no external photons present [14]. Here evidence is given that one source for these UPEs could emerge from submatter space as a photon accelerates from rest mass to its classical velocity.

Multiple experimenters have measured UPE levels in the order of 10^{-12} W·m^{-2} from different types of cells [15, 16] and bacteria [17] in culture as well as slices [18] of brain tissue (hippocampus) associated with memory consolidation in mammals. The whole living human cerebrum emits comparable flux densities of photons as measured by photomultiplier units when subjects sat in very dark settings and engaged in imaginative activities rather than banal reflections [19]. The imagination-dependent increases in photon emissions occurred from the right cerebrum but not the left [20]. The experiments had been inspired by the original and brilliant conceptions of Istvan Bokkon [21-22] who suggested that visual imageries were intracerebral photonic fields rather than the phenomenology of neuronal action potentials. Bokkon et al [23] calculated that the densities of photons within cells and within cerebral space were much greater than expected. Later Wang et al [24] measured photons from the optic tracts of mammals. Sun and his colleagues [25] have shown direct evidence of biophotonic conduction along neural fibers through interactions with membrane proteins.

Dotta and his colleagues demonstrated experimentally that the estimated energy associated with this flux density per cell was ~10^{-20} J per s [5]. This is the primary order of magnitude of the quantity of energy associated with the separation between potassium ions that contribute to cells' resting membrane potentials, the action potential of the neuron, and the values by which ligands are sequestered to receptors [26]. Persinger [27] showed these two aggregates, energy and power density, are related by the inverse of diffusivity which was calculated by dividing the value for wave impedance (376.73 Ω) applied over the hydrogen wavelength (21.1 cm) and dividing by the magnetic permeability μ of the vacuum. The frequency value required to balance the equations was the Bohr value of $6.59 \cdot 10^{15}$ s^{-1}. This implied a potential universality to the relationship to photon flux density from living systems and to the range of quantum energies whose equivalence may conjoin Planck's voxels [28]. The unit associated with that relationship is ~10^{-20} J.

Popp's implicit argument that "spontaneous" emissions of photons reflect the expression of virtual photons that ultimately originated from the sun suggest there may be a more fundamental source to UPE than epiphenomena from chemical reactions. If this were valid, then "back" photon dissipation or "re-emissions" should occur. This would be consistent with a general principle of equilibrium that is manifested in the most fundamental relationships such Newton's third law but applied over the total duration of the phenomenon. There is quantitative support for this revealing supposition. If one assumes 50 $W \cdot m^{-2}$ on the earth's surface from solar flux since the first life formed ~3.3 billions of years ago, the total energy is in the same order of magnitude as the estimated total biomass of the planet. This has been estimated to between 10^{14} kg and 10^{15} kg.

Assuming a typical cell emits $2 \cdot 10^{-12}$ $W \cdot m^{-2}$ of photon flux then the density within a cell with a width of 10 μm would be $2 \cdot 10^{-7}$ $J \cdot m^{-3} \cdot s^{-1}$. The mass of a cell with that diameter is ~$5.2 \cdot 10^{-13}$ kg which results in $4.7 \cdot 10^{4}$ J. Within the equivalent volume of the cell ($5.2 \cdot 10^{-16}$ m^3) the energy density could be equivalent to $9 \cdot 10^{19}$ $J \cdot m^{-3}$. The ratio of the two energy volumes or spectral radiance ($W \cdot m^{-3}$) reflecting the proportion of energy released as photons compared to the energy contained with the solargenic mass of the cell is $2.4 \cdot 10^{-26}$ per s. For that energy to be dissipated (reversed) over the duration since Life began 3.3 billion years (10^{17} s) the mediating variations would be in the order of 10^{9} s^{-1} which is congruent with the hydrogen line frequency (1.42 GHz). The hydrogen wavelength was the required parameter to relate 10^{-20} J with 10^{-12} $W \cdot m^{-2}$ through inverse diffusivity.

Salari et al [29] pursued the physical mechanism for discrete dark noise within the retina. Photoreceptor cells have been known for decades to display phasic and tonic fluctuations in membrane voltage. The median value for the current equivalents of the more or less continuous low amplitude component is about 0.2 pA while the spontaneous discrete components are ~2 pA [14]. Almost forty years ago Baylor et al had precisely measured the physical chemical parameters of the two components of electrical dark noise in toad retina that occurred without any impingement from external photons. The average frequency of the discrete component was 0.026 Hz (26 mHz) or about once every 38 s. This value is almost identical to the value to accommodate the discrepancy between the asymptote energy of a photon accelerating from the upper rest mass and entry into the discrete quantities of a single orbit of an electron that is reflected by Planck's constant. This congruence has significant implication for the expectations for the sources of dark noise in photoreceptor cells.

THE SALARI-SCHOLKMANN-BOKKON-SHABAZI-TUSZYNSKI EXPERIMENT

In one of the most elegant publications completed within this area of research in decades Salari et al [29] examined the spontaneous UPE from multiple sources of retinal pigments from human and non-human sources. Activation energies for reactions, measured rate constants and related parameters from the scientific literature were employed. The authors estimated that the UPE ranged from 10^{1} to 10^{4} photons per s per cm^2. This is equivalent, assuming a midlevel photon energy within the more sensitive region of the PMT, to be between 10^{-15} $W \cdot m^{-2}$ to 10^{-10} $W \cdot m^{-2}$. The median value would be 10^{-12} $W \cdot m^{-2}$. For comparison the background flux density for cosmic rays at the earth's surface is ~10^{-13} $W \cdot m^{-2}$.

They concluded that the classic Arrhenius equation even when based upon Hinshelwood distributions to accommodate idiosyncratic geometric factors that could not accommodate all of the experimental measurements for rods and cones. One form of the Arrhenius equation or the rate constant (k) for a chemical reaction is:

$$k = Ae^{-(E/RT)} \qquad (1),$$

where A is the frequency (or pre-exponential) factor, E is the activation energy, R is the gas constant (8.31 $J \cdot mol^{-1}$ T^{-1} and T is temperature in °K. In addition the distributions of UPE displays are more non-linear and Poisson-like rather than the Gaussian forms derived from the Central Limit Theorem upon which thermodynamics is often based. Salari et at al [29] concluded that the main source of UPE originated from the oxidative metabolism of mitochondria and lipid peroxidation. Dotta and Persinger [30] demonstrated the robustness of hypochlorite-hydrogen peroxide reactions for photon emissions that can be subject to the magnitude of excess correlations that define non-locality and "entanglement". Within living cells photon emitting molecules include triplet carbonyls and singlet oxygen which are common consequences of lipid peroxidation. However there are a plethora of other local mechanisms whose specification usually reflects the interests of the experimenters and their expertise.

CONVERGENCE OF ULTRAWEAK PHOTON EMISSIONS AND THERMAL ACTIVATION

The Salari et al [29] calculations indicated that flux power density of thermal radiation approaches the lower limit of UPE only within the infrared range that peaks around 1.28 μm at 37°C. Given the distribution of energies within the

boundaries proximal to the plasma cell membrane this is within the range of the value of 1.57 μm derived from Bohr's frequency and magnitude of quantum when one nucleus (a proton) is removed from another. The frequency is:

$$v_r=1.32\omega_o=\sqrt{(m\cdot M^{-1})} \qquad (2),$$

where m is the mass of an electron and M is the mass of a proton and ω_o is the frequency of the Bohr orbit. The role of a proton in the UPE reaction suggests a more significant role of water, the most prominent molecule within living cells [31]. Liquid water absorbs primarily within the range of 3.1±0.2 μm [32] which corresponds to the O-H stretching mode. The ½ wavelength is 1.56 μm, the Bohr value.

The hydronium ion (H_3O^+), the primary basis of pH or the acid-base continuum exits as a unit for ~10^{-12} s and involves the constant movement of protons with energies that are in the order of $2.1\cdot10^{-20}$ J. Consequently water is a unique molecule that maintains its structure as a single entity and as an aggregate despite its constituents (H^+) persistently being removed and added to any given molecule. As stated by De Coursey [33], there are at least a hundred fold more proton (water) channels in cell membranes than all other forms of ion channels combined. Murugan, Karbowski, and Persinger [34] have found that small shifts in pH within cell cultures are associated with significant increases in UPE.

Recent experiments indicate that the simultaneous, temporally patterned presentation of LED-generated photons and specific intensity magnetic fields facilitates the storage of "virtual photon" fields that can be remitted up to an hour after the termination of the magnetic field-photon exposures. The integrated or summed energy from the photons generated from the cells during the subsequent hour reflected the total magnetic energy from the applied field within the volume. Detailed measurements indicated that the wavelength of the LED dominated the peak flux density during the "re-emission" of photons during this subsequent hour. The capacity for the coherent domains within water as well as the physical-chemical properties of interfacial water [35] to absorb and to emit specific wavelengths within the UV and visible ranges has been shown experimentally [36].

Pollack and his colleagues [37-38] have reiterated the importance of the special condition of the condensed colloidal state or "coascervate" that is displayed by water near boundaries or surfaces, that is interfacial water, compared to bulk water. Within the exclusion zone (EZ), where solute penetrations are markedly reduced, the viscosity of water increases 10 fold. The charges from the concentrations of protons in the interface between the EZ and bulk water are sufficient to generate potential differences of up to 150 mV which could accommodate the range of resting plasma membrane potentials without contribution from traditional ion concentration gradients (e.g., potassium or chloride). The EZ displays peak light absorption of ~270 nm. Murugan et al [34] found that cells incubated at 37°C, which are natural sources of EZ, generate spontaneous photon emissions that peak at ~270 nm.

From the perspective of entropy, the transformation from virtual to real states through Casimir-like energies would involve quantities of ~$2\cdot10^{-20}$ J. According to previous calculations [28] there are about $0.15\cdot10^{5}$ virtual electron transformations to real particle equivalents per s which, once the numbers of coherent domains within water asymptote, involves about $4.5\cdot10^{-9}$ J in 1 cc of water. Viscosity is equal to energy divided by the volume and frequency. The solution for 1 cc within the range of biological temperatures is a five fold increase in viscosity. This would suggest that energy from universal sources would contribute to thixotropy and to the EZ. As calculated by Del Giudice et al [39] quantum-related coherence domains in the order of 100 nm can "trap" electromagnetic fields which produce a magnetic A vector in surrounding space. This indicates that the phase of a system could exhibit the Bohm-Aharanov effect [40]. The most common frequency of the matter in coherent domains and electromagnetic fields is 0.26 eV or 10^{-20} J.

The rod is an oddly elongated cell in the human retina with a length of about 25 μm and a width of 1.5 μm which is remarkably approximate to Bohr's wavelength (1.57 μm) of the equivalent energy to remove one proton from another. The number of water molecules in this volume would be ~10^{12}. If the activation energy is assumed to be 10.8 kJ per mole which is the second shell value for proton movement in water then the rate constant (k) for the Arrhenius equation (1) is about $1.46\cdot10^{-2}$. When multiplied by the numbers of molecules in the rod (cell) the value is $2.4\cdot10^{10}$ s^{-1} and when multiplied by Planck's constant is $1.6\cdot10^{-23}$ J.

This results in a temperature equivalent of about 1°K ($1.6\cdot10^{-23}$ J divided by $1.38\cdot10^{-23}$ $J\cdot°K^{-1}$). This quantity approaches the cosmic microwave background (CMB) which we [41] have shown could control the limit to the amount of energy possible within the magnetic field-induced excess correlation systems before they "de-correlate" spontaneously. The background flux density for UPE ranges from 10^{-14} to 10^{-10} $W\cdot m^{-2}$ according to Salari et al [29]. If the median 10^{-12} $W\cdot m^{-2}$ is assumed then the energy across the cell surface is about 10^{-22} $J\cdot s^{-1}$. When divided by Planck's constant this is equivalent to ~10^{12} events or then numbers of water molecules in single rod cell.

These calculations would indicate that the reason Salari et al's [29] data were not completely explained by thermal activation as predicted by the Boltzmann distribution is due to the addition of photon energies from origins responsible for thixotropic phenomena which are also strongly associated with the CMB. This does not negate the conclusion of Salari et al but instead indicates lipid peroxidation and related chemical reactions as well as mitochondrial activity are not the primary etiologies of UPE but rather the vehicles through which the energies are manifested.

IMPLICATIONS AND APPLICATIONS

There are several convergent operations. First, the 0.026 Hz (38 s) is the $v\cdot g^{-1}$ constant where v is the earth's rotational velocity and g is 9.8 $m\cdot s^{-2}$. A rotational variable might accommodate the unexplained spontaneous UPE recorded by Moraes et al [42] from germinating wheat seedlings maintained in constant darkened chambers that are synchronized with the rhythm of the local gravimetric tidal acceleration. Considering the relationship between jerks (third

derivatives) in earth's rotational velocity and hence angular momentum and its potential correlation with seismicity, the anomalous display of photons might be accommodated.

Second, this is the transformation time for the upper rest limit of a photon mass accelerating at c to approach Planck's constant (~$2\cdot10^{-52}$ kg·$9\cdot10^{16}$ m·s^{-2} is $1.8\cdot10^{-35}$ J) and when divided into the constant ($6.626\cdot10^{-34}$ J·s) which is ~37 s. Because the value for the constant is effectively the energy associated with the time for a single orbit of the energy equivalence of the mass of an electron and the square of the fine structure velocity, this time might be required to be incorporated into the unit (a single orbit) that creates its magnetic moment. The concurrence with the proton is supportive. The magnetic field strength required to converge with $1.8\cdot10^{-35}$ J (the rest mass of a photon accelerated at c^2) for a proton with a magnetic moment of $1.41\cdot10^{-26}$ A·m^2 (J·T^{-1}) is ~10^{-9} T. This is the increment frequently coupled with 10^{-12} W·m^{-2}, the median flux density for UPEs [43, 44].

Third the occurrence of discrete 2 pA currents occurring every 37 s in photoreceptors through classic membrane channel widths results in a magnetic field strength (10^{-9} T) that has been associated with 10^{-12} W·m^{-2}. Assuming the classic equation for magnetic field through a cylinder:

$$B=(\mu I)\cdot(2\pi r)^{-1} \quad (3),$$

where $\mu=4\pi\cdot10^{-7}$ N·A^{-2}, I is current ($2\cdot10^{-12}$ A) and r is the radius of the cylinder ($0.5\cdot10^{-9}$ m), the resulting magnetic field is 10^{-9} T. This is also the optimal intensity for the proton magnetic moment ($1.41\cdot10^{-26}$ A·m^2) to match the energy from the photon accelerated from rest mass. The equivalent frequency of that energy is ~37 to 38 s.

In other words the frequency implicit to the proton within the strength of the magnetic field correlated with the current associated with the phasic component of photoreceptor membrane attributed by Salari et al [29] to photon emissions is effectively identical to that found by Baylor et al [14] to reflect the temporal distribution of the "dark noise" potentials. Vares and Persinger [45] found a systematic inverse correlation in darkened settings between photon flux density originating from the earth and geomagnetic variation. Experiments involving plates of ~10^6 mouse melanoma cells housed in darkened settings indicated that for every 10^{-12} W·m^{-2} increase in photon emission as measured by digital PMTs there was a 1 nT decrease in adjacent static magnetic field intensity of the earth [46].

One interpretation of this consistent inverse correlation in context of the discrete electrical dark noise from photoreceptors reported by Baylor et al [14] and explored by Salari et al [29] is that the photons originated from the transformation of magnetic energy within the cell. Hence the increase in 2 pA current every 38 s was associated with the latency required for the photon to emerge in cell space. Assuming 10^{-12} W·m^{-2} and the functional width of the active portion of the photoreceptor cell to be 10^{-12} m^2 the energy accumulated over 38 s would be ~$3\cdot10^{-23}$ J which is within the range of that available from the CMB. Clearly discrete values in UPE and cross-sectional areas would be required.

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Author's Biography with Photo

Michael A. Persinger, Ph.D. is a Full Professor at Laurentian University in Sudbury, Ontario, Canada. He is affiliated with a number of different programs including Biomolecular Sciences, Behavioural Neuroscience and Human Studies as well as the Quantum Molecular Biology Laboratory where he is examining the relationship between 10^{-20} J events within the brain and complex functions. Dr. Persinger and his colleagues have experimentally demonstrated the validity of Cosic's Molecular Resonance Recognition Model, Bokkon's Cerebral Photon Field Hypothesis and the efficacy of proton driving patterned magnetic fields that inhibit the growth of cancer cells but not normal cells. He is an interdisciplinary scientist whose primary goal is to integrate the physical sciences, social sciences and humanities according to their fundamental operations. Within the last 50 years he has published more than 500 technical articles in a variety of areas that range from Astronomy to Zoology. His present experiments are focused upon understanding the relationship between the structure of space and distribution of energy, the shared dimensional equivalence of quantized gravitational and electromagnetic fields, and the empirical demonstration of an intrinsic entanglement velocity.