The Prevalence and Significance of $\sim 10^{-20}$ J and $\sim 10^{-12}$ W·m⁻² as Convergent/Divergent Nodal Units In the Universe

Michael A. Persinger

Laurentian University, Sudbury, Ontario, Canada P3E 2C6

E-mail address: mpersinger@laurentian.ca

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ABSTRACT. The dimensional analysis that produces the quantitative equivalence between two aggregate terms that have universal prevalence may reveal hidden variables. The value of 10^{-20} J per s can be derived from the total force of the universe when divided by the total numbers of Planck's voxels and distributed over the distance of the hydrogen wavelength. The radiant flux density of 10^{-12} W·m⁻² for photons is ubiquitous throughout cellular systems, including those associated with cognition, and background environment measurements. The most parsimonious relation is that the radiant flux density of photons (a divergent phenomenon) is equal to the fundamental energy from the entire force of the universe at the level of Planck's volume and the energy converging within the electrical (wave impedance) and magnetic (permeability) properties of space with every rotation of an electron. This quantitative relationship suggests there is equilibrium between the divergence of radiative phenomena and the convergence within the electrical and magnetic properties of space with each orbital rotation of an electron. The exactness of this equivalence may reveal the source and mechanisms by which the energies associated with chemical bonds, resting plasma membrane potentials and "entanglement" for rest mass photons could result in radiant flux densities of photonic fields.

1. INTRODUCTION

At the level of the total set (the universe) which would include the totality of space-time, the fundamental units could be related discretely with minimum contributions from the dynamics associated with entropy and the transformation between matter and energy. Because matter is distributed and heterogeneous within space at any given time over the duration of the universe the geometric descriptions and quantitative relationships require equations with polynomial forms as well as convoluted mathematics to accommodate these complex configurations. Here I describe quantitative evidence that a universal quantity of energy that traverses levels of discourse, 10^{-20} J, and a photon radiant power density that is displayed in space occupied by living and inanimate matter, $\sim 10^{-12}$ W·m⁻², are related in a manner that could accommodate some of the apparent contradictions displayed by radiation such as the electromagnetic photon and the electrical and magnetic properties of space.

2. THE INTRINSIC SOLUTION OF 10^{-20} JOULES

The relationship between the discernment of a phenomenon at any increment of space (Δs) is related systematically [1] to the similar magnitude of increment of time (Δt). For process or temporal phenomena to be detected a minimum of two successive Δt s is required. However at the level of the maximum ΔS , the entire universe, there would be only one ΔT and hence there would be no process. At this level simpler descriptors of basic properties could have greater validity and should be more conspicuous.

The total force within the universe employing Newton's approach would be a product of its mass ($\sim 10^{52}$ kg), length ($\sim 10^{26}$ m) and the square of the intrinsic vibration or Zitterbewegung ($\sim 10^{86}$ s⁻²) which is a variant of Planck's time [2]. The result is $\sim 10^{164}$ N. Assuming $\sim 10^{26}$ m for the length

and a cubic volume, which would be similar to a flatter shape with cross sectional widths of 10^{27} m and a thickness one-hundredth that value, the volume would be $\sim 10^{78} \text{ m}^3$.

The numbers of the smallest Δ s, Planck's Length ($\sim 10^{-35}$ m), within this universal volume assuming that each volumetric cube or voxel was $\sim 10^{-105} \text{ m}^3$ would be 10^{183} "Planck's voxels" within the universe. As a result there would be 10^{-19} N per Planck's voxel. When distributed across the neutral hydrogen wavelength ($\sim 10^{-1}$ m) which is spread throughout the universe there would be $\sim 10^{-20}$ J per voxel. Insertion of actual coefficients does not change this order of magnitude and results in a range between about 1.5 to $2.5 \cdot 10^{-20}$ J [3].

If the 10^{-20} J increment of energy is mediated through levels of discourse it should be evident at atomic levels. The two fundamental elementary particles are the proton and the electron. Dividing the magnetic moment of a proton ($1.41 \cdot 10^{-26} \text{ A} \cdot \text{m}^2$) by the unit charge ($1.6 \cdot 10^{-19} \text{ A} \cdot \text{s}$) displayed by a proton (or an electron) solves as a diffusivity term of $0.88 \cdot 10^{-7} \text{ m}^2 \cdot \text{s}^{-1}$ [4]. When applied to the average viscosity of water around life temperatures, e.g., (25°C) which is $\sim 6.3 \cdot 10^{-3} \text{ Pa} \cdot \text{s}$, the resulting force is $7.87 \cdot 10^{-11} \text{ kg} \cdot \text{m} \cdot \text{s}^{-2}$.

When this force is applied over the distance of two O-H bonds ($1.92 \cdot 10^{-10}$ m) that would constitute a water molecule the intrinsic energy is about $1.5 \cdot 10^{-20}$ J. Between 20°C and 37°C the value would be between 1.1 and $1.7 \cdot 10^{-20}$ J. This is also the energy involved with proton mobility within water [5]. Hence the fundamental quantum of energy that would be associated with each Planck's voxel applied over the distance of the neutral hydrogen wavelength may be quantitatively convergent with the energy resulting from magnetic moment/charge ratios of the major mass unit of the universe (the proton) that occurs between hydrogen-oxygen distance when the pressure within water molecules is considered over time (Pa·s).

This quantity of energy that defines the incremental force distributed across the neutral hydrogen line and the magnetic moment/charge ratio over the distance of the O-H bond also converges with the essential unit of energy that defines the cell membrane [6]. As calculated previously, the distance between K^+ ions that occupy the thin shell around the plasma cell membrane that is strongly correlated with the resting membrane potential is between 11 and 12 nm (which is similar to the thickness of the plasma membrane). The force from the electric fields between any two charges would be $\sim 1.5 \cdot 10^{-12}$ N. When distributed across the thickness of the plasma cell membrane, the value is $\sim 1.8 \cdot 10^{-20}$ J.

In cells such as neurons whose changes in energy occur quickly along specialized processes (axons), the intrinsic energy derived from the force associated with the net change (-70 mV to $+50 \text{ mV}$) of membrane potential upon a unit charge is $1.9 \cdot 10^{-20}$ J. This same value is the median energy associated with the difference between phosphorylated vs unphosphorylated subunits of some enzymes, the continuity during inter-synaptic transformations when action potentials elicit release of vesicle-containing chemicals, and the hinge motion of agonists like glutamate to the receptor [6]. Dotta et al [7] measured photon emissions from non-neural cells that had been removed from incubation and calculated that each cell within the aggregate of about one million was displaying about 10^{-20} J per s.

This quantity of energy generalizes to small and larger increments of space. For example voltage, current and time is energy. The product of a single ion channel ($0.3 \text{ } \mu\text{V}$), 10^{-10} A (from the current associated with a single post-synaptic potential) and the time required to move across the synapse (0.3 ms) is $\sim 10^{-20}$ J. Cell-cell adhesion, which involves forces that are (on average) within the range of $5 \cdot 10^{-9} \text{ N} \cdot \mu\text{m}^{-2}$, results in energies within the 10^{-20} J range when applied across the distance that defines atomic bonds. The dynamics of transformation between forms of energy, such as the action potential and the stacking energies of a base nucleotide upon a synthesizing RNA

sequence, involve $\sim 10^{-20}$ J and require about 1 ms [8]. Both values are the transformative physical properties of the action potential.

3. THE PERVASIVENESS OF $10^{-12} \text{ W}\cdot\text{m}^{-2}$ FOR PHOTONIC PHENOMENA

In several previous papers I have indicated quantitatively the possible relationship between the energy associated with light and gravity [9]. One approach indicates that they are related through an entanglement velocity of $\sim 10^{23} \text{ m}\cdot\text{s}^{-1}$ which was derived from two different approaches involving the four dimensional structure of the universe and the ratio of the total electrical potential per distance divided by the equivalent magnetic field strength during the final epoch [10]. For example the square of the entanglement velocity multiplied by median estimates of the upper limit [11] of the rest mass of a graviton ($\sim 10^{-65}$ kg) results in an energy that is within the wavelength associated with visible photons. The product of the upper boundary of the rest mass [12] of the photon ($\sim 10^{-52}$ kg), the entanglement velocity and the velocity of light in a vacuum is 10^{-20} J.

The difference between the two solutions for a graviton and photon approach zero when 8π (the second derivative of the surface of a sphere) is either subtracted or added as a constant on the appropriate side of the equation. This suggests that gravity and magnetic fields are related in a quantitative manner by discrete derivatives of space (velocity and acceleration). To obtain the quantity of energy associated with their upper boundary rest masses they must share the entanglement (or excess correlation) velocity.

If gravitational and electromagnetic energies related to photon flux density share a common source of variance and are partial identities there should be a negative relationship between their magnitudes. This would be analogous to the relationship for “between” and “within” sources of variance in statistical analyses. The total variance is constant. Consequently when the “between” sources of variance increases the “within” sources of variance decrease. Direct measurement indicates this occurs within multiple levels of spatial discourse and time frames for inferences of photon and magnetic field magnitudes.

Persinger et al [13] measured the second-to-second changes in the earth’s magnetic field above melanoma cells that had grown in culture dishes and the numbers of photons emitted around the cells. The numbers of photons per second were measured by a digital photomultiplier unit (PMT). An inverse relationship was found. Between 250 and 300 s or a change of ~ 0.5 to $1.5 \cdot 10^{-12} \text{ W}\cdot\text{m}^{-2}$ was required for a diminished shift of ~ 1 nT. Hence for every 1 nT increase in the strength of the adjacent geomagnetic field the photon flux density decreased by $\sim 10^{-12} \text{ W}\cdot\text{m}^{-2}$.

Vares and Persinger [14] measured a similar relationship within the space occupied by the PMT sensor and the nearby (within 0.5 m) sensor of a flux gate magnetometer. In this experiment the PMT was an analogue system. They recorded the minute-to-minute variations. They found that for every approximately 1 nT increase in the variation of geomagnetic intensity the photon radiant flux density decreased by about $10^{-12} \text{ W}\cdot\text{m}^{-2}$.

At more global levels a conspicuous relationship has been noted here (Laurentian University Station) between the daily average background photon flux density emerging from the earth and the intensity of the static geomagnetic field more than 500 km away. During the years 2013 through 2015 the correlation between the vertical (z) component of the earth’s magnetic field (which has been decreasing over the last few years) in Ottawa, Ontario and the PMT measures here in Sudbury, Ontario for this period of 1,538 days was -0.70. Regression analyses indicated that for every 1 nT decrease there was an increase of 0.058 units of the PMT. This was equivalent to between 2 and $3 \cdot 10^{-12} \text{ W}\cdot\text{m}^{-2}$.

The $10^{-12} \text{ W}\cdot\text{m}^{-2}$ value is particularly relevant for the volume and electromagnetic characteristics of the human brain. Assuming the estimated “total” energy in the universe to be $\sim 2.2 \cdot 10^{69} \text{ J}$ [15] and the universal volume to be $\sim 8.4 \cdot 10^{78} \text{ m}^3$, the average energy density is $\sim 0.3 \cdot 10^{-9} \text{ J}\cdot\text{m}^{-3}$. A similar value has been expressed by other methodologies [16]. Within the human cerebrum with an average volume of $1.3 \cdot 10^{-3} \text{ m}^3$ the energy would be $3.9 \cdot 10^{-13} \text{ J}$.

Represented within a relative fixed temporal quantity, the action potential, whose ΔV or change in voltage is about $1.2 \cdot 10^{-1} \text{ V}$ the energy on a unit charge ($1.6 \cdot 10^{-19} \text{ A}\cdot\text{s}$) is $\sim 2 \cdot 10^{-20} \text{ J}$. Hence with a total energy representation of $3.9 \cdot 10^{-13} \text{ J}$, the equivalent numbers of action potentials per second would be $\sim 2 \cdot 10^7$ neurons discharging at 1 Hz or about 2 million displaying 10 Hz. This number of neurons has been considered the critical mass for the experience of “a percept” or “awareness” [17].

When this value per second ($3.9 \cdot 10^{-13} \text{ W}$) is divided by the average of the surface area ($1.8 \cdot 10^{-1} \text{ m}^2$) of the entire cerebral cortices [18] the radiant flux densities range between $2.1 \cdot 10^{-12} \text{ W}\cdot\text{m}^{-2}$. These values are within the range of the flux densities of photon densities measured by digital photomultiplier devices near the temporal lobes of people sitting in the dark imaging light [19,20] as well as from the sections of rodent hippocampuses when stimulated by small electrical currents that induce long term potentiation [21, 22]. The latter is a primary pattern by which information (“memories”) is represented within the space occupied by the brain [23].

The value, $\sim 10^{-12} \text{ W}\cdot\text{m}^{-2}$, is approximately a factor of 10 above the average cosmic ray flux density on the earth’s surface. However $\sim 10^{-12} \text{ W}\cdot\text{m}^{-2}$ reflects a value found for the universe itself. The division of the total energy estimated for the universe from its mass equivalence ($2.2 \cdot 10^{69} \text{ J}$) by the surface area of the current universe ($2.43 \cdot 10^{54} \text{ m}^2$) is about $0.9 \cdot 10^{-15} \text{ J}\cdot\text{m}^{-2}$. If one assumes the time required for either an electron or proton to expand one Planck’s Length according to the Hubble parameter, 1 and 3 ms, respectively [24], the equivalent radiant power density is $\sim 10^{-12} \text{ W}\cdot\text{m}^{-2}$. In other words the photon flux density associated with aggregate of neurons that may be the “critical mass” for the emergent of awareness of conscious experience or of a percept reflects the average of this aggregate of units for the universe.

This “critical mass” or numbers of neurons is consistent with the numbers likely involved with the production of electroencephalographic (EEG) activity which is about $20 \mu\text{V}$ (peak to peak). When this voltage is divided by the averaged resistivity of the extracellular flux, $2 \Omega \text{ m}$ and multiplied by the averaged length of the cerebrum (10^{-1} m) the current is about $2 \cdot 10^{-6} \text{ A}$ per human brain. The numbers of charges associated with that value can be estimated by dividing by $1.6 \cdot 10^{-19} \text{ A}\cdot\text{s}$ per charge (q). This results in about 10^{13} charges per cerebrum (about one-half of which is cortical). The total numbers of charges associated with the resting membrane potential are $\sim 10^6 q$. This means that a total of $\sim 10^7$ neurons would be involved. This is the number of neurons per second whose energy matches the value within the cerebral volume based upon the average universal density.

If the $\sim 10^{-12} \text{ W}\cdot\text{m}^{-2}$ increment is a “narrow” band for communication across space between cells [25,26], then the energy within the cell area should be revealing. The cross section area of a typical neuronal soma ($\sim 10^{-10} \text{ m}^2$) when multiplied by the power is $10^{-21} \text{ J}\cdot\text{s}^{-1}$. Because the duration of an action potential is in the order of 1 ms (10^3 Hz) the energy within this increment of time would be 10^{-24} to 10^{-23} J . This is an important value (which would involve a range of coefficients) because when it is divided by Planck’s constant ($6.626 \cdot 10^{-34} \text{ J}\cdot\text{s}$) the solution results in a frequency that intersects and overlaps with the neutral hydrogen line (1.42 GHz). Potentially, when the photon energy from the pervasive $\sim 10^{-12} \text{ W}\cdot\text{m}^{-2}$ is applied to the average (10 μm) neuronal soma both could have the capacity to be related in a quantum form to the universal hydrogen line. One would not expect an exact and continuous convergence but rather a persistent oscillation or random excursions across the narrow value for the neutral hydrogen line.

The recent measurement of the $10^{-12} \text{ W}\cdot\text{m}^{-2}$ of photon densities during specific forms of human cognition while subjects sit in hyper-dark environments could be consistent with cosmological solutions that have been considered interesting but etiologically ambiguous. For example, the universal pressure [27] has been calculated as the product of the average proton density based upon Eddington's Number of 1 proton per cubic meter or $1.67\cdot 10^{-27} \text{ kg}\cdot\text{m}^{-3}$ and the square of the velocity of light in a vacuum ($9\cdot 10^{16} \text{ m}^2\cdot\text{s}^{-2}$). This value is $15.03\cdot 10^{-10} \text{ kg}\cdot\text{m}^{-1}\cdot\text{s}^{-2}$ and when multiplied by the average cerebral volume ($1.3\cdot 10^{-3} \text{ m}^3$) results in $2\cdot 10^{-13} \text{ J}$ within the cerebrum volume due to this dynamic pressure. If this value was persistent per second and the power density from the total cortical surface was considered ($1.8\cdot 10^{-1} \text{ m}^2$) the power density would be $\sim 10^{-12} \text{ W}\cdot\text{m}^{-2}$.

Given the considerations that the universal pressure should be related to the zero point or vacuum fluctuations which share characteristics with gravitational force [2], the fluctuations in gravitational energy (ΔG) should reveal similar radiant flux densities. Several empirical measurements [28,29] indicate that a pervasive "random" fluctuation in the measurement of G (the Newtonian Gravitational Constant) occurs within a range of $5.3\cdot 10^{-14}$ to $3\cdot 10^{-15} \text{ m}^3\cdot\text{kg}^{-1}\cdot\text{s}^{-2}$. Gravitational energy can be estimated by the product of ΔG and the square of the mass divided by its length. As we have calculated previously [30] for a human cerebral mass of 1.5 kg and an averaged three-dimensional length of 10^{-1} m the energy is $1.2\cdot 10^{-12} \text{ J}$ to $7\cdot 10^{-13} \text{ J}$. When divided by the total [18] or surface cross-section areas the median values are $\sim 10^{-12} \text{ W}\cdot\text{m}^{-2}$.

These convergent quantitative solutions would suggest that the light emission from the human brain during thinking could be modulated by some variable associated with ΔG . Persinger and Saroka [31] have provided some preliminary evidence that gravitational-like factors could contribute to changes in current densities inferred within the cerebral volume as measured by LORETA (Low Resolution Electromagnetic Tomography) within the right caudal cerebral hemisphere. More specifically the right parahippocampal region, whose activity is associated with subtle changes in the geomagnetic field and whose mesiobasal structure (the hippocampus) satisfies quantum conditions for potential excess correlation [32], was most activated.

4. RELATING RADIANT FLUX DENSITY TO ENERGY PER UNIT TIME

One relationship by which energy per second (Watts) and irradiant flux power density can be equated is:

$$\text{kg}\cdot\text{s}^{-3}=[(\text{kg}\cdot\text{m}^2\cdot\text{s}^{-3})\cdot(\text{s}\cdot\text{m}^{-2})\cdot\text{s}^{-1}] \quad (1),$$

or power density is equal to the product of Joules per second (Watts), the inverse of diffusivity, and frequency. If we assume the median value for the average power flux density for photons related to gravity and to many biochemical reactions within organisms is $\sim 2\cdot 10^{-12} \text{ W}\cdot\text{m}^{-2}$ and the average universal quantum of intrinsic energy is $\sim 10^{-20} \text{ J}\cdot\text{s}^{-1}$, then the values for the inverse diffusivity and the frequency must be very precise to result in a balanced equation.

For diffusivity to have a rational basis the resistivity and magnetic permeability should reflect universal properties. Here resistivity is assumed to be wave impedance (376.73Ω) applied over the hydrogen wavelength ($2.116\cdot 10^{-1} \text{ m}$) or $7.792\cdot 10^1 \Omega\cdot\text{m}$. When divided by the magnetic permeability of a vacuum ($1.26\cdot 10^{-6} \text{ N}\cdot\text{A}^{-2}$), the diffusivity is $6.326\cdot 10^7 \text{ m}^2\cdot\text{s}^{-1}$. The inverse value is $0.16\cdot 10^{-7} \text{ s}\cdot\text{m}^{-2}$. The simplest frequency to relate photon density to energy would be the orbital time of an electron. The fundamental frequency for this time, the Bohr value, is $6.59\cdot 10^{15} \text{ s}^{-1}$.

The product of $1.5\cdot 10^{-20} \text{ J}$, the inverse diffusion of $0.16\cdot 10^{-7} \text{ s}\cdot\text{m}^{-2}$, and the Bohr frequency of $6.59\cdot 10^{15} \text{ s}^{-1}$ is $1.6\cdot 10^{-12} \text{ W}\cdot\text{m}^{-2}$ which is within error measurement of the typical radiant flux

density measured in the terrestrial background and biological systems. A semantic interpretation of this relationship is that radiant flux density of photons (a divergent phenomenon) is equal to the fundamental energy from the entire force of the universe at the level of Planck's volume and distributed over the hydrogen wavelength when this energy is convergent within the electrical (wave impedance) and magnetic (permeability) properties of space with every rotation of an electron. The simultaneous requirement for convergent and divergent processes could be interpreted to reflect equilibrium.

The inclusion of the time required for one orbit of a Bohr magneton relates the phenomena to a fundamental constant for quantum descriptions: Planck's constant. The energy equivalent for the mass of an electron ($9.11 \cdot 10^{-31}$ kg) and the square of the fine structure velocity ($2.18978 \cdot 10^6$ m·s⁻¹) is $4.368369 \cdot 10^{-19}$ J. However when multiplied by duration of 1 orbit (the inverse of the Bohr orbital frequency) the duration is $1.517 \cdot 10^{-16}$ s or $6.626 \cdot 10^{-34}$ J·s. In other words every orbit is the bases of quantum relations: Planck's constant.

5. CONCLUSIONS

Boltzmann's entropy (S) states that:

$$S = k \cdot \ln W \quad (2),$$

where k is Boltzmann's constant ($1.38 \cdot 10^{-23}$ J·K⁻¹), K is the temperature in degrees Kelvin and W is the number of microstates contained within a macrostate. If one assumes the macrostate is the universe with a mass of 10^{52} kg and the microstates are all of the rest masses of photons each with an upper boundary of 10^{-52} kg per photon [12], then there would be $\sim 10^{104}$ microstates. In this instance there would be N number of identical particles. The value for $\ln 10^{104}$ is about 239.46. The value for S is $3.30 \cdot 10^{-21}$ J·K⁻¹. To obtain energy, temperature is required. The most pervasive is the cosmic microwave background.

The energy from the temperature associated with the cosmic microwave background (2.725 °K) is $\sim 10^{-20}$ J. This solution also emerges when the total force of the universe per the total numbers of Planck Length voxels is multiplied by the most prominent length in the universe: the hydrogen line of 21 cm. The relationship with the pervasive 10^{-12} W·m⁻² requires an intermediate term defined by diffusivity and the time required to complete a single electron orbit. The balance between this convergent process and the divergent process of flux density results in the universal value of 10^{-20} J.

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