Article

Heisenberg's Uncertainty Principle and Human Brain

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ABSTRACT

In this paper the Heisenberg's uncertainty principle is applied to the study of the quantum nature of the brain waves. Considering our model for the brain quanta the Libet's time for the human brain is calculated. The value 0.45 s is obtained which is in good agreement with the measured value (1.4 s). In the paper we calculated the temperature of the source of the photons located in human brain. It is well known that our space time is filled with Cosmic Background radiation. It was interesting to calculate the temperature of the Cosmic Background radiation source with the same model as for brain photons. As the result the shape of temperature was calculated, T=2.53 K, which is in very good agreement with observed value.

Key Words: Heisenberg's uncertainty, brain waves, Libet's time

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1. Introduction

The issue of observation in quantum mechanics (QM) is central, in the sense that objective reality cannot be disentangled from the act of observation, as the Copenhagen Interpretation (CI) nearly states in the words of John A. Wheeler (1981), we live in an observer-participatory Universe. The vast majority of today's practicing physicists follow CI's practical prescriptions for quantum phenomena, while still clinging to classical beliefs in observer-independent local, external reality. There is a critical gap between practice and underlying theory. In his Nobel Prize speech of 1932, Werner Heisenberg concluded that the atom "has no immediate and direct physical properties at all." If the universe's basic building block isn't physical, then the same must hold true in some way for the whole. The universe was doing a vanishing act in Heisenberg's day, and it certainly hasn't become more solid since (Schild, 2012).

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This discrepancy between practice and theory must be confronted; because the consequences for the nature of reality are far-reaching an impressive body of evidence has been building to suggest that reality is non-local and undivided. Non-locality is already a basic fact of nature, first implied by the Einstein-Podolsky-Rosen thought experiment despite the original intent to refute it, and later explicitly formulated in Bell's Theorem

Moreover, this is a reality where the mindful acts of observation play a crucial role at every level. Heisenberg again: "The atoms or elementary particles themselves . . . form a world of potentialities or possibilities rather than one of things or facts." He was led to a radical conclusion that underlies our own view in this paper: "What we observe is not nature itself, but nature exposed to our method of questioning." Reality, it seems, shifts according to the observer's conscious intent. There is no doubt that the original CI was subjective (Schild, 2012).

Quantum theory is not about the nature of reality, even though quantum physicists act as if that is the case. To escape philosophical complications, the original CI was pragmatic: it concerned itself with the epistemology of quantum world (how we experience quantum phenomena), leaving aside ontological questions about the ultimate nature of reality. The practical bent of CI should be kept in mind, particularly as there is a tendency on the part of many good physicists to slip back into issues that cannot be tested and therefore run counter to the basic tenets of scientific methodology.

2. Heisenberg's uncertainty Principle

Quantum physics, as exemplified by the Copenhagen school (Bohr, 1934; 1958; 1963; Heisenberg, 1930; 1955; 1958), also makes assumptions about the nature of reality as related to an observer, the "knower" who is conceptualized as a singularity. Because the physical world is relative to being known by a "knower" (the observing consciousness), then the "knower" can influence the nature of the reality which is being observed. In consequence, what is known versus what is not known becomes relatively imprecise (Heisenberg, 1958).

For example, as expressed by the Heisenberg uncertainty principle (Heisenberg, 1955, 1958), the more precisely one physical property is known the more unknowable become other properties, whose measurements become correspondingly imprecise. The more precisely one property is known, the less precisely the other can be known and this is true at the molecular and atomic levels of reality. Therefore it is impossible to precisely determine, simultaneously, for example, both the position and velocity of an electron.

However, we must ask: if knowing A, makes B unknowable, and if knowing B makes A unknowable, wouldn't this imply that both A and B, are in fact unknowable? If both A and B are manifestations of the processing of "knowing," and if observing and measuring can change the properties of A or B ,then perhaps both A and B are in fact properties of knowing, properties of the observing consciousness, and not properties of A or B.

In quantum physics, nature and reality are represented by the quantum state. The electromagnetic field of the quantum state is the fundamental entity, the continuum that constitutes the basic oneness and unity of all things.

The physical nature of this state can be "known" by assigning it mathematical properties (Bohr, 1958; 1963). Therefore, abstractions, i.e., numbers, become representational of a hypothetical physical state. Because these are abstractions, the physical state is also an abstraction and does not possess the material consistency, continuity, and hard, tangible, physical substance as is assumed by Classical (Newtonian) physics. Instead, reality, the physical world, is created by the process of observing, measuring, and knowing (Heisenberg, 1955).

Consider an elementary particle, once this positional value is assigned, knowledge of momentum, trajectory, speed, and so on, is lost and becomes "uncertain." The particle's momentum is left uncertain by an amount inversely proportional to the accuracy of the position measurement which is determined by values assigned by the observing consciousness. Therefore, the nature of reality, and the uncertainty principle is directly affected by the observer and the process of observing and knowing (Heisenberg, 1955, 1958).

The act of knowing creates a knot in the quantum state; described as a "'collapse of the wave function;" a knot of energy that is a kind of blemish in the continuum of the quantum field. This quantum knot bunches up at the point of observation, at the assigned value of measurement.

The process of knowing makes reality, and the quantum state, discontinuous. "The discontinuous change in the probability function takes place with the act of registration... in the mind of the observer" (Heisenberg, 1958).

Reality, therefore, is a manifestation of alterations in the patterns of activity within the electromagnetic field which are perceived as discontinuous. The perception of a structural unit of information is not just perceived, but is inserted into the quantum state which causes the reduction of the wave-packet and the collapse of the wave function.

Knowing and not knowing, are the result of interactions between the mind and concentrations of energy that emerge and disappear back into the electromagnetic quantum field.

However, if reality is created by the observing consciousness, and can be made discontinuous, does this leave open the possibility of a reality behind the reality? Might there be multiple realities? And if consciousness and the observer and the quantum state are not a singularity, could each of these multiple realities also be manifestations of a multiplicity of minds?

Heisenberg (1958) recognized this possibility of hidden realities, and therefore proposed that the reality that exists beyond or outside the quantum state could better understand when considered in terms of "potential" reality and "actual" realities. Therefore, although the quantum state does not have the ontological character of an "actual" thing, it has a "potential" reality; an objective tendency to become actual at some points in the future, or to have become actual at some it in the past.

Therefore, it could be said that the subatomic particles which make up reality, or quantum state, do not really exist, except as probabilities. These "subatomic" particles have probable existences and display tendencies to assume certain patterns of activity that we perceive as shape and form. Yet, they may also begin - play a different pattern of activity such that being can become nonbeing and something else altogether.

The conception of a deterministic reality is therefore subjugated to mathematical probabilities and potentiality which is relative to the mind of a knower which effects that reality as it unfolds, evolves, and is observed (Bohr 1958; 1963; Heisenberg 1955; 1958). That is, the mental act of perceiving a non-localized unit of structural information, injects that mental event into the quantum state of the universe, causing "the collapse of the wave function" and creating a bunching up, a tangle and discontinuous knot in the continuity of the quantum state.

Heisenberg (1958), cautioned, however, that the observer is not the creator of reality: "The introduction of the observer must not be misunderstood to imply that some kind of subjective features are to be brought into the description of nature. The observer has, rather, only the function of registering decisions, i.e., processes in space and time, and it does not matter whether the observer is an apparatus or a human being; but the registration, i.e., the transition from the "possible" to the "actual," is absolutely necessary here and cannot be omitted from the interpretation of quantum theory."

Shape and form are a function of our perception of dynamic interactions within the continuum which is the quantum state. What we perceive as mass (shape, form, length, weight) are dynamic patterns of energy which we selectively attend to and then perceive as stable and static, creating discontinuity within the continuity of the quantum state. Therefore, what we are perceiving and knowing, are only fragments of the continuum.

However, we can only perceive what our senses can detect, and what we detect as form and shape is really a mass of frenzied subatomic electromagnetic activity that is amenable to detection by our senses and which may be known by a knowing mind. It is the perception of certain aspects of these oscillating patterns of continuous evolving activity, which give rise to the impressions of shape and form, and thus discontinuity, as experienced within the mind. This energy that makes up the object of our perceptions is therefore but an aspect of the electromagnetic continuum which has assumed a specific pattern during the process of being sensed and processed by those regions of the brain and mind; best equipped to process this information. Perceived reality, therefore, becomes a manifestation of mind.

2. Model

In order to put forward the classical theory of the brain waves we quantize the brain wave field. In the model (Marciak-Kozlowska and Kozlowski, 2012) we assume;

A, The brain is the thermal source in local equilibrium with temperature T.

B, The spectrum of the brain waves is quantized according to formula

$$E = \hbar\omega$$
$$\Delta E = 0 \rightarrow \Delta t = \infty \qquad (1)$$

where E is the photon energy in eV, $\hbar$ =Planck constant, $\omega = 2\pi\nu, \nu$ -is the frequency in Hz. C, The number of photons emitted by brain is proportional to the $(\text{amplitude})^2$ as for classical waves. The energies of the photons are the maximum values of energies of waves For the emission of black body brain waves we propose the well know formula for the black body radiation.

In thermodynamics we consider Planck type formula for probability P(E)dE for the emission of the particle (photons as well as particles with m≠0) with energy (E, E+dE)by the source with temperature T is equal to:

$$P(E)dE = BE^2 e^{(-E/kT)} dE \qquad (2)$$

where B= normalization constant, E=total energy of the particle, k = Boltzmann constant=1.3 x 10^{-23} JK^{-1}. K is for Kelvin degree. However in many applications in nuclear and elementary particles physics kT is recalculated in units of energy. To that aim we note that for 1K, kT is equal k1K = K x 1. 3 10^{-23} J x K^{-1}= 1.3 10^{-23} Joule or kT for 1K is equivalent to 1.3 10^{-23} Joule= 1.3 10^{-23} /(1.6 10^{-19}) eV = 0.8 10^{-4} eV. Eventually we obtain 1K= 0.8 10^{-4} eV, and 1eV= 1.2 10^4 K

$$\frac{dN}{dE} = BE_{\max}^2 e^{(-\frac{E_{\max}}{T})} \qquad (2)$$

where, B is the normalization constant, T is the temperature of the brain thermal source in eV. The function *dN/dE* describes the energy spectrum of the emitted brain photons

In Fig.1 the calculated energy spectrum, formula (2) is presented. We present the result of the comparison of the calculated and observed spectra of the brain waves. The calculated spectra are normalized to the maximum of the measured spectra. The calculated spectrum is for temperature of brain source T= 0.8 10^{-14} eV. The obtained temperature is the temperature for the brain source in the thermal equilibrium. The source is thermally isolated (adiabatic well). However in very exceptional cases the spectrum is changed – by the tunneling to the quantum potential well. The temperature 1 eV ≅ 10 ^{4} K then brain wave thermal spectra T=0.8 10^{-14} eV= 0.8 10^{-10} K.

In Fig.2 we present the calculation of the energy spectrum for the Cosmic Background radiation (CBR). T_{ke} formula (2) was used for the model calculation. The normalized theoretical spectrum describes very well the observed CBR. The calculated temperature T=2.53K, which is in excellent agreement with experimentally verified values

It must be stressed that in a paper we abandon the idea that every physical object is either a wave or a particle. Neither it is possible to say that particles "become" waves in the quantum domain and conversely that waves are "transformed" into particles. It is therefore necessary to acknowledge that we have here a different kind of an entity, one that is specifically quantum. For this reason Levy-Leblond and Balibar developed the name *quanton* (Levy-Leblond and Balibar, 1990). Following that idea the human brain emits *quantons* with energies $E = \hbar\omega$ formula (8). The brain *quantons* are the quantum objects that follows all quantum laws: tunneling, the superposition and Heisenberg uncertainty principle. For the wave length of the *quantons* is of the order of Earth radius the quantum nature of the brain will be manifested in the Earth scale.

The formula for Heisenberg uncertainty formula can written as

$$\Delta E \Delta t = \hbar \qquad (3)$$

Where E is the characteristic energy of the system and t is the characteristic time. From formula (3) we can calculate the characteristic times for energy of the sources.In Table 1 the result of the calculations for characteristic times, formula (3) are presented. According to Libet theory (Libet, 2004), the characteristic time for the brain response is of the order of 1.4 s.

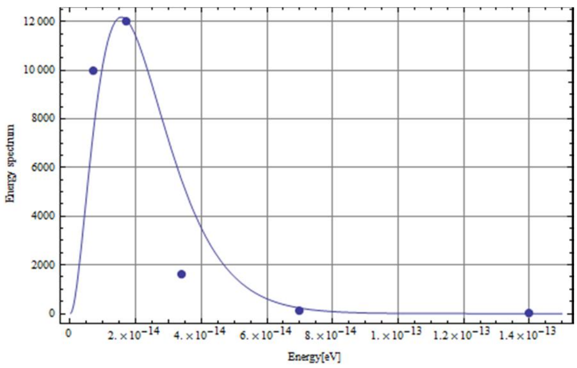

Figure 1. Model calculations for energy spectra of brain photons. The temperature of the source, T= 7.8 10^{-11} K.

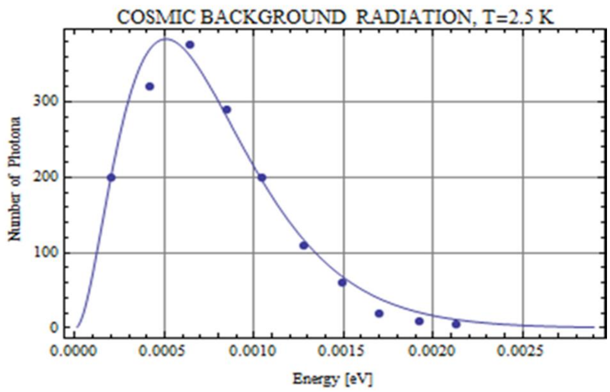

Figure 2. Model calculations for energy spectra of cosmic background radiation temperature of the source T= 2.35 K.

In history of the Universe the characteristic time for appearance of all interactions: gravity, electromagnetic, electroweak, and strong is of the order of 10^{-11} s (Perkins, 2000).

Table 1. Characteristic times for Human Brain and Universe.

Source	Energy [eV] (This paper)	Characteristic time, [s] Heisenberg inequality
Human Brain	$7.8\ 10^{-15}$	0.45
Cosmic Background Radiation	$2.5\ 10^{-4}$	$3.1\ 10^{-11}$

Table 2. Hypothesis.

Source	Energy [eV] (This paper)	Time [s] (This paper)	Comparison to: Libet and Perkins
Brain	$7.8\ 10^{-15}$	0.45	Libet, 1.4 s
Universe	$2.5\ 10^{-4}$	$3.1\ 10^{-11}$	Perkins , 10^{-11} s

Conclusions

It is obvious that consciousness is not located in space. According to special relativity theory all physically observed phenomena are located in 4D space-time. *In conclusion the conscious not exist in time also, consciousness is timeless*. The brain photons are the effect of the interaction of the timeless consciousness with human brain. The final result of this interaction is the alpha, beta, delta and theta waves.

In the paper we calculated the temperature of the source of the photons located in human brain. It is well known that our space time is filled with CBR. It was interesting to calculate the temperature of the CBR source with the same model as for brain photons. As the result the shape of temperature was calculated, T=2.53 K, which is in very good agreement with observed value.

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