

Biostructure as Endogenous EM Radiation

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Abstract: The Biostructure of living matter is proposed to be endogenous EM radiation produced upon the simple QED conversion of metabolic heat in microtubular structures of the cytoskeleton. Simple QED is the consequence of the Planck law that denies atoms in nanostructures the heat capacity to conserve heat by an increase in temperature. The high surface-to-volume ratio of the filamentary microtubules provides the EM confinement by which standing EM radiation is created across the tube diameters. Once the surface heat is expended in creating the standing EM radiation, the EM confinement vanishes, and the EM radiation is free to excite the water cytoplasm. The Biostructure is not physical, but rather massless non-thermal EM radiation distributed throughout the cellular cytoplasm. Because of the nanoscopic tubular diameters, the EM radiation is produced in the EUV. By fluorescence, the EUV excites the lower UV state of cellular water to strongly bind with tubules, thereby explaining why living and not non-living plant leaves under hydrostatic pressure retain water. Coherent EM radiation far from equilibrium characterizes the living biological cell allowing the large number of cells throughout the human body to communicate with the brain through the CNS by neurons to respond to environmental challenges and responses.

I. INTRODUCTION

In the 1970's, Macovschi proposed [1] living organisms possess a Biostructure comprising a form of matter having living features. The Biostructure is thought to be located in the living cell. The presence of the Biostructure was based on the experiment [2] of compressing living and non-living plant leaves as shown in Fig.1.

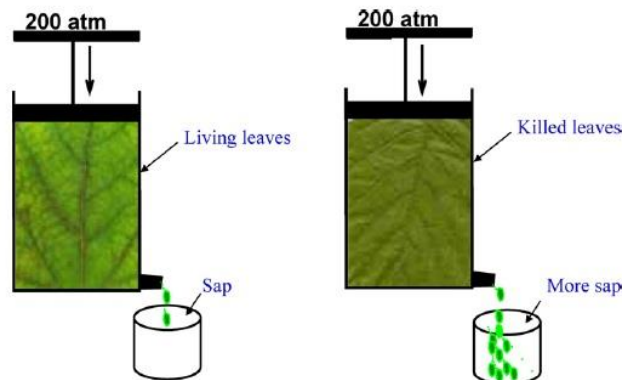


Figure 1. Living and Non-Living Leaf Experiment

Under hydrostatic compression, the living leaves produced little water or sap, but the non-living leaves produced far more water. Up to pressures of 200 atmospheres, the leaves remained alive. Macovschi considered the water released from living leaves being free water - not the water of the Biostructure itself. In the living state, the Biostructure can withstand high pressure without releasing little water, but once the leaves are killed, more water is released. Macovschi interpreted the difference in the water released from dead and living leaves as proof of the existence of a living Biostructure separately distinct from molecular matter in non-living systems. In so doing, Macovschi suggested a living biological cell consists of *both* a Biostructure and inanimate molecular matter. Upon cell death, initiated by metabolic inhibitors, heat, or UV radiation; the Biostructure breaks down to molecular matter comprising ordinary molecules. In mitochondria, the Biostructure and molecular structure [3] are shown in Fig. 2.

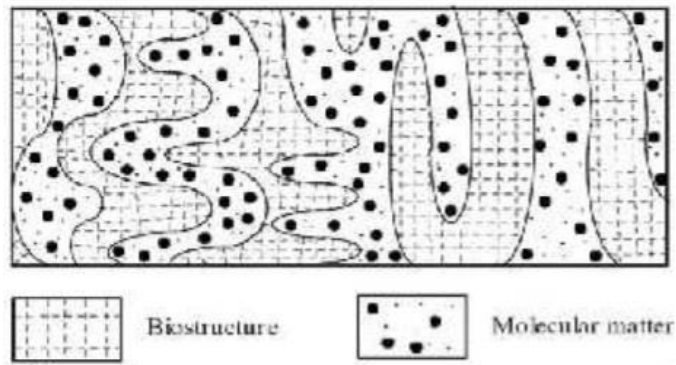


Figure 2. Biostructure and Molecular Structure in Mitochondria

Macovschi envisioned the inanimate cristae in mitochondria as molecular structure, but why the matrix is living and not the cristae is not clear. At that time, optical microscopy showed the matrix was transparent, perhaps why Macovschi thought the matrix was the Biostructure.

Consistent with the Biostructure proposed by Macovschi, the new electron microscopy [4] having sub-micron resolution showed of the whole-cell protoplasm comprised a filamentary microtrabeculae (MT) cytoskeleton that appeared to connect the mitochondria and other organelles with the cell wall. Typically, the MT were 5–10 nm diameter and 50–100 nm in length. The cytoplasm structure [4] is depicted in Fig. 3. Scale bar = 100 nm.

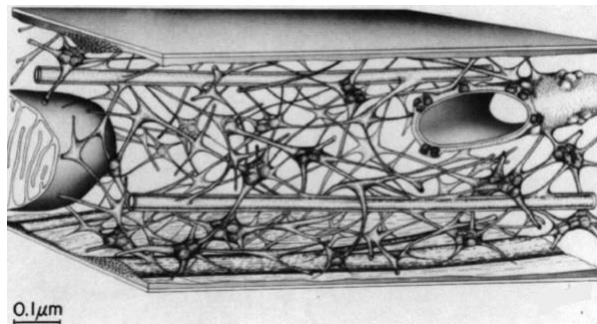


Figure 3. Structure in the cell cytoplasm

Later on, the electron microscopy [5] of MT dispersed in the living cell, freeze-dried to remove water, is shown in Fig. 4.

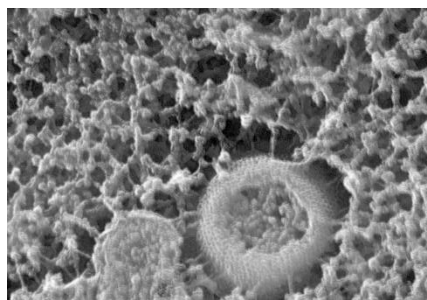


Figure 4. Freeze-dried micrograph of living cell

However, the MT were questioned [5] because the freeze-dried micrographs of cell specimens may include cell water, and therefore do not show the cytoskeletal structure itself, i.e., the MT were nothing more than artifacts of the freeze-dried state. Because of this, biology textbooks [6] on molecules of the cytoskeleton state “there is no evidence that MT consist of a major cytoplasmic component that has not yet been isolated.”

Nevertheless, Macovschi’s notion of the Biostructure may still describe living matter even though the material matter of the MT is not defined. Fundamentally, the question ‘What is life?’ is a challenge [7] to generations of scientists. Macovschi thought the laws of physics for living systems may require a new level of description above that of Crick & Watson on the structure of DNA which established the structure–function relations in biology.

Macovschi was not alone as other theories of living matter were proposed. Frey-Wyssling [8] thought the polypeptide chains of protein molecules link together forming a three-dimensional cross-linking structure forming the molecular skeleton that is continuously changing. Ling [9] proposed the Association-Induction (AI) Hypothesis, based on proteins in the living cell forming a three-dimensional crosslinking system with a charge of polarized water and ion carriers, but how the charge is created was not identified. Ling noted the living cell (water, proteins and K⁺) are closely associated, more than 80% of the water in highly concentrated solutions of proteins has been altered and is no longer free liquid water. Mitchell [10] explained living organisms by chemiosmosis based on pH proton gradients through the mitochondrial inner membrane. The chemiosmotic theory has been accepted as one of the great unifying principles of modern biology, but Macovschi argued chemiosmosis never distinguished between living and non-living matter.

In the cell, the Onsager–Morowitz definition of life [7] is most applicable to this paper: ‘Life is the property of matter that results in the cycling of bio-elements in aqueous solution, ultimately driven by radiant energy to attain maximum complexity’. Emphasis here is placed on the acquisition and disposal of radiant energy. But life by Onsager–Morowitz does not strictly apply because the sun as the source of exogenous radiant energy cannot reach internal organs. Because of this, Onsager–Morowitz radiant energy is extended to non-thermal EM radiation. Consistent with the need for an endogenous source of EM radiation, Frohlich in 1967 hypothesized [11] EM interaction within the cell based on excitation from the strong polarity of biological objects to produce longitudinal electric oscillations. Since the majority of proteins and protein structures are electrically polar, oscillations generate EM fields that induce motion with phases correlated over macroscopic regions superimposed on random thermal fluctuations. Frohlich’s hypothesis assumed the plasma membrane produced EM fields provided the basis for understanding cellular processes in biological systems.

In extending Frohlich’s hypothesis, Pokorny et al. [12] proposed living cells generate a coherent endogenous EM field based on MT as non-linear oscillating structures, only a brief summary of which is given here. The MT are hollow tubular structures having inner and outer diameters of 17 and 25 nm with variable lengths randomly arranged to form the cytoskeletal structure of the cytoplasm. Experiments on living cells showed the skeletal structure was the source of the EM field with frequencies in the microwave region from 1.5–52 MHz. Further, the microwave frequencies did not depend on the length of the MT and were not observed after release of water from the cell. The physical mechanisms of oscillations in MT generating an EM field at microwave frequencies were not fully understood, but thought to include free electric charges in ordered water. Pokorny assumed the EM field driving the skeletal oscillations was powered by ATP produced in mitochondria by chemiosmosis [10] using a proton H⁺ gradient across the inner membrane.

However, Drochioiu et al. [13] based on Biostructure arguments questioned the validity of chemiosmosis. Moreover, endogenous UV radiation as an alternative to chemiosmosis was proposed [14] to explain ATP synthesis in mitochondria. Endogenous UV differs from Pokorny’s EM field [12] in that the UV creates the EM field. Differences between UV and EM field aside, Onsager–Morowitz

suggests that because ATP synthesis by chemiosmosis based on a proton H⁺ gradient and not on radiant energy, chemiosmosis cannot explain living matter

Recently, Pereria [15] extended Macoschi's Biostructure as EM radiation to the human 'soul'. The soul is hypothesized to be massless EM radiation beyond the spatial extent of the cytoskeletal network of the protoplasm. EM radiations within and between cells forms a coherent 'Cell-Soul Pathway' to promulgate information to the brain, but upon death liberates the soul to the environment. With the brain allowing vast amounts of experience to be stored, the cell-soul pathway allows data processing to understand and respond to current situations based on prior experience.

II. PURPOSE

The purpose of this paper is to propose the living Biostructure is endogenous EM radiation created as nanoscopic skeletal features of the cytoplasm conserve metabolic heat. What distinguishes the Biostructure from non-living matter is metabolic heat necessary create endogenous EM radiation. Absent metabolic heat, the Biostructure becomes non-living matter.

III. ANALYSIS

In the cell, the Biostructure becomes living upon the creation of EM radiation by the simple QED conversion [14] of metabolic heat Q in the cytoplasm. Simple QED is based on the Planck law that requires the heat capacity of the atom to vanish under EM confinement in nanostructures. Heat Q therefore cannot be conserved by an increase in temperature, and instead standing EM radiation is created across the dimension d of the tubular MT having half-wavelength $\lambda/2$. Simple QED for the tubular MT is shown in Fig. 1.

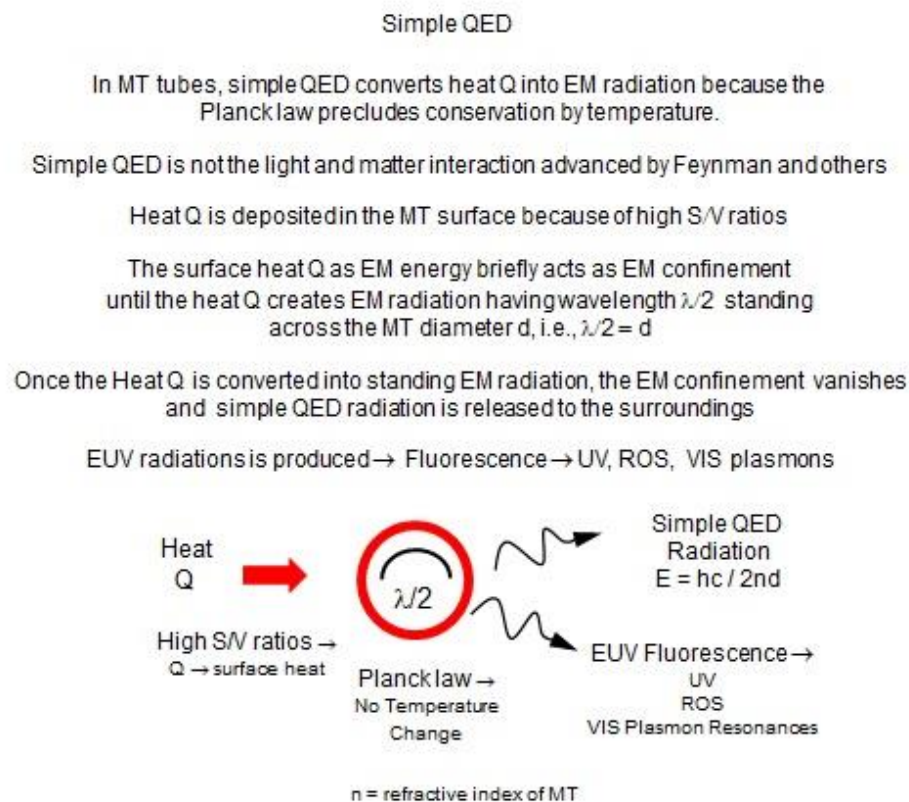


Figure 1. Simple QED induced EM radiation in MT of skeletal cytoplasm

EM confinement occurs by the high S/V ratio of the MT that requires the heat Q to almost totally be confined in the surface, the heat as EM energy itself providing the brief EM confinement to create the EM wave standing in the nanostructure. Once created, the EM confinement vanishes and the EM standing wave is emitted from the MT. The MT diameters $d < 25$ nm produce simple QED wavelengths $\lambda < 100$ nm having EM energy in the EUV. Fluorescence reduces EUV to excite lower MT quantum states, e.g., UV, ROS, and VIS plasmon resonances, although at low efficiency. In the cytoskeletal, the MT's are randomly arranged as shown in Fig. 2.

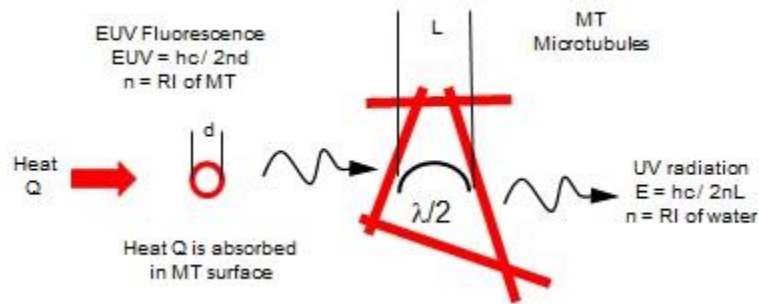


Figure 2. Simple QED conversion of Heat Q to EM radiation

For the large number of MT's, EUV excites a broadband of EM frequencies. Of interest are the UV states of cellular water to dissociate hydroxyl OH radicals at $E > 4$ eV at 310 nm. In Fig. 2, simple QED for water having $n = 1.33$ produces $UV = 310$ nm at MT spacing $L = 116$ nm. MT's exciting water at 310 nm forms OH radicals that recombine to form the $H_2O \cdot HO$ complex having dissociation energies in the ground and excited states [16] of 6.4 and 34.3 kcal/mol. Hence, EM excited water significantly increases the binding of $H_2O \cdot HO$ about 5X above that of the ground state, thereby explaining why EM radiation from living leaves retained [2] more water in Mucovschi's experiment .

In micrographs, simple QED radiation EM as waves standing between MT are illustrated in Fig. 3. Fig. 3A shows EM radiation (white) standing in Porter's conception [4] of the skeletal cytoplasm. Fig. 3B shows Heuser micrograph [5] with superposed EM radiation waves E (black) with MT diameter d and spacing L between MTs. Heuser's notation for mitochondria (M) and microtubules (Mt) is shown.

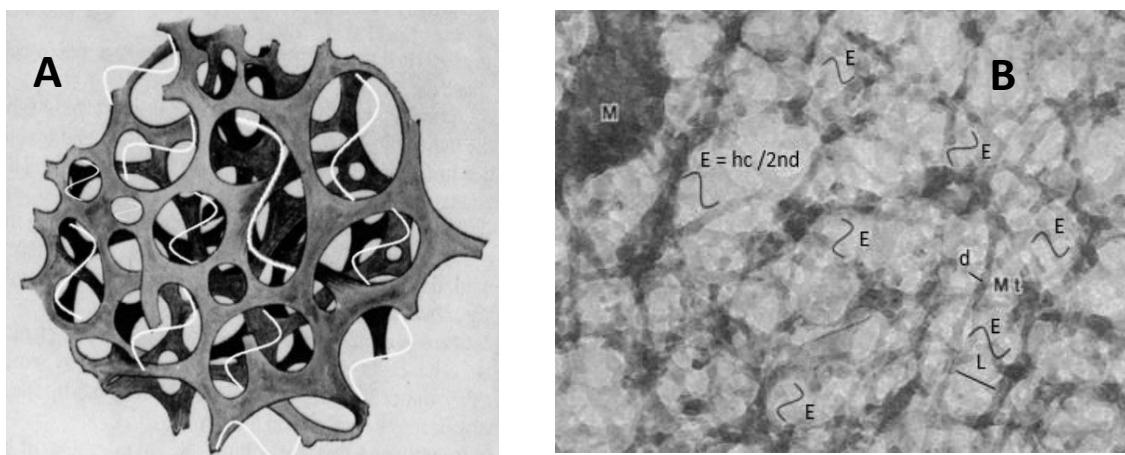


Figure 3. Simple QED induced EM Radiation and MT Skeletal Structure

III. ANALYSIS

Simple QED predicts MT's in water under metabolic heat produce at least 4 eV EM radiation to dissociate the OH radical and form the excited state complex $H_2O \cdot HO$ having binding energy about 5X higher than the ground state. But metabolic heat may simply increase the temperature T in the macroscopic surroundings as illustrated in in Fig. 4. In this analysis, a cylindrical 25 nm MT in blood or water producing a single simple QED photon $E = hc / 2nd$. For MT having $n = 1.4$, $E = 17.7$ eV which is in the EUV. The EUV photon is created in time $\tau = 2d / (c / n) = 0.23$ fs. Hence, the heat $Q = E/\tau \sim 12$ mW. But the next EUV photon cannot be created until the MT surface temperature is recovered. Fourier's law valid only for atoms in the MT having heat capacity kT is noted in the region $R > R_s$. Taking the cylindrical MT to be spherical, the recovery of the initial temperature change ΔT taken from [17] depends on the thermal diffusivity α of blood, $\alpha = K_b/\rho C_p$, where K_b , ρ , and C_p are the thermal conductivity, density, and specific heat. Hence, $\alpha = 1.24 \times 10^{-7} \text{ m}^2/\text{s}$ and $K_b = 0.52 \text{ W/m}\cdot^\circ\text{K}$.

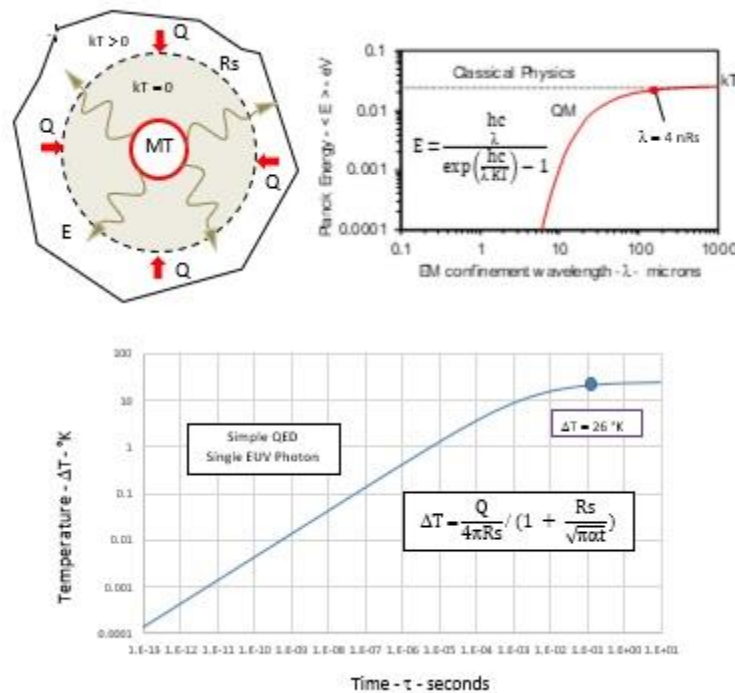


Figure 4. Recovery of MT surface temperature following single EUV photon emission

Planck law at 300 °K shows atoms to have thermal kT energy at EM confinement wavelengths $\lambda > 200$ microns. The radius R_s at which blood atoms have thermal kT energy is illustrated in Fig. 4. For blood having refractive index $n = 1.4$, the radius $R_s = \lambda/4n \sim 36$ microns. No temperature changes occur for $R < R_s$ including the MT. What this means is the heat flow Q from the bath for $R < R_s$ at temperature T is converted at R_s to EM radiation in the far IR and upon being absorbed at the MT produces the single EUV photon. For a temperature change $\Delta T \sim 26$ °K, the recovery time is about 0.1 s, or the NP produces about 10 EUV photon per second which can easily be measured in a water bath. Recall the spherical approximation is only a very small fraction of the MT length, i.e., each MT produces many EUV photons and a significantly larger number for the total length for of MTs in the cytoplasm.

However, to excite the intracellular water by creating $H_2O \cdot HO$ complexes requires EM radiation at UV > 4 eV at 315 nm. By fluorescence, the EUV at 17.7 eV produces UV at 4 eV, but at low efficiency. Data of 17.7 eV fluorescence efficiency at 4 eV is not available. However, OH photodissociation data [20] from Lyman-alpha photons at 10.2 eV and wavelength 121.6 nm to UV at 4 eV is shown in Fig. 5.

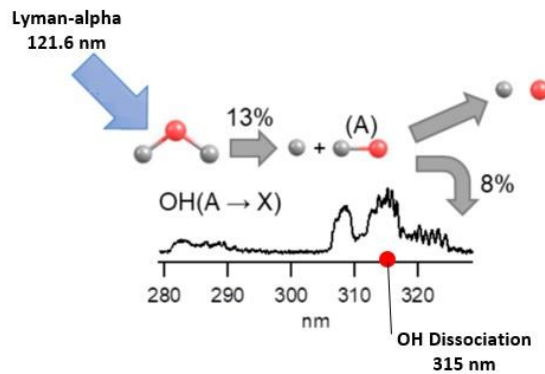


Figure 5. Lyman-alpha fluorescence in dissociation of water to form OH radicals

For the Lyman-alpha, the fluorescent efficiency at 4 eV at 315 nm is about 8 per cent. Hence, the efficiency for the EUV at 17.7 eV at 70 nm is < 8 per cent. Because of the loss in fluorescence efficiency, the alternative in exciting intracellular water to 4 eV levels may be more efficient by spacing $L = 116$ nm between MT's as shown in Fig. 2.

IV. DISCUSSION

A. Macovschi's Leaf Experiment

In 1958, Macovschi postulated [3] living organisms possess a Biostructure and coexisting molecular matter claiming modern biology was not yet capable of satisfactory explaining the nature of living matter. Macovschi thought living and non-living matter consists of the same substances and structural organizations, the only difference being coordination of physical processes in living matter that provide the metabolic processes characteristic of life. The Biostructure exists only in living and not in non-living systems. Macovschi proposed 'biobonds' bonds between components of the Biostructure matter in addition to ionic, covalent, secondary valences and hydrogen bonds. The Biostructure acquires a special state of living organisms representing a biologically continuously developing structure. Both Biostructure and molecular matter are in different states, interrelated with other cells, the unity of which represents the living matter itself. Hence, life itself depends on the Biostructure.

The Biostructure [2] considers three water species in living tissue in contrast to the two species in molecular matter - 19% free and 61% bound. Biostructure water is the water in living systems differing from free water and cannot be removed from living tissues at high pressures and only released with the death of the living system. However, simple QED producing EM radiation provides another explanation: water binding to the components of the cytoskeleton increases enormously [3] in the excited state compared to the ground state. The increased binding would explain the Macovschi Experiment if a source of EM radiation exciting the water was present in the experiment, and if so, there would be no need for a Biostructure having life as EM radiation would excite water in non-living systems.

Simple QED induced EM radiation is similar to EM fields by Frohlich [11] and Pokorny et al. [12] in the long-sought property of life in the Biostructure, perhaps explaining why Macovschi hypothesized [2] the Biostructure in living organisms behaves as a high-energy structure of proteins in the cytoskeleton, surrounded by water containing amino acids and salts. Importantly, the Biostructure having EM fields was allowed to have highly excited electronic states, but how the states are formed in the living and not the non-living is not clear.

In this regard, Macovschi's Experiment may be explained by simple QED producing endogenous EM radiation from the MT's of the cytoskeleton upon absorbing metabolic heat from the intracellular water

temperature of the cell. But the EM radiation would have to be at least in the UV to achieve enhanced water binding. Obviously, exogenous UV is ruled out leaving endogenous UV sources within the cell as the only alternative. Hence, the Biostructure may be nothing more than endogenous UV radiation produced in MT's that distinguish living from non-living systems.

The difficulty with simple QED in 25 nm MT's at UV levels at 4 eV is only produced by EUV fluorescence at 17.7 eV at low efficiency. Experimental fluorescence of water excited at 17.7 eV is recommended to show high water binding. Instead, spacings between MTs radiation of $L \sim 116$ nm that directly produce UV at 4 eV and 310 nm may be considered to induce high water binding.

B. The Soul and EM Radiation

Mankind has attempted to explain the 'soul' in relation to living and non-living systems by philosophy and religion. Generally, the soul is thought to be spiritual extending beyond the confines of the human body, i.e., the soul is based on man as a whole collection of cells, and not of a single cell. In this regard, science differs. Historically, Huter in 1904 suggested [18] that life is based on EM radiation, i.e., light control in the living cell of a spiritual energy that drives the evolution process in humans. Periera [15] hypothesized the soul to be an indefinite, non-structured energy, massless made up of EM radiations confined in the cytoskeletal network of the biological cell.

Scientific explanations assume the soul is related to the body, brain and mind of multicellular beings, but may include the single biological cell. Excited water binding aside, Macovschi's leaf experiment demonstrated [19] the existence and the main role of the biostructure as the difference between living and non-living systems, but did not comment on the soul.

In contrast, the simple QED production of massless endogenous EM radiation from MTs in the cell follows Pereira [15] in that the EM radiation is confined in the cytoskeletal structure, but differs as the EM radiation is definite and structured energy. EM radiation from simple QED is similar to the existence of Macovschi's notion of the Biostructure in living and not non-living systems, but

Simple QED claims EM radiation itself is the Biostructure envisioned by Macovschi.

Otherwise, simple QED takes exception to Macovschi's 'biobonds' between components of the Biostructure matter continuously developing structure as connections are made by EM radiation. Moreover, the Biostructure and molecular matter need not be in different states that upon unity represents living matter as EM radiation is produced directly by the Planck law from non-living matter.

The Biostructure of Macovschi aside, Periera [15] extended EM radiation to the human 'soul' by hypothesizing EM radiation to be massless beyond the spatial extent of the cytoskeletal network of the protoplasm. EM radiations within and between cells forms a coherent 'Cell-Soul Pathway' to promulgate information to the brain, but upon death liberates the soul to the environment. With the brain allowing vast amounts of experience to be stored, the cell-soul pathway allows data processing to understand and respond to current situations based on prior experience.

Simple QED differs from Periera [15] in that the EM radiation produced from non-living matter is transferred through the CNS to the brain by neurons cannot be construed as the soul. Perhaps, the notion of a soul is better left to spiritual explanations. Instead, EM radiation generated from cellular metabolic heat is physical and provides the brain with a measure of consciousness of the whole living system. The EM radiation links all cells to the brain through the CNS allowing the living system to learn how to respond to environmental challenges. The brain therefore learns from the cells of environmental challenges and what response is appropriate to survive. Learning by trial and error is inefficient, but after billions of years of evolution the process is commonplace.

VI. CONCLUSIONS

Simple QED is based on the Planck law that denies constituent atoms in MT nanostructures the heat capacity to conserve heat by an increase in temperature. Instead, conservation proceeds by creating standing EM radiation across the MT diameter. The EM confinement of the standing radiation is caused by the high surface-to-volume ratios inherent in nanostructures that constrains the applied heat to the nanostructure surface, the surface heat itself providing the brief EM confinement necessary to create the EM radiation. Once the surface heat is depleted in creating the standing radiation, the EM confinement vanishes, and the EM radiation is emitted from the MT moving into the surroundings to dissociate water into OH radicals. Upon recombination, the $\text{H}_2\text{O}\cdot\text{HO}$ complex is formed that increases the binding of water, thereby explaining why Macovschi's experiment showed living leaves retain water more than non-living leaves.

The Biostructure envisioned by Macovschi that describes the difference between living and non-living systems is actually simple QED induced EM radiation produced in MTs to conserve cellular temperatures induced by metabolic heat.

Simple QED induced EM radiation allows cells throughout the human body to communicate challenges from the environment and responses to continue survival, the external challenges and responses communicated and stored in the brain through the CNS by neurons in a continuous learning process to used in subsequent interactions in the environment.

Simple QED induced EM radiation allows living systems to react to environmental challenges in the manner of learning how to respond from experience, but has nothing to do with the spiritual soul.

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