



The Super-Coherent State of Biological Water

Claudio Messori

Str. Villaggio Prinzerà 1, Fraz. Boschi di Bardone, Terenzo, Italy

Email: messori.claudio@gmail.com

How to cite this paper: Messori, C. (2019) The Super-Coherent State of Biological Water. *Open Access Library Journal*, 6: e5236.

<https://doi.org/10.4236/oalib.1105236>

Received: February 11, 2019

Accepted: February 25, 2019

Published: February 28, 2019

Copyright © 2019 by author(s) and Open Access Library Inc.

This work is licensed under the Creative Commons Attribution International License (CC BY 4.0).

<http://creativecommons.org/licenses/by/4.0/>



Open Access

Abstract

Exceptional solvent, water is the life-giving molecule on Earth: it covers about 70% of the Earth's surface, accounts for 65% of a human and 90% of macro-molecules present in biological systems. If the water did not exist, no chemical reactions, no transport of nutrients and waste, etc. would exist. In a word, without water, there would be no life. Within the range of environmental temperature and pressure, water is found in three conventional physical aggregation states plus one: solid (ice), liquid (liquid water), gaseous (water vapor) and *semi-crystalline* (biological water). Most of the models proposed to explain the peculiar properties of water start from the study of an isolated water molecule, then extend its characteristics and behaviors to the water molecules bound to it. Each model aims to predict the behavior of water in its three conventional aggregation states and subsequently verify its compatibility with experimental chemical-physical properties. Problems arise when, through intermolecular electrostatic attraction forces (short-range forces), a lot of water molecules are assembled to form the liquid phase together. None of the water models proposed to date, based on short-range forces, is able to describe satisfactorily the "abnormal" chemical-physical behavior of water. In the present work, it is presented the Quantum Electro Dynamics (QED) approach to water, introduced and developed, with the contribution of other physicists and researchers, by Giuliano Preparata and Emilio del Giudice, two Italian theoretical physicists and researchers of the National Institute of Nuclear Physics (INFN), over the last thirty years. According to QED, an essential prerequisite is that H₂O molecules possess continually fluctuating dipole moments and that fluctuating dipole moments radiate electromagnetic fields (EMF). In a two-body interaction between atoms or molecules mediated by electromagnetic field, only static fields are important. But in the general case of N-body interactions, the time-dependent radiative part of the EMF is no longer negligible and, as a result, the small individual fluctuations of many individual components may superpose coherently (in phase). A brief overview of *enantioselectivity*, *homochirality* and *autopoiesis* of biological systems, which seems to be related to the *phase transition* of water from the ordinary coherence of

its liquid state (bulk water) to the *semi-crystalline* or *glassy* and *super-coherent state of biological water*, is given. The role of *interfacial* and *intracellular water* in living organisms is discussed. The link between the overall dynamics of the living and the oscillatory rhythm of water and the related energetic events is discussed. In conclusion, the *Oxhydroelectric Effect*, *i.e.* electricity extraction from water by twin electrodes mediated by oxygen molecules, is introduced.

Subject Areas

Hydrology

Keywords

Chirality, Resonance, Biological Water, Coherent Domain, Exclusion Zone, EMF Long Range Interaction, Oxhydroelectric Effect

1. Introduction

Water is a polar molecule; it has positive and negative charges separated by a dipole length and thus exists as an electric dipole. This is due to the 104.5° angle of the hydrogen bonds to the oxygen atom. The electronegativity of the oxygen atom attracts the electron of the hydrogen atom. Thus the region about the oxygen is negative compared to the region around the hydrogen atoms, which are comparatively positive. Because of this molecular configuration, water molecules mutually attract one another due to the (–) and (+) regions.

Individual water molecules are linked by these hydrogen bonds and form what are called *clusters* (structural water). In addition, water at an interface, as with the atmosphere, has a *surface tension* due to the polar interactions of water with other water molecules at the interface surface. This clustering imparts a *crystalline like* property to the water. In the bodies of living organisms, the clusters form hydration layers around biological molecules. It is known from electronics that different patterns which contain *information*¹ result within a cluster depending upon its structure. Thus, depending on its structure, each molecule has an oscillatory pattern (resonance frequency) that can be determined by spectroscopy. It is known, through spectrographic analysis, that water and other dipole molecules are able to be entrained to exogenous oscillatory patterns by rearranging their cluster patterns. The cluster rearrangements then resonate with

¹It must be stressed out that the physical concept of “*information*” it has absolutely nothing to do with that of “*data transmission*”, and even less with that of “*transmission of messages containing a (semantic) meaning*”. The former (physical concept) consider “*information*” as a measure of coherence or structural “*complexity*” of surrounding system related to various entropic processes in physical world, that is the measure of in-formation amount, related to a certain object, may be a complexity of its internal structure (*negentropy*), while the latter (IT concept) consider “*amount of information*” as frequency characteristic of code letters-signals, that is improving of messages coding and decoding methods and solving of other questions related to optimization of technical communication systems operation.

the entraining frequency. Quantum electrodynamics calls for the existence of long range electromagnetic fields that can be transmitted by large, hundreds of angstroms, coherent domains present in water. Electromagnetic field (EMF) interactions afforded by the capacity of water to support long range EMF fields yield the specific and rapid long distance attraction of co-resonating mates.

Biological systems are thermodynamically open *transient energetic systems*, *i.e.* free to exchange energy and matter with the environment, at the phase boundary between order and chaos, whose existence depends on their capacity and possibility of exploiting an adequate external energy source (biocompatible).

Furthermore, they are transient systems tuned on *state variations* (stimuli) of the internal and external environment: their subsistence depends on their ability to adapt to (specific) applied perturbations. To adapt they must be, at first, selectively excitable. Selectivity is an essential condition for the existence of an *autopoietic system*. An example of biological selectivity is *enantioselectivity*. Biological systems are enantioselective, *i.e.* they strictly select the enantiomeric forms of the molecular species of which they consist (biological reactions synthesize and use always and only one of the two enantiomeric forms of a given molecule).

The enantioselectivity of biological systems is the reason for their *homochirality*, namely the presence of groups of molecules that have all the same enantiomeric configuration (e.g., the amino acids are all in the levorotatory configuration, while the ribose and deoxyribose of the nucleic acids have only dextrorotatory configuration).

Enantioselectivity, homochirality and autopoiesis of biological systems seem to be related to the *phase transition* of water from the ordinary coherence of its liquid state to the *semi-crystalline* or *glassy* and *super-coherent state of biological water*, the liquid medium within which the *protoplasm* (the colourless, translucent, viscid, gelatinous and semi-fluid matrix of all cells) is formed.

2. Chirality and Enantioselectivity in Biological Systems

At the ultra-microscopic level (elementary particles) chirality is given by the right-handed *vs* left-handed orientation of the spin, namely angular momentum (spin-up *vs* spin-down), and is an intrinsic property of the energetic phenomenon, which does not vary with the adopted reference system. At this level, what can vary with the variation of the reference system is not *chirality* but another property often confused with *chirality*, exhibited only by particles with mass (*i.e.* fermions), called helicity.

Helicity is the *apparent lateralization* of a massive particle, and is defined as the projection of the spin (in **Figure 1**: red arrow for right-handed spin and blue arrow for left-handed spin) along the direction of the *pulse vector* (gray arrow), the vector which indicates the direction of motion of the particle. When the projection of the spin orientation coincides with the direction of motion of the particle, the particle has left-handed helicity, on the contrary, when it is opposite to the direction of motion of the particle, the particle has right-handed helicity.

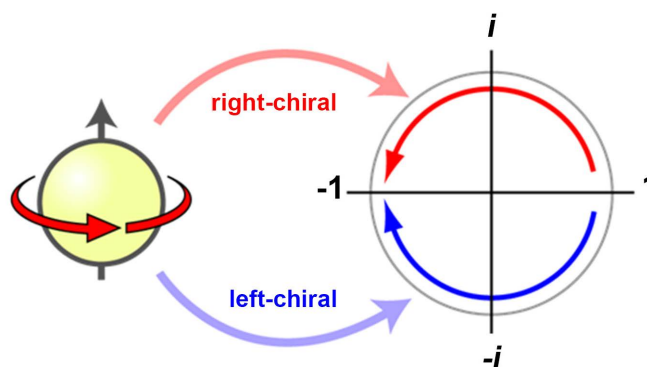


Figure 1. Image source: Tanedo, F. (2011) Helicity, Chirality, Mass, and the Higgs.

<http://www.quantumdiaries.org/2011/06/19/helicity-chirality-mass-and-the-higgs/>.

What happens when you rotate a left- vs right-chiral fermion 360 degree about its direction of motion. Both particles pick up a -1 , but the left-chiral fermion goes one way around the complex plane, while the right-chiral fermion goes the other way. The circle on the right represents the complex phase of the particle's quantum state; as we rotate a particle, the value of the phase moves along the circle. Rotating the particle 360 degrees only brings you halfway around the circle in a direction that depends on the chirality of the fermion. Only the rotation by 720 degrees is continuously connected to "doing nothing"; a rotation by 360 degrees is not.

As Matthew Evans points out [1]: *When we speak of the helicity of a particle, we are speaking of the apparent handedness of the particle, given by the projection of its spin onto its momentum vector (...). When we speak of chirality, we are speaking of an innate property of the particle, its "intrinsic" handedness. Chirality is not necessarily directly observable (...) but it is the term which appears in the mathematics of electroweak theory.*

If the particle is massless (e.g. photon), chirality and helicity coincide (a given massless particle seems to rotate in the same direction along its axis of motion regardless of the observer's point of view), that is helicity (frame dependent) decays in favor of chirality (frame independent).

At the mesoscopic (molecular) level chirality is the physical capacity of some molecules or chemical compounds to rotate to the right (right-handed form) or to the left (left-handed form) the plane of linearly polarized light. As such, chirality (molecular) is a property that can vary with the variation of the adopted reference system. The explanation of the molecular chirality is due to the French chemist Louis Pasteur, who was able to give an explanation to the property of some molecules (in 1848 Louis Pasteur discovered, almost by sheer luck, the property of *optical isomerism*, i.e. two forms of the same chemical compound, *isomers*, were found to rotate polarized light in two different directions: one to the left, the other to the right), known as *optical activity* (the ability of molecules to rotate the plane of polarized light), discovered in 1815 by the French physicist Baptiste Biot. Following the studies of Pasteur, it was discovered that optically active molecules can exist in two isomeric forms identical in number and type of atoms and structure, which are one the mirror image and not superimposable of the other (at the same way of how the right hand is the mirror image but not

superimposable of the left hand: no rotation can transform an enantiomeric form into the other, just as no rotation can transform the shape of one hand into that of the other), called enantiomers (which constitute one of the two categories of *configurational stereoisomers*), or *chiral molecules*.

The optical activity exhibited by a pair of enantiomers, given precisely by the fact that one of the two gives an angle ($-\alpha$) of deviation-rotation to the plane of polarization of the light to the left (or left-handed, of minus sign), while the other gives an angle ($+\alpha$) of deviation-rotation to the polarization plane of the light identical to the other but in the opposite direction, to the right (or right-handed, of plus sign), is called chirality, and isomers that exhibit this property are called chiral.

When a solution contains the exact same quantity of the two enantiomers of a given molecule (its left and right-handed form), the solution is called *racemic*. A racemic solution does not show any optical activity: the optical activity of the two enantiomers (their respective rotatory power), being identical but of opposite sign, is compensated annihilating, so that the polarization plane of the light that passes through the solution does not undergo any deviation-rotation, letting the light continue to vibrate on a single plane.

Pasteur also observed that living organisms synthesize and use only one of the two enantiomers and never the other. Unlike the inorganic reactions, which do not seem to show any preference with respect to which enantiomeric form is produced (in the reactions the isomers are produced in equal quantities), the biological reactions are strictly enantioselective, *i.e.* they synthesize and use only one of the two enantiomeric forms of a given molecule.

Enantioselectivity of biological systems is the reason for their homochirality, *i.e.* the presence of groups of molecules that all have the same enantiomeric configuration (e.g., the amino acids are all in the left-handed configuration, while the ribose and deoxyribose of the nucleic acids only have right-handed configuration). In the case of complex macromolecules such as proteins, for example, these can be formed only starting from the optically pure amino acids (left-handed form), and they could not form starting from a racemic solution.

Autopoiesis and Cell Autocatalytic Dynamics

In 1972, Chilean biologist and philosopher Humbert Maturana, coined the term autopoiesis (*auto* = *self*, or *it-self*, and *poiesis* or *creation*) [2] in order to give a definition of a living system that was unrelated to specific functional characteristics such as mobility, the ability to reproduce itself, or metabolism, but exclusively based on the system as such. In practice, an autopoietic system is a system that responds to the laws of non-equilibrium thermodynamics [3], that constantly redefines itself, and in its interior, supports and reproduces itself. The autopoiesis dynamics of a cell are organized around biochemical and biophysical self-catalytic patterns (Figure 2), accelerated and regulated by continuous, non-linear [4] fluctuations of selective energy transfer, between internal and external environment. Trans-membrane selectivity is the central element of the

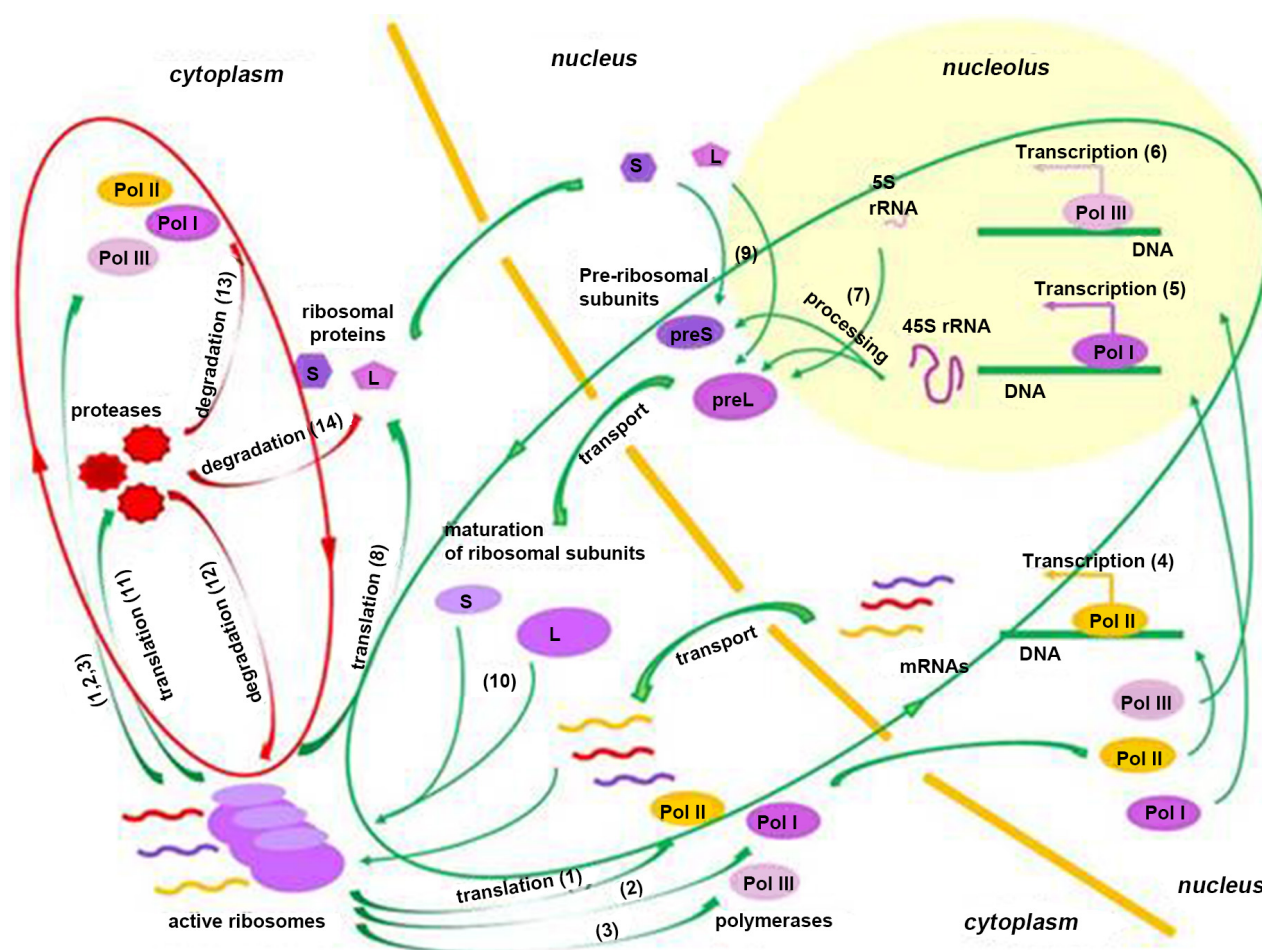


Figure 2. The scheme of a simple gene network of autocatalytic synthesis of ribosomes and degrading enzymes in eukaryotes. Credit: Likhoshvai, V. A., *et al.* (2016) Chaos and Hyperchaos in a Model of Ribosome Autocatalytic Synthesis, Scientific Reports. Image source: <https://www.nature.com/articles/srep38870>. (1), (2), (3)—polymerase synthesis (Pol I, Pol II, Pol III), synthesis of enzymes ensuring the transcription of ribosomal RNA (rRNA) and messenger RNA (mRNA); (1), (4), (8)—biosynthesis of ribosomal proteins—parts of a large (L) and a small (S) ribosomal subunits; (2), (3), (5), (6)—rRNA biosynthesis; (7), (9), (10)—ribosomal RNA processing, formation of large and small ribosomal subunits, their assembly and maturation of active ribosomes; (1), (4), (11)—biosynthesis of degrading enzymes; (12), (13), (14)—degradation of proteins and ribosomes. Synthesis processes are shown with green arrows, processes of degradation—with red arrows. Processes (1–10) imitate a positive regulation loop for ribosome synthesis (green oval); processes (1, 4, 12–14)—a negative regulation loop (red oval).

autopoietic cellular dynamic. There is a catalytic core (Microtubule Organizing Centre, MTOC) [5] [6] capable of interacting with the substrate so that it can produce the components that make up the membrane. As a result, a membrane separates this network of interactions with the environment, so that a standalone unit can exist. A cell is a continuous and recursive production of components, which through the membrane, define the cell. Although there are myriads of sub-cellular structures inside the cell, in addition to atoms, molecules, macromolecular polymers, mitochondria, chloroplasts, and so on, the properties of the components do not determine the properties of the cell, as an autopoietic system. Cell properties are the properties of relationships and interactions which are produced and that produce its components. The conventional method

(neo-positivist paradigm) of the reductive approach towards complex systems, is to break it down into smaller components. If these are still too complex, the process of decomposition continues until they become small enough to be included. In the cell nucleus alone, more than one hundred different chemical reactions have been identified, but the properties of isolated components add little, if anything, to the understanding of the operating mode of a cell. A cell, as an autopoietic system, cannot be understood by studying the properties of its components. Its properties, as a whole, are determined by the properties of nonlinear interactions between the components, *i.e.* by its dynamical organization. Trying to allocate a certain function to each component, whether it be DNA, RNA or a virus, is a reductionist artifice [7].

3. Super-Coherent Oscillatory Water Domains

Quantum Field Theory (QFT) and QED (Quantum Electrodynamics Field Theory), describes the water of which all living systems are composed, *i.e.* biological water [8]-[16], as water in a coherent oscillatory phase or state other than that of common water, named *super-coherent oscillatory state* (Figure 3).

The water (H_2O) is the third most common molecule in the Universe (following the H_2 and CO molecule), and its chemical structure, based on the hydrogen bond, it is studied long since. Many models have been proposed to explain a number of water properties considered anomalous [17] and some baffling effects, e.g. the so called *floating water bridge* [18], and among these models the most promising seems to be the one introduced by QED.

Quantum Field Theory (QFT) and QED have produced a vision of water in a liquid state as a *medium*, which for a peculiarity of its molecular electronic spectrum reveals itself as an essential tool for long range communications (a resonance phenomenon), being able to change its supra-molecular organization in function of the interaction with the environment.

In QFT it is known that the ordering of the elementary components of a system is achieved as a result of the spontaneous breakdown of symmetry (SBS)² and constitutes the observable manifestation of coherence. Ordering is thus not

²In QFT it is well known that the ordering of the elementary components of a system is achieved as a result of the SBS and constitutes the observable manifestation of coherence. According to QFT, the dynamics of a system is described by a set of field equations which are postulated to contain all the characteristic features of the system. The fields represent the elementary components of the system, e.g., the EMF, the atomic and molecular system's constituents, their electric charges, and dipole moments, etc. In general, one may consider transformations, e.g., rotations, translations, etc., of the fields such that the field equations do not change their form when the fields undergo the said transformations. The dynamics is then said to be invariant under the considered transformations, and these are named symmetry transformations of the dynamics. It may happen that under the action of some external perturbation, the state of minimum energy of the system (vacuum), is not symmetric under the symmetry transformations of the dynamics. Then, the symmetry is said to be spontaneously broken. Spontaneously means that the system is driven into the non-symmetric state by its own (internal) dynamics, not forced by the external perturbation which only acts as a trigger. SBS allows the transition from the microscopic scale of the elementary components to the macroscopic scale of the system behavior.

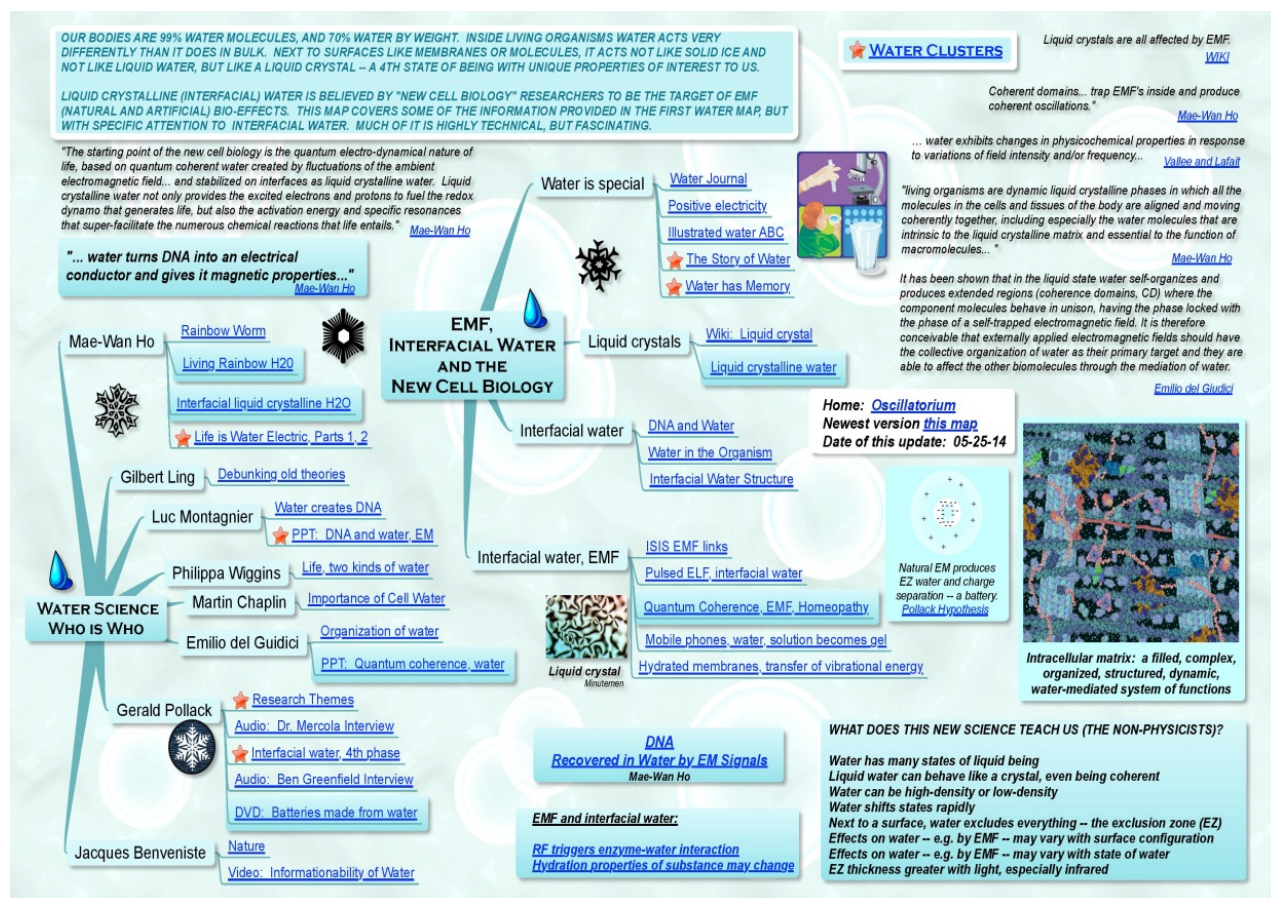


Figure 3. EMF, Interfacial water and the new cell biology. Image source: www.oscillatorium.com/id54.html.

the result of short range forces, but of long range collective coherent correlation. In the present case, the symmetry which gets broken is the rotational symmetry of the electrical dipoles of the water molecules and correlation modes are the ones associated to the dipole waves (similar to *spin waves* in ferromagnets).

The belief that *coherence* is possible only at very low temperatures is disproved by the fact that coherence is observed in a wide range of temperature, from very low to very high ones [19].

Also the so called BEC systems (which are mostly condensates of atoms) need very low temperatures and are not so stable. All these systems are macroscopic systems and they are described in Quantum Field Theory in terms of coherent Bose-Einstein condensates. The bosons that condense in a crystal are called the *phonons*, i.e. the *quanta of the elastic waves* responsible of the ordering in crystals; in the magnets, they are called the *magnons*, namely the *quanta of the spin waves* in magnets; in the water, they are called “*dipole wave quanta*” (DWQ), the *quanta of the fluctuating molecular dipole waves*, and so on.

This teaches us that the ordered patterns we observe at a macroscopic scale in these systems are sustained and generated by *long range correlations* maintained by these waves. One would never be able to construct any of these systems by using short range interaction among the nearest neighbours. Short range inte-

raction, if it is there, is made possible by the long range one which brings “near” the components (e.g., making possible the formation of H-bonds in water). Decoherence in QM would forbid the existence of crystals, magnets, superconductors, etc. However, these systems do exist and are observed since they are QFT systems.

The theoretical analysis based on QED shows that liquid water appears to behave as an active medium able to perform through extremely weak electromagnetic fields (non-thermal EMF effects). Short range H-bond and electric dipole-dipole static interactions among liquid water molecules set in as the consequence of the molecule interaction with time-dependent radiative EMF over an extended region called coherent domain (CD). Short range H-bond and electric dipole-dipole static interactions are themselves the dynamical effects caused by the most fundamental long range molecular and radiative EMF interaction. This last one is thus responsible for the dynamic origin of short range interactions.

The EMFs that are trapped within the *Coherent Domains* (CDs) of water and within their coherent matrices [20], produce electromagnetic potentials that regulate the phase of the entire system, which in turn gives rise to selective attractions between the molecules of the solute.

The Role of *Interfacial Water* in Living Organisms

The resonance phenomena induced by the EMF occupy a central role in the explanation of the establishment of the *super-coherent phase* of biological water, which in living organisms results also in *plasma membranes*, *amniotic fluid* (AF), *cerebrospinal fluid* (CSF), *interfacial and intracellular water*, the latter being considered a key characteristic that has been exploited by Nature in setting up a mechanism able to match the quite different time scales of protein and solvent dynamics [21], and a key characteristic for *intercellular signal transmission* [22] [23] [24] [25].

As Pagnotta and Bruni observe [21]: (...) *interfacial and intracellular water is directly involved in the formation of amorphous matrices, with glass-like structural and dynamical properties. We propose that this glassiness of water, geometrically confined by the presence of solid intracellular surfaces, is a key characteristic that has been exploited by Nature in setting up a mechanism able to match the quite different time scales of protein and solvent dynamics, namely to slow down fast solvent dynamics to make it overlap with the much slower protein turnover times in order to sustain biological functions. Additionally and equally important, the same mechanism can be used to completely stop or slow down biological processes, as a protection against extreme conditions such as low temperature or dehydration* (...)

In living organisms, water can be considered as *interfacial water*, due to the fact that there is almost no point in an organism that is not far more than a fraction of a micron from a surface (cell membranes, skeletons of macromolecules, etc.). The interfacial water assumes a glassy appearance and has been studied by several researchers [11] [12], suggesting the possibility that it is of a different

phase from that of common water in the liquid state [26].

In particular, it has been found that thick viscous layers of water contiguous to the biological surfaces (called EZ, Exclusion Zone), in which the solutes are not able to penetrate and whose existence in eukaryotic cells was detected for the first time by Mollenhauer and Morre in 1978 [13], remain static when the surrounding fluid is vigorously stirred [14] [15].

All biological envelopes, from cell membrane to epithelial tissue, contain this aqueous phase in a *semi-crystalline state* (likened to the *liquid ice*) or are perfused by it. It is water in a particular phase of quantum organization (*oscillatory super-coherence*) that gives it a high capacity to:

- 1) retain electronic charges, in the form of vortical excitations of quasi-free electrons, storable as energetic reserve;
- 2) induce an electronic and protonic long-range and long life excitation of the different molecular species available, enabling their selective activation and mutual attraction (\rightarrow *enantioselective absorption*);
- 3) convert mechanical vibrations (phonons) in quantum of electromagnetic energy (photons) and vice versa (piezoelectric effect).

The CDs of liquid water, unlike the CDs of other molecular species, is susceptible to give rise to a large number of excited states [27]. Arises, consequently, the possibility of a further level of coherence, generated by the collective oscillation of a plurality of CDs of water, between two own configurations: a coherence between CDs, namely *Super-coherence*, that on one hand makes it grow the size of the related region by the tenth of a micron of the elementary CDs of water, up to microns of the cells, to centimeters of the organs, or to the meters of higher organisms.

How it happens the collective oscillation of these CDs?

Given the plurality of the excited levels of the CD, it is able to withdraw from the environmental noise small amounts of energy, transforming them into coherent vortices of quasi-free electrons. The duration of these vortical excitations can be very long (days, weeks, months), since because of the coherence the internal friction is zero, there are no collisions and the CD can not dissipate energy in thermal form. Given the long duration of these excitations, it is possible to accumulate a large number of them within the domain, such as being able to accumulate a capital of 1 million euro in coins from 1 cent. Each vortex is a motion of electrons [28] [29], that is, electrically charged particles, which gives rise to the appearance of a magnetic moment, which in turn aligns with the environmental magnetic field, which in the final analysis can also be the Earth's magnetic field. The vortices therefore can not cancel each one another, but add up coherently, then transforming low-quality environmental energy (high entropy), in high quality coherent energy (low entropy), capable of inducing, as predicted by Szent-Gyorgyi, the electronic excitation of the molecules surrounding the CD. When the energy accumulated in the CD reaches the level corresponding to the energy of chemical activation of biomolecules present in the CD in the water, it

develops, for electromagnetic resonance, the energy transfer [27] [30] [31]. The CD will discharge, thus completing its oscillation, and a set of well-defined chemical reactions take place, ruled by an electromagnetic resonance law, and not by the diffusive regime based on the random motions and collisions of molecules typical of non-biological chemistry. This makes it possible to achieve two objectives simultaneously:

- it allows the oscillation of the water CDs, a necessary precondition for the onset of the Super-coherence, extending the correlation radius to biologically relevant distances;
- it creates a biochemistry not governed by random collisions between molecules, but by a code of mutual recognition and recall among molecules based on long-distance electromagnetic interaction.

The biochemical reactions become therefore selective, that is obedient to specific organic codes, and fast. Furthermore, the chemical energy released during chemical reactions once taken from the CD modifies its characteristic frequency of oscillation, causing in turn the change of the type of molecular species able to resonate with the domain. We have, therefore, a non-stationary coherent regime, but that evolves over time, generating in turn a time-dependent biochemical framework. This way, we get a qualitative agreement with the main manifestations of the living dynamic, which appear incomprehensible in the conceptual framework of a chemistry ruled by diffusive regime and by the accidental collisions. The overall dynamics of the living appears to emerge, ultimately, by the oscillatory rhythm of water and by the related energetic events.

The existence of a plurality of liquid water phases has received important confirmations [32]. Experimental evidence has been provided that by subjecting liquid water to well-defined physical treatments (e.g.: irradiation of electromagnetic waves; suspension of microspheres of inert materials; melting of fullerene macromolecules, an allotropic form of carbon discovered in 1985), special liquids varieties are obtained, which have properties different from those of common water and similar to the EZs interfacial water [33] [34]. Furthermore, a variety of water having properties similar to water present in biological organisms has been obtained by carrying out particular biological processes on common water (bulk water), essentially connected with the process of photosynthesis [16]. A result that confirms the theory supported by Szent-Gyorgyi A. [35], according to which the energy of living beings can be understood in terms of photosynthesis and its reverse process, bioluminescence³.

4. The Phenomenological Two-Phase Model of Water

The interaction between the vacuum EMF and liquid water induces the forma-

³The establishment and maintenance of biological structures is based on the process of photosynthesis, thanks to which the surplus of energy supplied by the photon to the electron in the electronic excitation is converted into binding energy. The inverse process is called bioluminescence. In this case there is a transfer of energy from a bond to an excited electron, with the consequent emission of a photon.

tion of large, stable coherent domains (CDs) of about 100 nm in diameter at ambient conditions, and these CDs may be responsible for all the special properties of water including life itself. The CD is a self-produced cavity for the EMF; the photon of the trapped EMF acquires an imaginary mass, and is therefore unable to leave the CD.

According to Giuliano Preparata, Emilio Del Giudice and colleagues, the water CD is a quantum superposition of ground coherent state and excited state (in the proportion of 0.87 and 0.13). Liquid water is therefore a two-fluid system consisting of a coherent phase (about 40 percent of total volume at room temperature) and an incoherent phase. In the coherent phase, the water molecules oscillate between two electronic configurations in phase with a resonating EMF.

To understand the phenomenological two-phase model of water, the QED approach assumes that the cluster-forming H_2O molecules are in a ground state that differs from the ground state of the isolated molecule. In this new ground state, the H_2O electron cloud is deformed, the effective radius and the dipole moment are increased, so as to generate the hydrogen bonds which stabilize the clusters. In the clusters *the water dipoles oscillate coherently, in-phase*, the clusters are *coherent domains* (CDs). Thus pure bulk liquid water consists in two interspersed phases, *coherent* and *incoherent*, having widely different dielectric constants (that of the coherent phase is 160, due to the high polarizability of the coherently aligned water molecules that are oscillating in concert; while the dielectric constant of the incoherent state is about 15). The incoherent phase comprises water molecules in the molecular ground state (as observed in the gas phase) packed in a highly dense state in the interstices around large clusters in which the water molecules perform hindered rotations and interact coherently with a large electromagnetic field.

The externally applied electric fields are therefore only felt in the non-coherent phase. Because coherent water is excited water with a plasma of almost free electrons, it can easily transfer electrons to molecules on its surface. The interface between fully coherent interfacial water and normal bulk water becomes a “*redox pile*” [36].

In line with this proposal, water EZ (Exclusion Zone) does act as a battery. According to Del Giudice and colleagues water CDs can be easily excited, and are able to collect small external excitations to produce single coherent vortices whose energy is the sum of all the small excitation energies, turning the originally high entropy energy into low entropy coherent energy, which is trapped stably in the water CDs.

This coherent energy in turn enables selective coherent energy transfer to take place. All molecules have their own spectrum of vibrational frequencies. If the molecule's spectrum contain a frequency matching that of the water CD, it would get attracted to the CD, and become a guest participant in the CD's coherent oscillation, and settle on the CD's surface. Furthermore, the CD's excitation energy would become available to the guest molecules as activation energy for chemical reactions to take place. This selectivity may be the reason why out of a

hundred different amino acids only 20 have been selected for making proteins in living organisms. There is indeed independent evidence that molecules taking part in a biochemical reaction do share a common frequency, which is how they attract each other, essentially by resonating to the same frequency.

So it is likely that the reactants are attracted to the surface of the same water CDs, where the reaction will take place, greatly facilitated by the excitation energy of the water CD. After the reaction, the energy released can also be absorbed by the water CD, shifting the CD's oscillation frequency, and hence changing the molecular species that become attracted to it, thereby in principle, facilitating the next reaction to take place in a chemical pathway.

5. Extracting Electrical Energy from Perturbed Water

A group of Italian researchers [37] [38], followed by others, have demonstrated that micron-sized supramolecular H₂O aggregates are producible by perturbing pure water (deionized and doubly distilled water), *i.e.*, by immersing a hydrophilic perfluorinated membrane (Nafion) in Milli-Q water, stirring the liquid, removing and drying the membrane, and repeating these steps. Circular dichroism spectra of the liquid remaining after removal of the membrane shows an excess of one enantiomer, that is homochirality, *i.e.*, the resulting H₂O aggregates are chiral, while bulk water is known to be achiral.

The lyophilization, or hydration, of the perturbed water produces a solid, water-soluble residue, formed by the micron-sized supramolecular H₂O aggregates having an amorphous fractal structure, which, once redissolved in pure water, carry specific signals (Electro-Magnetic Signals having specific interferential properties) of the pre-lyophilized or dried perturbed water.

Furthermore, whereas non-coherent water is an almost perfect insulator and chemically an oxidant, coherent water is a semi-conductor and chemically a reducer; the interface *coherentwater/non-coherentwater* is therefore a *redox pile* and moreover a difference of electric potential can be found across it (estimated to be included in the interval between 50 and 100 mV) [39].

On this basis, it has been developed a patented technique for extracting electrical energy from an aqueous electrolytic solution by twin Platinum (Pt) electrodes, mediated by oxygen molecules, a process called *Oxhydroelectric Effect* [40] [41], opening the way to the possibility of using this effect in practice as a new type of "solar cells" operating in the infrared.

6. Conclusions

What emerges from the new coherent solutions of QED is a completely new world, totally removed from the common intuition built upon three centuries of galileo-newtonian science and essentially agreed upon by the Generally Accepted Condensed Matter Physics' scientist of today: a world where the little balls-atoms become true matter waves, capable to interact collectively and not locally, sensitive to time-dependent electromagnetic perturbations with which they re-

sonate when certain frequencies happen to belong to their spectrum. A new scenario thus opens, totally unknown to the normal condensed matter physicist, where a new dimension, the electromagnetic one, gets unveiled and with it a hoard of new mechanisms of interaction and order for matter systems, living and inanimate. In particular the oscillation phase of the new coherent states introduces a fascinating new element, capable to suffer modulations of high physical relevance through totally negligible energy exchanges, *i.e. subtle energies*. A large effort has been made in the study of water, which has turned out to be completely different from what is predicted by the problematic bio-molecular standard models: it is organized in Coherent Domains in which the structure of molecules is completely different from the gas phase that is what Gerald Pollack called the *fourth phase of water*.

It is about time to address the problem of how the paradigm shift in condensed matter physics will finally bear upon Medicine, and in general upon our understanding of life.

This article is dedicated to the memory of Emilio del Giudice (Naples, 1 January 1940-Milan, 31 January 2014) and Giuliano Preparata (Padua, 10 March 1942-Frascati, 24 April 2000), two theoretical physicists and researchers of the National Institute of Nuclear Physics (INFN) in Milan, as a tribute to their genius in the field of high energy physics, to their ability to transfer their knowledge in the field of biology and medicine opening up new and promising research horizons, and to their contribution on how the paradigm shift in condensed matter physics can be achieved effectively and for the good of the future generations.

Conflicts of Interest

The author declares no conflicts of interest regarding the publication of this paper.

References

- [1] Evans, M. (2013) On the Discovery of Symmetry Violations and Their Effect on the Trajectory of Elementary Particle Physics Research. *Erasmus Essay*, 6. <http://mtdevans.com/wp-content/uploads/2012/12/OnTheDiscoveryOfSymmetryViolations.pdf>
- [2] Varela, F.G., Maturana, H.R. and Uribe, R. (1974) Autopoiesis: The Organization of Living Systems. Its Characterization and a Model. *ByoSystems*, 5, 187-196. <http://homepages.math.uic.edu/~kauffman/MUV.pdf>
- [3] Prigogine, I. and Kondepudi, D. (2002) Termodinamica. Dai motori termici alle strutture dissipative, Ed. Bollati Boringhieri, Torino.
- [4] Cugini, P. (2006) Biostatistica Cronobiologia Caosbiologia nella Metodologia Medica, Part III. Società Editrice Universo, Roma.
- [5] Efimov, A., *et al.* (2007) Asymmetric CLASP-Dependent Nucleation of Noncentrosomal Microtubules at the Trans-Golgi Network. *Developmental Cell*, 12, 917-930. [http://www.cell.com/developmental-cell/abstract/S1534-5807\(07\)00149-9](http://www.cell.com/developmental-cell/abstract/S1534-5807(07)00149-9) <https://doi.org/10.1016/j.devcel.2007.04.002>

- [6] Nguyen, M.M., Stone, M.C. and Rolls, M.M. (2011) Microtubules Are Organized Independently of the Centrosome in *Drosophila* Neurons. *Neural Development*, **6**.
- [7] Preoteasa, E.A. and Apostol, M.V. (2008) Collective Dynamics of Water in the Living Cell and in Bulk Liquid. New Physical Models and Biological Inferences, Eprint arXiv:0812.0275. <https://arxiv.org/abs/0812.0275>
- [8] Zhou, E.H., *et al.* (2009) Universal Behavior of the Osmotically Compressed Cell and Its Analogy to the Colloidal Glass Transition. *Proceedings of the National Academy of Sciences of the USA*, **106**, 10632-10637. <https://doi.org/10.1073/pnas.0901462106>
- [9] De Ninno, A., Del Giudice, E., Gamberale, L. and Congiu Castellano, A. (2014) The Structure of Liquid Water Emerging from the Vibrational Spectroscopy: Interpretation with QED Theory. *Water Journal*, **6**, 13-25. <http://www.waterjournal.org/uploads/vol6/deninno/WATER.2013.13.DeNinno.pdf>
- [10] Ho, M.W. (2014) Large Supramolecular Water Caught on Camera—A Review. *Water Journal*, **6**, 1-12. <http://www.waterjournal.org/uploads/vol6/ho/WATER.2013.12.Ho.pdf>
- [11] Clegg, J.S. (1982) Alternative Views on the Role of Water in Cell Function. In: Franks, F. and Mathias, S.F., Eds., *Biophysics of Water*, John Wiley and Sons, New York, 365-383.
- [12] Antonenko, Y.N., Pohl, P. and Rosenfeld, E. (1996) Visualisation of the Reaction Layer in the Immediate Membrane Vicinity. *Archives of Biochemistry and Biophysics*, **333**, 225-232. <https://www.jku.at/biophysics/content/e54633/e54639/e54665/> <https://doi.org/10.1006/abbi.1996.0385>
- [13] Mollenhauer, H.H. and Morré, D.J. (1978) Structural Compartmentation of the Cytosol: Zones of Exclusion, Zones of Adhesion, Cytoskeletal and Intercisternal Elements. In: Roodyn, D.B., Ed., *Subcellular Biochemistry*, Plenum Press, New York, 327-362. https://doi.org/10.1007/978-1-4615-7942-7_7
- [14] Barry, P.H. and Diamond, J.M. (1984) Effects of Unstirred Layers on Membrane Phenomena. *Physiological Reviews*, **64**, 763-872. <https://doi.org/10.1152/physrev.1984.64.3.763>
- [15] Pollack, G.H. and Clegg, J. (2008) Unexpected Linkage between Unstirred Layers, Exclusion Zones, and Water. In: Pollack, G.H. and Chin, W.C., Eds., *Phase Transitions in Cell Biology*, Springer Science & Business Media, Berlin, 143-152. https://doi.org/10.1007/978-1-4020-8651-9_9
- [16] Tedeschi, A. (2010) Is the Living Dynamics Able to Change the Properties of Water? *International Journal of Design & Nature Ecodynamics*, **5**, 60-67. <http://www.witpress.com/Secure/ejournals/papers/D&NE050108f.pdf> <https://doi.org/10.2495/DNE-V5-N1-60-67>
- [17] Keutsch, F.N. and Saykally, R.J. (2001) Water Clusters: Untangling the Mysteries of the Liquid, One Molecule at a Time. *Proceedings of the National Academy of Sciences USA*, **98**, 10533-10540. <https://doi.org/10.1073/pnas.191266498> <http://www.pnas.org/content/98/19/10533.full.pdf>
- [18] Del Giudice, E., Fuchs, E.C. and Vitiello, G. (2010) Collective Molecular Dynamics of a Floating Water Bridge. *Water Journal*, **2**, 69-82. <https://arxiv.org/abs/1004.0879>
- [19] Montagnier, L., Del Giudice, E., *et al.* (2015) Transduction of DNA Information through Water and Electromagnetic Waves. *Electromagnetic Biology and Medicine*, **34**, 106-112. <https://arxiv.org/pdf/1501.01620.pdf>

- <https://doi.org/10.3109/15368378.2015.1036072>
- [20] Murugan, N.J., Karbowski, L.M. and Persinger, M.A. (2014) Serial pH Increments (20 to 40 Milliseconds) in Water during Exposures to Weak, Physiologically Patterned Magnetic Fields: Implications for Consciousness. *Water Journal*, **6**, 45-60. <http://www.waterjournal.org/volume-6/persinger-summary-2>
- [21] Pagnotta, S. and Bruni, F. (2007) The Glassy State of Water: A “Stop and Go” Device for Biological Processes. In: Pollack, G.H., *et al.*, Eds., *Water and the Cell*, Springer Verlag, Heidelberg, 93-112.
- [22] Agnati, L.F., *et al.* (1995) Intercellular Communication in the Brain: Wiring versus Volume Transmission. *Neuroscience*, **69**, 711-726. [https://doi.org/10.1016/0306-4522\(95\)00308-6](https://doi.org/10.1016/0306-4522(95)00308-6)
- [23] Agnati, L.F. and Fuxe, K. (2014) Extracellular-Vesicle Type of Volume Transmission and Tunnelling-Nanotube Type of Wiring Transmission Add a New Dimension to Brain Neuro-Glial Networks. *Philosophical Transactions of the Royal Society B*, **369**, Article ID: 20130505. <https://doi.org/10.1098/rstb.2013.0505> <http://rstb.royalsocietypublishing.org/content/royptb/369/1652/20130505.full.pdf>
- [24] Agnati, L.F., *et al.* (2010) Understanding Wiring and Volume Transmission. *Brain Research Reviews*, **64**, 137-159. <https://doi.org/10.1016/j.brainresrev.2010.03.003>
- [25] Agnati, L.F., *et al.* (2014) Information Handling by the Brain: Proposal of a New “Paradigm” Involving the Roamer Type of Volume Transmission and the Tunneling Nanotube Type of Wiring Transmission. *Journal of Neural Transmission*, **121**, 1431-1449. <https://doi.org/10.1007/s00702-014-1240-0>
- [26] Del Giudice, E. and Vitiello, G. (2011) Influence of Gravity on the Collective Molecular Dynamics of Liquid Water: The Case of the Floating Water Bridge. *Water Journal*, **2**, 133-141. <http://waterjournal.org/uploads/vol2/delgiudice/WATER.2011.1.Vitiello.pdf>
- [27] Voeikov, V.L. and Del Giudice, E. (2009) Water Respiration—The Basis of the Living State. *Water Journal*, **1**, 52-75. <http://www.waterjournal.org/uploads/vol1/voeikov/WATER-Vol1-Voeikov.pdf>
- [28] Meyl, K. (2012) DNA and Cell Resonance: Magnetic Waves Enable Cell Communication. *DNA and Cell Biology*, **31**, 422-426. http://www.k-meyl.de/go/Primaerliteratur/Magnetic_Waves-Enable-Cell_Communication.pdf <https://doi.org/10.1089/dna.2011.1415>
- [29] Meyl, K. (2012) About Vortex Physics and Vortex Losses. *Journal of Vortex Science and Technology*, **1**, Article ID: 235563. <http://omicsonline.com/open-access/about-vortex-physics-and-vortex-losses-2090-8369.1000101.pdf?aid=15110>
- [30] Del Giudice, E. and Tedeschi, A. (2009) Water and the Autocatalysis in Living Matter. *Electromagnetic Biology and Medicine*, **28**, 46-54. <http://www.ncbi.nlm.nih.gov/pubmed/19337894> <https://doi.org/10.1080/15368370802708728>
- [31] Brizhik, L.S., Del Giudice, E., Tedeschi, A. and Voeikov, V.L. (2011) The Role of Water in the Information Exchange between the Components of an Ecosystem. *Ecological Modeling*, **222**, 2869-2877. <https://doi.org/10.1016/j.ecolmodel.2011.05.017> https://www.researchgate.net/publication/229327908_The_role_of_water_in_the_information_exchange_between_the_components_of_an_ecosystem
- [32] Kurcz, A., Capolupo, A., *et al.* (2010) Energy Concentration in Composite Quantum

- Systems. *Physical Review*, **81**, Article ID: 063821.
<https://arxiv.org/pdf/0909.5337.pdf>
- [33] Katsir, Y., Miller, L., *et al.* (2007) The Effect of Rf-Irradiation on Electrochemical Deposition and Its Stabilization by Nanoparticle Doping. *Journal of the Electrochemical Society*, **154**, 249-259. <https://www.tau.ac.il/~yakir/yahp/yh163.pdf>
<https://doi.org/10.1149/1.2437055>
- [34] Korotkov, K., Krizhanovsky, E. and Borisova, M. (2004) The Dynamics of the Gas Discharge around Drops of Liquid. *Journal of Applied Physics*, **95**, 3334-3338.
<http://www.biowell.eu/assets/files/papers/Water%20Oils/2004%20JAP%20oils.pdf>
<https://doi.org/10.1063/1.1651343>
- [35] Szent-Gyorgyi, A. (1957) Bioenergetics. Academic Press, New York.
- [36] Hwang, S.G., Hong, J.K., Sharma, A., Pollack, G.H. and Bahng, G. (2018) Exclusion Zone and Heterogeneous Water Structure at Ambient Temperature. *PLoS ONE*, **13**, e0195057. <https://doi.org/10.1371/journal.pone.0195057>
<https://journals.plos.org/plosone/article?id=10.1371/journal.pone.0195057>
- [37] Elia, V., *et al.* (2016) Chiral Micron-Sized H₂O Aggregates in Water: Circular Dichroism of Supramolecular H₂O Architectures Created by Perturbing Pure Water. *Water Journal*, **8**, 1-29. <http://www.waterjournal.org/volume-8/elia>
- [38] Capolupo, A., *et al.* (2014) Self-Similarity Properties of Nafionized and Filtered Water and Deformed Coherent States. *International Journal of Modern Physics B*, **28**, Article ID: 1450007. <https://arxiv.org/abs/1312.7744>
- [39] Marchettini, N., Del Giudice, E., Voeikov, V. and Tiezzi, E. (2010) Water: A Medium Where Dissipative Structures Are Produced by a Coherent Dynamics. *Journal of Theoretical Biology*, **265**, 511-516. <https://doi.org/10.1016/j.jtbi.2010.05.021>
- [40] Germano, R., *et al.* (2012) Oxhydroelectric Effect: Electricity from Water by Twin Electrodes. *Key Engineering Materials*, **495**, 100-103.
http://digilander.libero.it/kems/Cirillo_Oxhydroelectric_Effect.pdf
<https://doi.org/10.4028/www.scientific.net/KEM.495.100>
- [41] Germano, R., Del Giudice, E., *et al.* (2013) Oxhydroelectric Effect in Bi-Distilled Water. *Key Engineering Materials*, **543**, 455-459.
[http://digilander.libero.it/kems/KEMI\(2013\).pdf](http://digilander.libero.it/kems/KEMI(2013).pdf)
<https://doi.org/10.4028/www.scientific.net/KEM.543.455>