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The Origin of Life from Quantum Vacuum, Water and Polar Molecules

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Abstract: In contemporary established biology life is almost exclusively treated as a molecular phenomenon. Therefore the mystery of the origin of life is sought in molecular terms and processes. But according to certain advanced researches and considerations, life has also other essential "ingredients": active information and a special electrodynamic state of the liquid living matter characterized by coherent domains interspersed by the non-coherent ones. Coherent domains are the product of interaction of water molecules with the vacuum electromagnetic field; life has thus a special electromagnetic nature that is bound to the quantum vacuum field. This characteristic should also form the basis of the pre-biotic evolution, the phase of more or less organized liquid systems that leads from non-life to life. In this view water as an ensemble (not as an aggregate of molecules) replaces the famous DNA molecule in its importance and is seen as an active medium where the principle of active information can begin with its triumphant march from inanimate liquid systems up to contemporary highly organized organisms.

Keywords: Origin of Life, Pre-biotic Evolution, Coherent Modes, Coherent Domains, Fröhlich's Theory, Quantum Electrodynamics of Water, Active Information, Quantum Vacuum

1. Introduction

1.1. Molecular views

Until Pasterur's famous experiment that yielded the proverb "Omne vivo ex vivo" (all living from the living), the origin of life was not regarded as a problem. Biological thinkers believed into the so called *generatio spontanea*, ie. spontaneous generation of life from the inanimate matter at least at the level of microorganisms. After this Pasteur's great leap in scientific knowledge a big question began to loom large in the minds of biologists – since contemporary inanimate nature proved to have no power to spontaneously "ignite" life and there was a time in the past of the Earth when there was no life at all – there had to be a time that life emerged from the inanimate nature, i.e. from no-life. Through many years of trying to solve this new riddle three main conceptions arose:

- the emergence of life on the Earth was just a highly improbable event, never to be repeated again. It is only a high local aberration, nothing at home in the Universe. There are no laws leading nonliving matter to life, it just happened once.
- the emergence of life was due to a) a special living force or b) of God's creation. In both cases it would emerge form causes extraneous to matter in which it emerged and has evolved;
- the emergence was due to laws of self-organization of chemical processes under certain circumstances. Life's origin is therefore a law-like process (event) and could be widespread in cosmos and even in our galaxy. As any law-full physical event the emergence of life would need to have fulfilled certain conditions, after which it would appear with 100% certainty. The role of a biological scientist is then only to identify these laws.
- As the first two views leave no room for scientific experimentation, even for their own rejection, they are not regarded as truly scientific issues. The third one, however, is scientific par excellence, since it enables a scientist to make hypotheses and test them. But we are still in darkness as to any true and fulfilling mechanism explaining the path from non-life to life. There are three

main lines of search for the emergence of life, namely exploring:

- the chemical possibilities of synthesis of basic molecules our life needs for its minimal operation,
- self-organizing capabilities of autocatalytic chemical systems to have a sort of evolution,
- any forms of possible life extraneous to the Earth-bound one – exobiology, research of asteroid remnants …

In all these approaches life as well as its origin are regarded basically and almost totally as a chemical phenomenon within certain physical limits (the laws of entropy for instance). It is true that self-organizational approaches seek also more subtle entities like information, complexity, order etc., but they attach all these attributes again to chemical processes. Even one of the most modern physically based hypotheses proposed by Jeremy England [1] – arguing that life's origin obeys physical laws (entropy) and that it is highly probable, like rolling a rock downhill – is based on conviction that life is in the first place a complex *molecular phenomenon*. Yet, the exclusively chemical outlook on life may be a wrong attitude, a cul-de-sac that will never explain either life itself or its origin. Namely, according to certain well founded theories and findings is life basically an *electrodynamic phenomenon* with coherence at its roots.

If this is true, a completely new horizon for the solution of the origin of life problem is open. In the following we shall try to establish that for the emergence of life a system of coherent electrodynamic regime should sprang first. It would be bound to certain molecules, not necessarily similar to the present life's one and would gradually evolve into first life forms that would resemble contemporary life. On this path it could be led mostly by sophisticated, partially emergent (or systemic) physical laws.

1.2. Life as Organized Information

Contemporary biology is imbued with the language of information. Organisms are increasingly seen as exceedingly complex information processing systems. Basically we have two types of information: *passive*, storing organism's complexity (genetic information, seen as residing mostly in genes) and *active*, manipulative information, understood as mostly working through proteins. Of course, since even the simplest organisms are hierarchical systems information processing can work on many levels: biochemical (like already mentioned proteins), physiological (intercellular that may comprise many organ systems), behavioral or psychological (bound mostly to a complex nervous system in animals and humans). If the genetic information is mostly centralized, the manipulative, dynamic information is widely dispersed, included in a bafflingly complex arrangement of loops. From a certain standpoint this organized information that has also capacity for self propagation can be regarded as the gist of life. This was also the theme of a recent publication [2].

According to this recent consideration the starting point for the emergence of life means establishing causal powers from the side of biological information over matter, where the former is encrypted in a disperse way. In other words, the causal power of life is trans-material, but this is not about vis vitalis or mysticism, but about the *dynamically organized information*. Only partially this dispersed and organized information "resides" in the DNA. The organisms are seen here as the so called *non-trivial* duplicators, systems that can

a) multiply their organization (complex organized information) in a complex and widely dispersed way and
b) simultaneously actively process information and express a high degree of flexibility (variability).

According to this illuminative view, the origin of life means an establishment of non-trivial duplicators, capable of further potentially limitless enrichment of information and its dynamic organization. With the origin of life the information as an active principle of nature gains the ability of causation from the top to bottom (from the whole to its parts). It should be worth considering that here we are faced with a relatively new notion of information, standing far from the Shannon's information theory. As regards life, it is no more passive, just data, knowledge, records … On the contrary, in its specially organized, dynamic and vastly complex form it arises as a powerful active natural principle. It works in mater, yet is casually "above" it. Life, therefore, has its special principle that surpasses ordinary (inanimate) physical and chemical world. This principle resides in the inanimate matter as a potential – and emerges when the suitable conditions arise.

In the following I shall try to disclose an already assumed and researched organization of energy-matter in living systems that can represent the ontological basis of the above discussed active information. It is true that it may be organized through material (molecular) processes, but here it can work only in a very limited fashion, namely via short range contacts, where it is limited in its distribution and is also quite fragmented. In case of working via specially organized electromagnetic fields, it can function in a highly integrated manner, as would be expected knowing a highly integrated character of organisms or the living process.

2. Electromagnetic Nature of Life

2.1. Fröhlich's Theory

Electromagnetic fields and phenomena enter the prevailing biological thinking at most in connection with ions, electric potentials stemming from their differential distribution (resting membrane potential) and their currents. Here the integrity of the basic molecular nature of life is preserved. However, even in the seventies, an English biophysicist, Herbert Fröhlich [3, 4], began to see life as a fundamentally electromagnetic phenomenon based, of course, on molecules, but having emergent collective properties, irreducible to the molecules themselves. Fröhlich was attracted by extraordinary dielectric properties of many molecules within cells. On this basis he formed a theory about coherent oscillations. In the latest version of the theory he sees three

essential properties of the living systems: (1) they are stable but far from equilibrium, and thus they are metastable; (2) they are characterized by a nontrivial order (dynamic and nonlinear); and (3) they exhibit extraordinary dielectric properties. All three properties give rise to coherent (metastable) oscillations of endogenous cellular electromagnetic fields at frequencies around 10^{11} Hz (high microwaves). The energy for the oscillations is supplied by the normal cellular metabolism, whereas the frequency is given by the size and properties of the membrane. Here it should be stressed that the intensity of the transmembrane electric field is as high as 10^7 V/m. According to the theory, coherent electromagnetic oscillations in cells permit ordered intermolecular processes and highly selective attractions between enzymes and substrates. These oscillations, expanding as they are also among cells, represent an important means of intercellular long-range connection and thus have an important role in maintaining an intercellular order. In this connection it is interesting that, according to Fröhlich and Cooper, neoplasms (cancer) follow from the fact that some of the cells within the organism (because of certain inner transformations) escape from the covering intercellular coherent field and thus from the intercellular order [5]. If such cells are too many, the evasion becomes stable and cancer follows inevitably. As regards the emission of coherent oscillations, which could serve as a basis for their detection, Fröhlich maintains that since the usual resonant transfer of energy characterizing coherent oscillations, being almost without loss, the emission should normally be very small, achieving higher values only at defects on inner surfaces.

In spite of the postulated very low intensity emission, Pollock and Pohl [6] experimentally confirmed the emission of electromagnetic oscillations from cells through microdielectrophoresis, even if the identified frequencies were somewhat lower (4.2-9 MHz). Maximum effects of the emission were noted in mitosis, which is in harmony with Fröhlich's supposition, and they were not found with dead cells. Emission was found in all the main taxonomic groups of organisms. Species-specific aggregations of living erythrocytes into rouleaux formation represent a similar empirical support to Fröhlich's theory for a number of reasons, such as a small gap at each end of the fibrils (responsible for the adhesion of erythrocytes), or a very high species specificity of adhesion, etc. (for more details, see ref. [7, 8]. Another type of empirical confirmation of the Fröhlich-Iike fields comes from experiments relating to the influence of microwaves on organisms. Thus, Grundler and Kaiser [9] found that the irradiation of yeast cells with microwaves of frequency 40 GHz and very low power (1 nW/cm^2 or 5 pw/cm^2) clearly showed resonance effects, indicating that yeast cells have their own high-frequency field. Similar experiments with confirmatory results were also done by Wu [10].

2.2. Quantum Bioelectrodynamics

Based on the above theoretical considerations proposed by Fröhlich, an Italian group of quantum field theorists (Del Giudice, Vitiello, Preparata) developed what is probably the most profound theory of quantum bio-electrodynamics [11, 12], roughly presented as follows. Their theoretical basis for the understanding of living begins is the quantum field theory. This theory is able to predict how a macroscopic order (e.g., in ferromagnets, superconductors, etc.) can arise from the collective properties of microscopic components. Of course, the situation with organisms is rather more complicated than with magnets, since they are characterized by a highly complex and dynamic order in comparison to ordinary magnets with a relatively simple and static field structure.

According to the theory, the most important order parameter is the density of electric polarization. In this context a living being is defined as a final step of dynamic evolution originating from basic interactions within a set of electric dipoles. At a certain density of dipoles, providing there is also a constant inflow of free energy, polarization oscillations become coherent.

The quantum field theory for such a system indicates that its electromagnetic field begins to behave as a particle of very small mass and rather peculiar form, namely, as very thin filaments. All these particles build a fine filamentous network within cells, which is highly stable since it survives even some time after destruction of the underlying order of dipoles. Furthermore, it is interesting that to achieve this filamentous structure, the correlations among dipoles are allowed to be neither too strong nor too weak. Life is thus seen as existing on the boundary between order (coherency) and disorder (non-coherency) or between differently ordered domains. The filamentous electromagnetic field in organisms is not an epiphenomenon but a central entity that ensures order and coordination of chemical and (micro)mechanical processes within cells. This field should represent a basis for the synthesis and disintegration of microtubules and other microfilaments that build the cellular skeleton and locomotory organelles. If the frequency of an electromagnetic filament resonantly matches a neighbouring molecule, the latter is attracted to its outer surface and is oriented at the same time. In the filamentous field, chemical interactions are therefore ordered and interconnected through the resonance induction. The filamentous field is also important from the thermodynamic standpoint: the output energy of a chemical reaction is not dispersed since it continues travelling as a polarization wave. In harmony with Fröhlich, Del Giudice's group also postulates that the coherent field may leak only from some defects occurring on internal cell’s surfaces and that this emission should be coherent at all frequencies.

The biological electrodynamic system is abstract as to its concrete molecular basis – it should only fulfill certain dynamic systemic conditions (coherent regime in our case). If we look at the contemporary life many articles devoted to endogenous cellular coherent regime argue that there is a strong connection between coherent oscillations of the endogenous electromagnetic field (water coherent domains included) and the orchestration of chemical reactions. Within

cells a huge number of chemical reactions occur with well defined time sequences without mistakes and at rates much higher than in vitro. The high rate and the absence of mistakes imply that the underlying chemical dynamics should not be based on random collisions but on the mutual long range attraction of the molecules in a selective way that can be attributed to the coherent cellular regime, as pointed out in 2.2, see also [13]).

This theoretical thesis is corroborated by Popp's empirical findings concerning the so-called ultraweak bioluminescence [14, 15]. The filamentous field has even further peculiarities: on the lateral boundaries of the filaments, an electric current without loss (like in superconductors) is established, and this could represent a basis for the already known hypersensitivity to very weak magnetic fields found in various organisms, where the energies are too small for the phenomenon to be explained in more classical terms [16-18]. A superconducting electric current within living beings (mostly involving the DNA molecule) has also been postulated by other authors [19-21].

The ideas of Liberman, Fröhlich, and Del Giudice are combined in the work of Hameroff and other authors, who have focused their research on the organizational and informational properties of the cytoskeleton [22, 23]. Hameroff maintains that coherent oscillations of Fröhlich's type present a possibility of intermolecular cognition. Here the cytoskeleton is understood neither as a skeleton nor as a moving organelle, but above all as an information network of a cell, whose basis represents the filamentous field of Del Giudice. In a sense it is a nervous system of the cell.

Here we have supposed only some of the most important theoretical as well as empirical biophysical considerations and findings, revealing the profound electromagnetic nature of life. Although our path was completely different from the one taken by Liboff [24], it led us to the same basic conclusion: in essence, life is *an electromagnetic phenomenon*.

3. Coherent Nature of Water

Modern quantum field theory does not only unveil life as a profoundly electromagnetic phenomenon, it maintains that all liquids including water have special electromagnetic properties involving coherence. This is important for the origin of life since water is seen as a fundamental substance for organizing biochemical processes [25–28]. Consequently, the organizing potential of water bound to countless biochemical as well as biophysical processes is proposed to play an important if not totally essential role in the origin of life scenario. In the following the brief outline of the theory is presented.

In QED the following theorem can be proven (see [29] for more detail): an ensemble of a large number (N) of molecules becomes dynamically unstable when the density N/V exceeds a threshold at a temperature T below a critical value. The ensemble evolves from a gas-like configuration where molecules are independent, into a new configuration having a well-defined phase, where all molecules fluctuate in unison between two individual configurations in tune with the enveloping vacuum electromagnetic (VEM) field. The collective dynamics spans over a region (Coherence Domain, CD) whose size is the wavelength $\lambda = hc/\Delta E$ of the EM mode, whose frequency in the free space is $\nu = \Delta E/h$; h is the Planck constant and c is the speed of light. Within the CD, the field frequency ν is renormalized by the interaction with molecules to a lower value so that the squared mass of the field photons

$$m^2 = h^2 \left(\nu^2 - c^2/\lambda^2\right) < h^2 \left(\nu_0^2 - c^2/\lambda^2\right) = 0$$

becomes negative. In the above inequality ν_o is the frequency of the free EM field in vacuo, i.e. VEM field, where photons have zero mass. The consequence of the above result is that within the CD photons acquire an imaginary mass so that they are unable to propagate and appear as the cohesion energy of the molecules. The CD thus becomes a self-produced cavity for the VEM field, which fuses with the matter field of an ensemble of excitable molecules, hence giving rise to a unique field describing the collective dynamics of the molecules that behave as a single object.

Stability of the coherent configuration is kept by its lower energy level, namely by the existence of an *energy gap*, the difference in energy between an independent (non-coherent) and correlated (coherent) molecular configuration. In order to destroy the coherent configuration, it is necessary to supply the system with energy equal or larger than the energy gap (0.26 eV). At a given temperature T, thermal dynamics through the molecule collisions pushes a fraction of the molecules out of tune, so that there is a continuous balance between the coherent and non-coherent phase, as in the Landau model of superfluid helium [30]. A peculiar property of quantum field theory is that it describes the coherent state as a stable (low energy) and at the same time ordered state, having low entropy; thus *no energy is required for the maintenance of order* [31]. The reason for this is the fact that in fluid systems interactions between molecules and VEM field lowers energy of the molecular ensemble [53] proportionally to $N\sqrt{N}$, while it grows proportionally only to N. Therefore, starting from some small ensemble of molecules (water for instance) that has positive energy, as it grows sooner or later it comes to the crucial point when its total energy becomes zero (its positive energy becomes counterbalanced by its negative one due to interactions with VEM field). At that point, a phase transition occurs. The coherent oscillations of molecules in the CD no longer require any external supply of energy, and the oscillation is stabilized [53]. It may be said that VEM field stabilizes coherent domains with far reaching consequences. At any given temperature that allows liquid water there is some proportion of water molecules in coherent domains and another in the non-coherent ones; at room temperature a molecule of water spends around half the time in a coherent domain.

A specific property of water in contrast to other liquids is

that the coherent oscillation in water occurs between the ground configuration where molecules keep their own electrons tightly bound (the ionization energy is 12.60 eV) and an excited configuration where one electron is quasi-free; the energy of the excited state is actually 12.06 eV, only one half of an eV below the ionization threshold. Consequently, a water CD contains an ensemble of almost free electrons kept coherent by the underlying molecular dynamics, and which can be further excited, giving rise to coherent excited states (vortices). This allows the CD to become a physical system able to collect environmental noise with high entropy, and transform it into low entropy, high grade energy able to perform electrochemical work, implementing the Prigogine requirement of dissipativity [32, 33].

Quantum electrodynamics further predicts a picture of living matter, which accounts for a decisive role of water. Biological polymers present in the interstices between CDs are subjected to the tails of the coherent EM (evanescent) fields, protruding from the CDs. According to general theorem of electrodynamics, molecules able to oscillate at the same frequency of the CD field are strongly attracted and therefore able to react chemically [27, 28]. Hence, in an extended coherent region a diffusive regime of molecules is replaced by a selective dynamic regime, where molecules recognize and interact on the basis of frequency codes. Biological dynamics appears therefore as a close interplay between electromagnetism and chemistry, where fields are able to make the molecules interact through resonance, and molecules are able to regulate the field frequency through their reaction energies.

According to the general scheme outlined above, water molecules in bulk are predicted to give rise to CDs having size of 0.1 μ 25 In biological environments, however, these CDs are presumed to give rise to extended domains constrained by the particular level excited by the metabolic energy flow, and may extend to the size of molecular complexes, or even a whole cell or tissue [13]. Since the excitable spectrum of a CD is very rich [34], a variety of extended domains can emerge that may assume fractal (nested) architecture, as analyzed by Vitiello [35]. Extended domains [13] imply two important consequences, namely a defined size of the coherent system, and the appearance of geometrical shapes. In order to have precise frequency matching, the relative positions of reacting molecules must assume a specific spatial configuration, corresponding to biological structures[1]. When the coherence is switched off, geometrical order would break down; the system's size would no longer be defined, as it is primarily determined by the wavelength of an EM mode. Once selected molecules react chemically, the output chemical energy is absorbed by the surrounding water, which will change its frequency spectra; the previous coherent configuration is no longer possible and a new configuration emerges [13, 29].

[1] The recent experiments on photosynthetic systems provide an example where spatial arrangement of the component molecules within a coherent system must be carefully controlled in order to optimize the flow of energy [36].

4. Origin of Life Based on Active Information and Coherent States of Matter

4.1. Three States of Energy-Matter

After this short introduction with relatively new and largely ignored (bio) physical theories (at least from the standpoint of the established science) let's see how life could emerge from the inanimate matter. Our first question will be, if there is a sharp separation between life and non-life. If we identify life with the actively manipulating information (see Chapter 1.2), we can roughly say (not diving into the problem of the ontological status of the potentials, see also [37]) that the so called non-life has only a more or less remote potential for such organized (active) information, while with living organisms it is actually manifested through highly organized matter (living matter). This matter as such, regarding only its separate elements (atoms, molecules and physical forces) is just ordinary energy-matter, since only its special organization gives it the attribute of aliveness. Therefore, from this point of view (needless to say, not the only one) the separation between life and ordinary matter turns out to be the difference between the (remote) potential and its realization. The phase of evolution of a complex material system that is on the verge of becoming alive may then correspond to Kauffman's *adjacent possible* [38].

On the other hand we may just do a quick look into the vacuum field that – as we already know – has an essential role in organizing coherent domains in water. We learned that when fulfilling certain conditions, VEM field turns a portion of liquids (depending on temperature) into a coherent phase. But what with the vacuum field itself? Is it organized and if yes - how? Empirically, not a lot is known about it, but there are thorough theoretical considerations that see the state of vacuum as a sort of a superfluid, like Helium 3 close to 0°K [54]. It stems from the fact that vacuum should possess mainly pairs of particle-antiparticle and these pairs represent bosons. Since the effective vacuum temperature is close to 0°K the pairs should produce a Bose-Einstein condensate, making from vacuum a superfluid medium. Superfluid, ether-like properties of vacuum were proposed even by Einstein and were later studied by many physicists [55]. The physical vacuum can thus be considered as a strongly correlated system with dominating collective effects [54]. The nature of quantum vacuum indicates that, at least to some measure, before discussed electromagnetic properties of organisms as well as water coherent domains are very similar in nature. At least some aspects of living organization, pertaining to coherence and collective modes can thus be found in superfluid quantum vacuum. It does not mean quantum vacuum is alive, but that it has some characteristics that relate it to the living process of organisms and therefore that the VEM field is one of life's important potentials.

Therefore on the line between a chaotic non-life and the assured highly organized life we may demarcate the following three more or less distinct states (see Table 1):

Table 1. *Three phases of evolution of energy-matter systems towards (and including) life.*

	a-biotic phase	**pre-biotic phase**	**biosis**
potentials	only remote potentials for the life's appearance: VEM field, CDs in water	potentials for life's appearance become more and more direct: polar molecular systems in water solutions	potentials for life's evolution: developing organisms
coherent domains of water <=> molecules	coherent domains of liquids (water) are not in organized feed-back relations with molecular interactions of the surrounding medium	coherent domains of liquids (water) are in a partial feed-back relation with molecular interactions of the surrounding medium	coherent domains of liquids (water) are in a full feed-back relation with molecular interactions of the (presumably cellular) medium
coherent molecular oscillation	non existent or very rare	existent, but not yet homogenously prevailing through the medium	highly organized and widespread within cells and even among them
organization (complexity	organization (complexity) of the system is oscillating and is relatively low	organization (complexity) of the system is growing in an oscillatory manner, gaining in power	organization (complexity) of the system is very high and has a tendency to grow – owing to its own laws operating
active information	remote potential	gradually forming	

Therefore, the living organization does not exist only on the chemical level of complex molecular interconnected webs, but also, and maybe primarily, on quantum electrodynamicic level with the coherent regime at its basis. There is still matter composed of atoms and molecules, but their exact composition is not so important in detail as it would hold for a system based solely on chemistry. Life would therefore have three main constitutional elements: a) a highly complex (bio)chemistry – material level, b) a complex coherent regime as introduced by Fröhlich and later elaborated by Giudice et al. (see Chapters 2.2 and 3) – (bio)energy level, and c) active information working on both previous levels and integrating them into one organized, functioning whole – trans-material informational level.

4.2. The Importance and Function of Water

Among countless substances involved in life it is not the DNA that merits a primary attention (as it holds for the contemporary established biology) but water as a highly interacting system of molecules, water as an irreducible ensemble (therefore not water as an aggregate of more or less independently flickering molecules [39]. The reason for this is disclosed in Chapter 3) and rests on findings from many researchers that water is not a passive solvent of organic molecules (as understood and treated by contemporary biology) but an active, dynamic medium of living processes [28, 40]. Only every 1/100 molecule in the human body is *not* a water molecule and similar proportions characterize all life. With such strong outweighing of other molecules intra-organism water should be the most responsible for the spreading and organization of the endogenous coherent electromagnetic field that can organize countless molecular reactions within cells, as already described in Chapter 3. In other words, it seems that water is most responsible for the emergence and functioning of the active information underlying life.

On this basis we could say that as far as the Earth's life goes water was a cradle of first living beings. Taking into consideration all possibilities of water self-ordering – is it possible to say that water itself can manifest the potential of active information? Maybe not by itself although no proof of such statement is possible at present. However, this potential may come much closer to realization if water becomes surrounded by hydrophilic surfaces that greatly extend its adjacent coherent domains and if some heavier polar molecules are added into water [28]. As a specific case of this view the following prediction may be provided. Consider a tissue as an ensemble of microspheres (for instance Oparin's coacervates of Fox's microspheres [42] or some other colloidal formations) having on their surfaces a non-vanishing density of positive or negative charge. Namely QED predicts (see [29] for more detail) that coherent oscillations will induce attraction among the components of a coherent system and may completely account for the observed attraction among similarly charged spheres that form stable colloidal crystals, reaching at least 8 kT at d of about 2 μ [43].

Taking into account also the possibility that coherent domains of water can induce chemical reactions between various molecules that match its frequency, it is not difficult to envisage the possibility that water through its coherent domains plays a very important if not essential role in ensuring living organization at the intermolecular and/or cellular level. The most important characteristic of CDs is their capability to absorb (to some measure, of course) all surrounding free energy that can then be transformed into useful work without thermal losses [13, 40]. As already said, Giudice et al. (see also [56]) propose also higher level of coherent domains in water systems – the domains composed of basic CDs that could orchestrate countless molecular interactions necessary for the living process to go on.

4.3. From Water to Life

Now, let's see the most probable scenario for the origin of life following the lines of thought given in the previous chapters. First, there should be water with dissolved longer (possibly, but not necessarily organic) polar molecules of sufficient concentration. Many already proposed scenarios for the origin of life together with experiments simulating Earth primordial conditions come easily to such possibility

[44]. Therefore this shouldn't be a huge problem.

The next conditions would be a constant inflow of (Gibbs) free energy. This again should represent no serious problem as there were supposedly very intensive and frequent storms, Volcano eruptions and a relatively strong UV irradiation on the primordial Earth. Therefore, taking into account the most probable conditions on the primordial (a-biotic) Earth, to get a liquid system with coupled coherent modes of water CDs as well as polar (Fröhlich like) (macro)molecular oscillations, should not only be possible, but also highly probable (remember the finding of the Del Giudice's group that *at a certain density of dipoles, providing there is also a constant inflow of free energy, polarization oscillations become coherent*, already mentioned in Chapter 2.2). Thereby we should have got a system that is highly dynamically ordered. We can assume that this system would have been the starting point of pre-biotic evolution. For this point to be true a further condition should be fulfilled, namely it should have a direct potential for the growth of complexity (organization). This condition should have been fulfilled if the oscillating liquid had the potential for growing in chemical complexity and especially if it included some polymer species (like proteins, RNA …) that could in principle function as catalysts for reactions within the same polymer system (see Kauffman's autocatalytic net theory for more detail [45]). With more and more complex and at least partially autocatalytic chemical reactions taking place, sooner or later a coupling between chemical reactions and coherent oscillations of the medium should have started. And as it was already said in Chapter 3: … *in an extended coherent region a diffusive regime of molecules is replaced by a selective dynamic regime, where molecules recognize and interact on the basis of frequency codes*… The autocatalytic (i.e. cyclic) reactions that were in mutual support with coherent modes were stabilized in the system. This coupled reactions represented then the starting point for further, even more complicated autocatalytic cycles. The system should have been still open (i.e. with no cellularization) and the pre-biotic evolution should have proceeded via attractor basins of the whole liquid-coherent-chemical pre-biotic phase system. There was no need for Darwinian selective mechanism, so called molecular Darwinism, although there could come to some selection between different autocatalytic nets. Chemically regarded, the system should have been close to the Kauffman's supercritical system of polymers [45], i.e. it should have been very plastic, adaptive and capable of further evolution.

The pre-biotic system was therefore established in a very complex and dynamic (changeable) phase space, while its concrete trajectory should have been driven by proximal attractors in this space. Because of many more or less violent disturbances of the pre-biotic world, the system would frequently derail from its temporary shallower attractor thus having chance to find a new, deeper and therefore more stable one. One of very important attractors was the one connected with cellularization, in which the pre-biotic coherent-chemical process enveloped itself into cell-like structures. As the theory of the last universal common ancestor (LUCA) tells us [46], the membranes (probably isoprenoid like) were still very vulnerable, passable to some degree. But from the point of view of the present life's origin hypothesis, it was important that they should have had an organized electrical field on the surface as it has already been found by Pollack's group concerning the so called exclusion zones and by very interesting pre-biotic experiments having found not only something akin to resting membrane potential but something resembling even to action potential as well. Following the Fröhlich's ideas this field would further organize the by now cellular coherent regime. Somewhere here we could speak of the origin of life – of relatively stable self-organized systems, capable of reproduction and further evolution. At the point of cellularization and as far as the chemistry and the cell's "anatomical" appearance go, the system could be understood in terms of the LUCA theory. The latter only lacks the electrodynamic aspect that in our view has been essential to 1st organizing pre-biotic evolution and then 2nd stabilizing it to pass the threshold of the origin of life and 3rd remaining the essential element of the evolving life on Earth.

Regarded from the standpoint of organized "information over matter", i.e. active information, it should have started from the beginning of the pre-biotic evolutionary process. It may stem even from superfluid state of vacuum, since in the case of superfluidity its states are highly correlated, ordered. In this case, however, life could in fact be a much more cosmically widespread process than considered in conventional biological thinking. This has also been proposed by Šorli et al. [57].

The coherent oscillations regime in water solutions enabled the active information to be dispersed and stable to some measure. Coupling of coherent water regime to a rich chemical polar system enabled its evolution – evolution in a very complex and dynamic (constantly changeable) phase space with a multitude of attractor basins of various depths. The pre-biotic system should have been stable enough to ensure the continuation of the already established information complexity (richness of information content involved in the essential constituents of the pre-biotic self-organized process). This should have been connected to the appearance of extended coherent domains, strongly coupled to countless molecular interactions [56]. On the other hand it should have been sufficiently mutable to enable its further evolution, since otherwise it could have got stuck in one of the first attractors forever and no true life would follow.

5. Conclusion

As already stated in my previous publication [49] and the one of Pollack [50] life's origin is not only a chemical process, as almost exclusively treated by the established contemporary science. Following many theoretical and empirical findings on the field of biological electrodynamics as started by Fröhlich and later elaborated by some other groups, contemporary life is not only a chemical (molecular)

phenomenon, but at least as significantly a physical (electrodynamic) one, based on vacuum electromagnetic field. This basic electrodynamic character gives it much order and self-organizing powers. From the standard biological community the latter are seen as a consequence of countless chemical processes and macromolecules: genes, proteins, protein complexes etc. It is true that the contemporary life's chemistry is highly complex and organized even with the simplest organisms. However, this bases on the genetic and epigenetic continuation of this same achieved complexity. Genetic reductionists would say that the present life's complexity reflects the complexity of its genomes. Yet, when we go into a distant past and regarded retrospectively, we are challenged first with a huge problem of the origin of the genetic code, since even for its most primitive functioning it should work with almost 100% precision. This condition allows no space for any evolution from more imprecise starting points. And even if we ignore this problem and go further into the past, we come to a problem of almost the same magnitude, namely the problem of the self-reproduction of first "genes" (replicating molecules), when, following Manfred Eigen's brilliant mathematical reasoning [51] and taking into account a high mutability of possible replicators (RNA like molecules) on the primordial Earth, the replicators could have had the informational complexity of only around 200 bits (maximally 100 nucleotides long chains), while the needed informational richness of even the simplest organisms would amount to some 10,000 bits. Eigen tried to cover this huge gap between 200 and ~10,000 bits by involving processes called hypercycles that had their own problems with parasites 52, low probability, instability etc. and have already been severely criticized by many authors. This case shows that it is very difficult if not impossible to overcome the first steps in the evolution of self-replicating systems just by chemistry.

We tried to find another solution to the riddle of the origin of life, namely when the Earth's primordial chemistry did not allow complex and precise autocatalytic cycles (even the contemporary genetic code can be regarded as such cycle) the continuation of a relatively high organization of a pre-biotic system could have been ensured in a special coherent regime of polar oscillations, stemming from water and later spread on a more complex and dynamic chemical system within water. The beauty of this outlook is that the water coherent regime can be highly organized even when the pre-biotic chemistry is in its infant stage and, when leaved to it, would prove to be incapable of any growth in informational (organizational) richness. At the beginning there was neither DNA nor RNA and therefore the pre-biotic liquid (a more or less rich solution of various polar, possibly also organic molecules) had no molecules capable of semiconservative replication.

Even today, when systemic approach to understanding life (even on the genetic level!) gained much power, many natural scientists see life as based on DNA; here the famous DNA molecule plays a role of an ultimate secret, ultimate basis of life. According to many already mentioned findings and the hypothesis presented here, the present life and the pre-biotic systems have the common basis in water as an ensemble of coherent domains dynamically interspersed by non-coherent ones.

The offer of the present hypothesis is that the shift from DNA (and molecules in general) to quantum electrodynamic states of water and its solutions involving a sufficient concentration of polar (macro)molecules could a) solve the problem of the origin of life with testable working hypotheses and b) give much deeper outlook on present life with a possibility to build a rational theoretical biology that would replace contemporary views of life in terms of mutation, selection and a staggeringly complex web of organized molecular interactions, with a systemic view, where water as a special electrodynamic ensemble coupled to quantum vacuum on one side and to polar molecules on the other will play the pivotal role.

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