The interplay of biomolecules and water at the origin of the active behavior of living organisms

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Abstract. It is shown that the main component of living matter, namely liquid water, is not an ensemble of independent molecules but an ensemble of phase correlated molecules kept in tune by an electromagnetic (e.m) field trapped in the ensemble. This field and the correlated potential govern the interaction among biomolecules suspended in water and are in turn affected by the chemical interactions of molecules. In particular, the phase of the coherent fields appears to play an important role in this dynamics. Recent experiments reported by the Montagnier group seem to corroborate this theory. Some features of the dynamics of human organisms, as reported by psychotherapy, holistic medicine and Eastern traditions, are analyzed in this frame and could find a rationale in this context.

1. Introduction

Modern molecular biology has been able to produce a scheme of the living organism where most biological events are traced back to sequences of chemical reactions, ordered in space and time [1]. Such chemical reactions don't seem to occur at random, since there is no evidence of the presence of the results of molecular encounters not obeying specific chemical codes [2,3]. However the mainstream molecular biology has not been able so far to show a rationale for the appearance of such codes.

On the other hand an increasing evidence has been accumulated along the years about the role of electromagnetic fields in the biological dynamics [4,5]. Recently a group led by Luc Montagnier [6] has reported that some bacterial and viral DNA sequences have been found to induce low frequency electromagnetic waves in high aqueous dilutions. These waves are able to imprint pure water contained in nearby vessels so that similar sequences are able to grow up when the appropriate component molecules are poured in the liquid .

The problem arises of finding a dynamics including molecular chemical activity and electromagnetic fields. An intriguing feature of the electrodynamics of living organisms is the property of such organisms to respond to very weak fields, quite unable to transfer significant amounts of energy. This property has been detected for the first time in the microwave experiments. For instance in the 70's the group led by Devyatkov [7] was able to show that unicellular organisms had significant changes when irradiated with microwave fields at selected frequencies and very low intensities. The biological response didn't depend on intensity (above a very low threshold) but on frequency; each organism had its own spectrum of frequencies, possibly dependent on time, at which a microwave field was able to elicit a response. The interaction therefore seemed to imply not an

exchange of energy but a correlation mediated by the phase. The possibility of a phase interaction in biological organisms could open the way to the understanding of the class of the so called synchronic phenomena [8] occurring in living organisms, investigated in holistic therapeutic approaches and in psychotherapy where biological events are induced without the presence of significant exchange of energy.

The aim of the present paper is to try to shed some light on the above questions. Our conceptual framework is Quantum Electrodynamics (QED), which is the theory describing the interaction between the electromagnetic field and an ensemble of molecules. It has been shown recently [9,10,11,12] that an ensemble of molecules, put initially in the empty space in absence of externally applied fields, becomes unstable above a density threshold and below a temperature threshold. The system in the above conditions decays into a lower energy state where all the molecules are phase correlated among them in tune with an electromagnetic field grown up from their vacuum quantum fluctuations. This theorem could provide the rationale for establishing the interplay between chemistry and electrodynamics we have asked for above. Moreover this scheme would implement the requirements formulated more than 40 years ago by Herbert Fröhlich [13].

The article is organized as follows. In section 2. we will provide the theoretical scheme of the interplay between molecules and e.m.f.; in section 3. we will apply this scheme to an analysis of Montagnier experiments. In section 4. we will analyze in some depth the phase relationships emerging from such scheme, whereas in section 5. we will apply the above concepts to understand the emergence of an active behavior in living organisms and of phenomena which cannot be reduced to exchanges of energy.

2.   Electrodynamics of water and living matter

In this section we summarize shortly the quantum field theoretical mechanism able to produce the spontaneous emergence of a coherent electromagnetic (e.m.) field within an ensemble of molecules which become in turn coherent among them because of the interaction with the self-produced field. This phenomenon depends on the basic tenet of quantum physics that all physical objects (either matter or fields) fluctuate spontaneously. As far back as in 1916, Walter Nernst [14] wondered whether such spontaneous fluctuations of microscopic components could tune together giving rise to a macroscopic oscillation of the ensemble of components, which would become in this way phase correlated. Many decades later [9÷13] the above question has found a positive answer through the introduction of the concept of coherence, which means the property of an ensemble of components of having a well defined value of the phase in tune with a field present in the ensemble.

The physical entities Quantum Physics deals with include of course the vacuum, which is the minimum energy state of the system; vacuum too fluctuates and its fluctuations couple with the fluctuations of the components. In particular, let us consider an ensemble of molecules/atoms, which are composite systems made up of electrically charged particles (nuclei and electrons), able to show a spectrum of configurations, having each one a defined energy.

Let us consider a state q belonging to the spectrum. Its excitation demands an energy E_q

$$E_q = h \nu_q = h \omega_q / 2 \pi \qquad (1)$$

where h is the Planck constant and ν is the frequency of the e.m. mode, whose wavelength is λ, which is able to raise the atom/molecule from the ground state to the excited state by resonating with it. The probability of its excitation is governed by the so called oscillator's strength f_{0q} [15]. The ensemble of the oscillator's strengths for all possible excitations obeys to the Thomas-Reiche-Kühn sum rule [15].

$$\Sigma_q f_{0q} = n \qquad (2)$$

where n is the number of electrons of the single molecule. At the lower order in the equations (see below) the state q can be excited in two ways:

1) by direct excitation via a photon of frequency ν_q

2) by a two step excitation where a level $q' \neq q$ is excited and subsequently decays into the state q. The levels q' to be considered are not only the bound states but also the levels belonging to the continuum spectrum where one electron is expelled from the molecule; in this case the excitation energy would be larger than the ionization energy.

We will give now an intuitive argument in the simplified case that the possibility 1) only is at work. Let us assume that N microscopic units, as described above, are present within a volume $V = \lambda^3$ spanned by the e.m. mode resonant with them. According to QED there is a probability P (which can be calculated for instance by the Lamb shift [16]) that a photon emerging from the vacuum could be coupled with an isolated molecule. If there are N molecules in the volume occupied by the photon, the probability P_N that the photon would be coupled with one of them is

$$P_N = P\, N = P\, \lambda^3 (N/V) = P\, \lambda^3\, d \qquad (3)$$

It is apparent that when the density d becomes large enough, P_N reaches the value 1, namely each e.m. vacuum fluctuation is transformed into a molecular excitation. In the volume V (which from now on we will term Coherence Domain (CD)) a self-trapped e.m. field makes molecules oscillating in unison. Let us address the general problem now in mathematical terms. We single out from the spectrum a particular level q, whereas the other levels are present as mediators, as in the way 2) of excitations described above. We describe the e.m. field by its potential $\mathcal{A}$ (averaged on the directions) and the ensemble of molecules by a two-component matter field χ describing the space-time distribution of molecules; the field χ_0 describes the molecules in the ground state, whereas the field χ_q describes the molecules in the level q. It has been shown in refs. [10,11] that the interaction between the matter field and the e.m. field is governed by the equations :

$$i\dot{\chi}_0(\tau) = g\,\chi_q(\tau)\mathcal{A}^*(\tau)$$

$$i\dot{\chi}_q(\tau) = g\,\chi_0(\tau)\mathcal{A}(\tau)$$

$$-\frac{1}{2}\ddot{\mathcal{A}}(\tau) + i\dot{\mathcal{A}}(\tau) - \mu\mathcal{A}(\tau) = g\,\chi_0^*(\tau)\chi_q(\tau)$$

$\qquad\qquad\qquad\qquad\qquad\qquad\qquad (4)$

In eqs. (4) the dot means a differentiation with respect to the "adimensional" time $\tau = \omega_q\, t$; moreover we have neglected the space dependence of the fields which can be assumed not varying too much in the CD. The coupling constants which appear in eqs. (4) are connected with the two ways of excitation. The constant g

$$g = \frac{\omega_p}{\omega_q}\sqrt{2\pi f_{0q}} \qquad (5)$$

where ω_p

$$\omega_p = e\sqrt{\frac{N}{Vm_e}} \qquad (6)$$

is the plasma frequency of the ensemble of electrons whose mass is m_e , is governing the direct excitation of the level q (possibility 1)). The constant

$$\mu = \mu_0 + \mu_{cont} \qquad (7)$$

where

$$\mu_0 = -\frac{3}{2}\omega_p^2 \sum_{n\neq q} \frac{f_{0n}}{\omega_n^2 - \omega_q^2} \qquad (8)$$

$$\mu_{cont} = -\frac{3}{2}\omega_p^2 \int_{\omega_{cont}}^{+\infty} \frac{f_0(\omega)d\omega}{\omega^2 - \omega_q^2} \qquad (9)$$

is governing the two step process (possibility 2)) of the excitation of the level q. Finally eqs. (4) admit three constants of motion :

$$\chi_0^* \chi_{0+} \chi_q^* \chi_q = 1 \qquad (10)$$

$$Q = \mathcal{A}\mathcal{A}^* + \frac{i}{2}\left(\mathcal{A}^*\dot{\mathcal{A}} - \dot{\mathcal{A}}^*\mathcal{A}\right) + \chi_0^*\chi_0 \qquad (11)$$

$$H = Q + \frac{1}{2}\dot{\mathcal{A}}^*\dot{\mathcal{A}} + \mu\mathcal{A}^*\mathcal{A} + g\left(\mathcal{A}^*\chi_0^*\chi_q + \mathcal{A}\chi_0\chi_q^*\right) \qquad (12)$$

Eq. (10) expresses the conservation of the total number of molecules spread between the two levels. Eq. (11) is connected with the conservation of the total momentum Q whereas eq. (12) gives the energy per particle of the system. A deeper understanding of the above mathematics can be achieved in refs. [10÷12]. It is important to point out that the above quantities (in particular *H*) are conserved until the system keeps the same ground state; when the ground state changes as a consequence of the phase transition the conserved quantities could have a sudden jump. This is not the case of eqs. (10) and (11) but is the case of eqs. (12) where *H* will be shown to decrease.

   We will show now the mechanism of the transition of the system to the coherent state. Let us assume as initial condition at τ=0 :

$$A(0) = \chi_q(0) = O(q.\ f.) \sim 0$$
$$(13)$$
$$\chi_0(0) = 1$$

which means that all molecules are in their individual ground state and there is no e.m. field, apart from the quantum fluctuations. This situation holds only at zero temperature T. The case T$\neq$0 is discussed in ref. [10]. Let us now differentiate once more the third of equations (4) , introduce into it the first two eqs. (4) and eqs. (13). We get finally the third order linear equation describing the evolution of the system just after the initial configuration:

$$-\frac{1}{2}\dddot{\mathcal{A}}(\tau)+i\ddot{\mathcal{A}}(\tau)-\mu\dot{\mathcal{A}}(\tau)+ig^2\mathcal{A}(\tau)=0. \qquad (14)$$

We look for solutions like exp(ipτ) which express the usual oscillatory behavior of the e.m. field in the quantum fluctuations. By replacing the exponential in eq. (14) we get the following algebraic equation for the parameter p :

$$\frac{1}{2}p^3-p^2-\mu p+g^2=0. \qquad (15)$$

which admits three solutions. When these solutions are all three real, the system is stuck in an oscillatory behavior, whose amplitude is in the order of quantum fluctuations. The most interesting case is when there is one real solution and two complex conjugate ones. It is possible to realize that this occurs when

$$g^2\geq g_c^2 \qquad (16)$$

$$g_c^2=\frac{8}{27}+\frac{2}{3}\mu+\left(\frac{4}{9}+\frac{2}{3}\mu\right)^{3/2} \qquad (17)$$

From eqs. (5), (6), (7), (8) and (9) we can see that both g^2 and μ are proportional to the density d so that condition (16) is a condition on the molecule density. Equation (14) would admit a runaway exploding behavior (p having an imaginary part) when density exceeds a threshold as suggested by our initial intuitive argument. The e.m. field therefore grows up evolving toward a new configuration. It is possible to check by direct inspection [10,11] that eqs. (4) admit a nontrivial limit cycle. The physical process can be therefore summarized as follows. The system has initially the configuration where all particles are independent and the e.m. field is absent; subsequently it runs away from this configuration, driven by the exploding e.m. field and finally settles in the configuration described by the limit cycle. This limit cycle describes just a coherent situation since the fields, both e.m. and matter, have defined phases and moreover the frequency of the e.m. field happens to be equal to the difference of the frequencies of χ_0 and χ_q , which is the frequency of oscillation of the molecular system. Therefore molecules and e.m. field oscillate in tune.

Finally it is possible to show that *H* , after inserting the limit cycle fields, assumes a negative value, which means that the phase transition is a spontaneous process.

The e.m. field is trapped in the CD because in the limit cycle its frequency decreases sharply producing on the internal border a situation of total reflection. The field therefore falls off exponentially out of the CD, giving rise to an evanescent field. This field acts as a trap for surrounding molecules so that the molecule density in the coherent state increases until reaching a saturation value when the intermolecular distance reaches the value of the radius of the molecular hard core.

The above mathematical treatment could be applied to all levels of the molecule spectrum and the level should be selected for which the density threshold is the lowest, namely the first one to be encountered by the system when evolving from a low density situation (gaseous state).

Water has been analyzed [10,11] in the above QED framework and the coherent state has been shown to exhibit the following features:

1. the critical density has been found to be 0.31 g/cc [11] , in striking agreement with experiment
2. the selected level appears to be the 5d state at 12.06 eV , just below the ionization threshold at 12.60 eV. Consequently the size of the CD is the wavelength of the e.m. mode of 12.06 eV, namely 0.1 microns.
3. the coherent state is the superposition of the ground state with a weight of .87 and the excited state with a weight of .13 ; this means that in the CD there are .13 almost free electrons per molecule. Since in each CD, at the density of liquid water, there are several millions of molecules, we get about 1 million of almost free electrons per CD, a quite large number indeed! Coherent water becomes therefore a semiconductor, whereas noncoherent water, where all electrons are tightly bound to their parent molecules, is an insulator. Therefore the pair coherent water-noncoherent water would be an electric pile.
4. the situation at T≠0 has been examined and appears to be similar to the one predicted for superfluid Helium [17]. Thermal fluctuations are able to push out of tune some molecules which would therefore give rise to a gas like ensemble filling the interstices among CDs. Consequently the whole liquid is a mixture of coherent and noncoherent phases. The dependence of the relative abundances upon T is shown in ref. [18]. At room temperature the two fractions are almost equal.
5. near a wall the attraction molecules wall could decrease the impact of thermal fluctuations so that interfacial water should be more coherent (or much more coherent , like in the case of biological surfaces) than bulk water.
6. the interface between CDs and noncoherent fraction exhibits highly interesting properties. Solute molecules which are unable to penetrate the CDs because of the close packing of coherent molecules are confined within the noncoherent fraction. Those of them which are able to approach the CD surface could feel the evanescent field whose phase is well defined. According to a general theorem of electrodynamics, whose validity has been proven in Laser physics [19] , molecules able to resonate with an extended e.m. field where they are embedded attract strongly each other on a range having the size of the e.m. field. A selective long-range attraction able to account for the existence of the organic codes mentioned in the introduction therefore appears. Moreover the CD surface is a place able to release electrons coming out either by quantum tunneling or by mild external excitations. This feature could account for the huge discharges of electric charge from water droplets which give rise to lightning. Recently evidence for charge release in liquid water has been achieved [20]. This property could give a rationale for the dominance of redox chemical reactions among biochemical reactions [21]. The well known fact that this dominance decreases sharply in degenerative diseases could be considered as an evidence that these diseases imply a loss of coherence.
7. the existence of a field gradient at the interface between CDs and noncoherent fraction implies the appearance of a difference of electric potential across the interface. This difference has been calculated in ref. 22 the existence of a field gradient at the interface between CDs and noncoherent fraction implies the appearance of a difference of electric potential across the interface. This difference has been calculated in ref. [22] and found to be enclosed in the interval between 50 and 100 mV, in striking agreement with the observed cell membrane electric potential. Consequently we are forced to conclude that the membrane is the effect of the potential difference and not vice-versa as usually believed! The decrease of the value of the membrane potential should then be interpreted as a loss of coherence.
8. the presence of a plasma of almost free electrons within the CDs makes possible the excitation of CDs into higher states. The existence of excited coherent states of CDs , produced by the

formation of electron vortices, has been discussed in ref. [23]. The presence of a spectrum of CDs makes possible in principle an iteration of the procedure producing the emergence of coherence among molecules. Emergence of coherence among Coherence Domains, or supercoherence, has been discussed in refs. [24, 25] . Since the CD spectrum is not a permanent feature of the CD, like a molecule spectrum but depends on the dynamics of excitations, a large number of coherences is made possible to arise. Moreover the procedure could be further iterated and a hierarchy of coherences would appear bridging the gap between the initial CD as large as one tenth of a micron up to the largest biological organisms, passing through all the intermediate steps.

9. the phase φ of a coherent state is connected with the e.m. potential , not with the field, according to the equations [11]:

$$\vec{A} = \frac{h}{2\pi e}\,\text{grad}\,\phi$$
$$V = -\frac{h}{2\pi e}\frac{d\phi}{dt}$$

(18)

Moreover, contrary to the velocity of propagation of energy, the phase velocity does not have an upper bound. In a coherent state, contrary to the usual noncoherent situation, a change of phase produces observable consequences since could change the vorticity of the electrons and the CD spectrum. This change of phase according to eqs. (18) could be produced by the e.m. potential, without any role of e.m. fields and any exchange of energy.

3. Molecular dynamics and e.m. fields in living organisms

In this section we sketch an outline of the dynamics of living matter in the framework described in the above section.

First of all, we are now in a position to understand the physical consequence of the predominance of water (60 ÷80 % of the mass and more than 99% of the molar concentration) among the components of a living organism. The role of water molecules appears to be that of the producer of a background e.m. field able to govern the dynamics of the other biomolecules according to codes determined by the interplay of their frequencies with the frequency of the water CDs. Coherence is therefore the basic request that biological dynamics demands to water. Actually there is no point in a living organism which is farther than a fraction of a micron from a surface (either membrane or molecular backbone). Consequently we can assume that the whole biological water is interfacial water , which , as said in the last section, is almost totally coherent. Moreover, as discussed in ref. [24], this water is usually supercoherent in the sense that the water CDs are coherent among them. As a matter of fact there is experimental evidence [26] that water within cells is in a seemingly glassy state , meaning that is totally coherent, such as water at low temperature (T<220 K) [18] . As discussed in depth in refs. [25, 27], water CDs are devices able to store large amounts of energy, collected from the environment, and transform them in coherent energy; in a nutshell CDs are able to transform n quanta having a frequency ν into one quantum of frequency n ν . This happens since lifetimes of the coherent excited levels of CDs are very long [23] so that many excitations produced by the external noise could pile up in the CDs producing higher and higher coherent excitations. Starting from a very low frequency noise it is therefore possible [25] to produce high energy excitations able to resonate with the electronic degrees of freedom of molecules, activating them chemically. The following picture therefore emerges: at a given time coherent water oscillates with a particular frequency, all the molecules able to resonate with this frequency get attracted and become able to interact chemically, the energy output of the chemical reaction is assumed by the CDs which consequently change their

frequency, becoming able to attract new molecules. Electron transfer from CDs to biomolecules plays an important role in this biochemical scheme. More details can be found in ref. [21].

A corroboration of the scheme outlined above is provided by the experiments performed by the Montagnier group [6]. An analysis of these experiments in the framework of QED has been presented in ref. [28]. In these experiments highly diluted aqueous solutions containing bacterial DNA sequences are found to produce e.m. fields in the low frequency (500÷3000 Hz) interval, provided that an e.m. very low frequency (a few Hertz) noise is present; in absence of this noise nothing happens. Experimental analysis gives evidence that those fields are coming from water surrounding DNA; since water is at the origin of the observed e.m. fields it is clear that by diluting the solutions fields get enhanced.

The fields emitted by the culture are supplied to pure water contained in nearby vessels for a suitable time (about one day). When the appropriate biomolecules are poured in the imprinted water, original microorganisms appear in the solution. The fields emitted by the organisms in the first solution have induced in the irradiated pure water a spacetime distribution of the phase such that it drives the formation of similar organisms, when the appropriate biomolecules become available. These experiments appear to be not inconsistent with the theoretical framework outlined above.

4.   Dynamics of living organisms governed by the phase.

The outcome of the above section implies that in a biological system water CDs are kept coherent among them on a large scale (supercoherent) by the interplay of the frequency of their trapped e.m. fields with the energy output of chemical reactions. In this way a macroscopic phase emerges, which in general depends on space and time. This phase function is the continuation on a larger scale of the phases of the single CDs, which in principle don't depend on space in their inside. According to Quantum Field Theory (QFT) [12] an uncertainty relationship connects the phase and the number of elementary components:

$$\Delta N \, \Delta \Phi \geq \tfrac{1}{2} \qquad (19).$$

Since the optimal requirement for a living organism is the vanishing of $\Delta \Phi$, ΔN is compelled to become as large as possible. However the number of components of a living organism, although quite large, is finite so that the organism is forced, say, to go out of himself, to share its oscillation with the oscillation of the largest possible part of the environment. In this way the need of being an healthy individual compels the organism to have a dialogue with other individuals, species, natural objects. The deep meaning of each organism is therefore the dialogue with a large part of the external world, which then becomes its own Double [29]. Contrary to the objects described by Classical Physics, a coherent quantum system is not defined in isolation, but gets defined by the array of its relationships.

In conclusion the biological organism, being coherent, can interact with environment in two basically different ways:

1) through the conventional exchanges of energy which amount to the application of mutual forces. This mechanism of interaction obeys of course to the causality principle, since energy cannot travel faster than light.

2) Through the sharing of the phase with other coherent systems (biological organisms), which amounts to the establishment of a resonance with them. The phase velocity is not bounded above and can be larger than c. As we will discuss in next section, this relationship could provide a rationale to the property of synchronicity introduced by Jung [8].

Eqs. (18) tell us that the phase is connected with the e.m. potential in a mutual relationship so that we could be able to change the phase of a biological organism by applying an e.m. potential [30, 31, 32].

It is conceivable that the e.m. potential could coincide, as suggested by Mae-Wan Ho [33], with the morphogenetic field which is produced by each growing organism and govern its further development. We could interpret now the biological effectiveness of very weak e.m. and magnetic fields , mentioned in the introduction [7], just by assuming that the agent at work in the interaction is not the field but the potential and the mechanism of interaction is the phase-sharing.

Following this line of thought, it is possible now to understand the extraordinary impact of specially prepared waters [34, 35] . Let us describe the procedure of preparation reported in ref. [34]. We quote verbatim:

The following operations are performed:

1)   *1 litre of carbonated water enclosed in a 2 litre container is strongly succussed and agitated manually…..Hydrated algae and triturated leaves are dropped in the succussed water.*
2)   *The mixture of water and vegetables is succussed again 100 times whereas constantly illuminated by the light of the bulb lamp. Subsequently it rests for 45 minutes, still illuminated. This is the necessary time for the photosynthetic system to reach the peak of self-adaptation.*
3)   *The mixture is poured in the transparent vessel. This system becomes the environment able to imprint the plate of glass or plastic. The imprinting is performed as follows. The plate is heated in an oven (up to 200° centigrades in the case of glass and 80° in the case of plastic). The heated plate is hit by the lamp light beam, which has traversed the vessel containing the mixture. The exposition is kept until the plate cools down to the room temperature. This procedure is assumed to produce the imprinting, namely to induce the transition of the inner configuration of the plate to a coherent excited state.*

It is important to stress the following important points in this procedure:

1) a large number of vegetal species is necessary in order to have a highly nontrivial phase function; this accounts for the important role of biodiversity for the health of each individual

2) the irritation of the vegetal leaves is meant to increase as much as possible what could be termed "the instinct for survival" of each species so that their coherent activity is strongly enhanced

3) water receives all these phase signals and modifies correspondingly its own phase distribution

4) because of the long life-time [23] of the coherent excitations of water, this imprinted phase lasts a long time

5) when this phased water is put in contact with another coherent system, in particular a biological organism, shares its phase with it.

In order to store the phase of this special water for a long time glassy materials are imprinted which in turn are used to imprint water and biological organisms when necessary. The mechanism of such phase sharing has been checked experimentally. We quote again from ref. [34]:

The qualitative measurements of the heats of mixing have been performed in the Department of Chemistry of Naples University in the laboratory of Prof. V. Elia by using a flow-mix calorimetry (LKB standard flow microcalorimeter at 25°C with a sensitivity of 0.1 μW). Two vessels, one containing a solution of Sodium Hydroxide and the other containing demineralised water, are connected by a two way peristaltic pump with the calorimeter where the two fluids mix in a cell whose temperature is carefully measured. The heat of mixing is derived by the observed variation of temperature. This procedure allows to have the value of the heat of mixing in real time. By observing this power-time graph we can see that in a normal case we have a transient phase and a stationary phase. If the instrument parameters don't change with time, the stationary phase is represented by an horizontal line, that could last a very long time. A change in the nature of the tested liquid would

imply a new stationary phase that would correspond to the heat of mixing of the new fluid. Should the two mixed fluids be identical, the power-time graph would coincide with the baseline.

In Figure 1 the power-time graph shows the outcome of our experiment. We start with normal demineralised water. The arrow 1 denotes the start-up of the experiment. As expected the first part of the graph shows the reaching of the stationary value of the heat of mixing of normal water. At the time marked by the arrow 2 an imprinted plate is slipped below the vessel containing normal water, without the occurrence of any exchange of energy between the plate and the vessel. The graph shows an instant decrease of the heat of mixing, as if water had changed nature! At the time denoted by the arrow 3 part of the water in the vessel is extracted by reducing its volume to 20 ml. A sharper decrease of the heat of mixing is got, indicating a new reorganisation of water. This result is surprising since an intensive quantity as the molar heat of mixing seems to become an extensive one. In conclusion the observation can be summarized as follows: the heat of mixing decreases when water is in contact with the "informed material", which means that presumably a flow of information and hence of negentropy has occurred. The amount of the decrease depends on the volume of water….
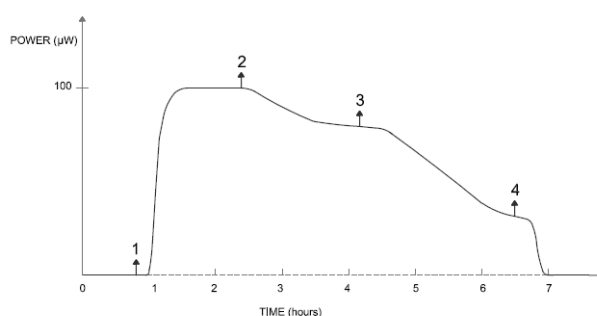
Figure 1

As a control at the time marked by the arrow 4 the plate has been removed and the vessel of water has been replaced by a vessel containing the same titrated alkaline solution. The graph recovers the initial baseline showing that no variation has occurred in the sensitivity of the detector. It can be observed also that the sensitivity of the calorimetric device (0.1 μW) is very high in relation to the differences of the power values between normal and treated water (in the scale of 100 μW), as can be seen in the curve of the calorimetric graph; hence it can be assumed that the phenomenon is real.

This experiment suggests that the phase relationship between coherent systems is a physically sound concept.

5. Evidence of a biological interaction depending on phase

In this section we will exhibit some evidence of phase relationships between living organisms, extracting them from the tradition of healing techniques belonging mainly to the Eastern medicine, but widely spread today in the West, too. In the Japanese tradition Hado is the innate transforming power of each thing and each living being. "Shiatsu" means "finger pressure" and indicates a discipline connected with traditional Chinese medicine. Hado Shiatsu is a therapeutic approach based on "empathetic connections", that means "resonate with" namely the onset of a phase resonance between the therapist and the patient. In this approach results happen without any physical or mental exertion. A sort of "meditative state", where phase is no more chaotic, tunes the phases of the therapist and the patient, between them and with healthy environment. A better life quality is then supported by a sharper definition of the phase of each organism. In this interaction the connectedness of the organism is essential, not the amount of exchanged energy, which could on the contrary be harmful when its amount exceeds the threshold of the "energy gap", namely the amount of energy necessary to make the coherent system boiling and therefore losing coherence.

Important changes are consequently induced in the organism by very gentle touch and very small stimuli. This fact is in agreement with the Weber and Fechner law [36], which states the proportionality of the response of a living organism to the logarithm of the stimulus. Consequently very small stimuli induce very large negative responses, namely responses directed inwards. This law can be understood in the frame of a quantum interaction based on a phase exchange instead of an energy exchange.

It is worthwhile to observe that coherent fields, and hence the phase, are trapped in the coherent regions of water which are present mainly around the long chains of macromolecules; these chains are the microtubules in the cellular medium whereas in the extracellular medium are the chains of the collagen. Should we identify the phase of the field travelling along the shells of water surrounding the chains with what the Eastern tradition calls Qi, which is considered the acting principle of life, then the above water shells could be coincident with the meridians of the Eastern tradition. This point of view has been recently suggested in refs [37, 38].

In the framework of a biology based on coherence, the health of an organism depends on his ability of constructing a well defined phase during the mainly unpredictable vicissitudes of life; the phase has of course to change during the experiences of life but the organism should always be able to have a well defined phase. The external stimuli should always give rise to well defined changes of phase. When this happens, we say that this organism is able to self repair. The capability of self repair of an organism is enhanced by the presence of a well defined phase in what we have called his Double, namely the part of the environment he is connected to. This property coincides just with the Eastern concept of Hado. The connection of the organism to this phase, which could come from loving fellows, from plants, animals, Nature as a whole, but also by dreams and ideas which are the coherent manifestation of a coherent organ, the brain, would give him the ability to self repair.

In a therapeutic setting [39, 40], the therapist acts as a main part of the Double of the patient (transfer), and in some sense also the opposite occurs (counter transfer). They should give rise to a phase relationship, so no exchange of energy is needed, but only a touch expressing the mutual connection of the two. Should the two phases tune together, the phase of the patient, which is disturbed by the loss of coherence produced by the illness, becomes more clearly defined and a process of recovering starts. However, in case of severe diseases, the chemical structure of the organism could become so modified to be unable to resonate with his background water; in these cases of course a chemical repair seems to be necessary. The therapist, for example through a gentle touch, supports his patient to resonate with the environment, namely to dialogue with it. Being a resonance, both partners are on an equal ground, so that the therapist could feel in his own body the phase of the patient, disturbed by the disease. Without any talking or "objective" test, the therapist is able to feel the disease of his patient and to direct his attention to it. He is therefore able to talk to the disease of his patient, who in turn can reply to the therapist in their established correlation. The human strategy

outlined above could be always supplemented, and in extreme cases replaced, by artificial means able to deliver a defined phase, such as weak magnetic fields (Magnetotherapy), the phased water described in the last section, low intensity microwave irradiation and so on.

Physics of coherent systems suggests the opening of new horizons to Medicine.

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