

EMERGENCE OF SELF-ORGANIZATION IN AQUEOUS SYSTEMS AND LIVING MATTER

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Abstract. Intermolecular interactions in living beings take place not as individual and independent events, but as components of a collective net of related events. The issue of these collective dynamics with related bio-communications can be found in the settings of Quantum Field Theory (QFT). Here, bio-molecules acquire the ability to move in an interrelated manner. The interrelation is comprised of a mutual phase agreement between molecules that are tuned with an electromagnetic field of their own production. Interestingly, this set exhibits a fractal structure, meaning a structure that is characterized by self-similarities which allow every part of the structure to reproduce the whole. Moreover, the fractal structure present in water displays a state of harmonization among the frequencies of various oscillatory movements similar to those that can be found in a music score. All signals underlining the biochemical order of living matter is a spontaneous result of molecular dynamics, exhibiting an intrinsic signified. In biologic dynamics, the signifier, meaning the set of electromagnetic signals, is unified and the same as the signified, meaning the set of biochemical reactions they generate. In this specific sense, by identifying the function with the dynamical behavior of the system, and the structure with the agents producing such dynamics, which in turn binds the same agents in a coherent motion, we observe that in biological systems the distinction between structure and function disappears. If an oscillatory stimulus of external origin enters this dynamic scenario, the evolution is stimulated. Its nature will not be determined entirely by the structure of the provided signal but will also be dependent on the structure of the system (Milieu) on the receiving end of the signal and on its history. Following, the external signal does not provide information in the sense of the conventional theory formulated by Shannon but is a stimulus for the development of the organism's spontaneous dynamics

INTRODUCTION

The difference between living and non-living matter is intuitively clear. Until recently though, the dynamics giving origin to these two types of matter have been not clear. However, the study of living organisms though, has brought to

light some unique characteristics that allow to highlight the difference between living organisms and non-living physical ones, albeit highly organized systems.

The living organism – the components of which are for the most part made up of water molecules – is capable of snatching, storing, and making use of energy in a coordinated manner in every part of the organism. It is capable of sustaining high level of organization during the whole of the process. The use of energy mentioned above takes place thanks to cyclical processes recognizable by biological rhythms the oscillatory periods of which may last seconds as well as centuries. These cyclical processes are mutually related; from one cycle to the other we observe energy exchanges taking place. From a thermodynamic point of view, these cyclical processes occur at small oscillating changes of entropy, which allows the system to sustain its organization. Entropy is a function of the number of arrangements of the microscopic components of the system determining its ability to evolve in time. A high level of entropy corresponds to an elevated level of internal disorder, whereas a physically ordered system will manifest a low level of entropy. A very low level of entropy component guarantees that greater part of the total energy will acquire the nature of free energy, capable of work. A detailed discussion of these aspects may be found in an interesting article by Mae-Wan Ho [1].

This result implies the existence of a relationship between the parts of the living organism even when separated by great distances. This relationship though is not sustained by a flow of energy, something that would require the organism to pay a high price energy-wise. The correlation inherent to the living organism is instead sustained by a typical quantum mechanism. The explanation in mathematical terms of the physical property by which quantum fluctuations, described by the physical variable called phase (intuitively associable to the rhythm of oscillation), are not observable implies that equations of motion must not vary from arbitrary phase changes.

It has been mathematically proved that this invariance requires the introduction of a new field, called gauge field by physicists, characterized by invariance properties in relationship to unique physical transformations that allow for compensation with phase transformation. It is possible that this gauge field must obey equations corresponding to Maxwell's equations that describe the electromagnetic field's potential. We can therefore conclude that quantum fluctuations of the atom cannot be observed directly because they get diluted over the whole space-time as a result of electromagnetic potential spreading them at phase speed, fully capable, as explained in subject literature, of exceeding the speed of light, the maximum speed energy can travel at. Phase speed, and consequently with it, the speed at which quantum fluctuations will spread, is capable of infinite magnitude.

The set of quantum fluctuations characterizing the components of a complex system can be of two different kinds. In the first kind, these fluctuations are not

reciprocal in tune, they remain unrelated, producing very little on a global scale with oscillations values reading close to zero. Though, it is also possible that these fluctuations tune in together via a non-null gauge field acting as a correlation agent for the components. This correlation is not connected to a transmission of energy though as much as the sharing of an oscillatory rhythm (called phase in physics) [2]. A metaphor possible to describe such a state (called coherent state in physics) of the physical system is that of an orchestra comprised of many players, each equipped with a specific instrument. If lacking coordination, the ensemble of sound emissions generated by the musicians would produce the noise that can only turn into music in the presence of a conductor capable of tuning the emissions of the individual players together. To reach such a result, the conductor does not emit any kind of energy to the musicians, each solely in charge of their own sound emissions, to which the energetic content is related. The physical quantity emitted by the conductor to the orchestra is not the energy but the phase

This metaphor is not perfectly adequate in describing what happens in a coherent physical system, though. We can see the metaphor showing the conductor as being separate from the players while in a coherent physical system the development of a well-defined collective phase is a spontaneous process generated by the self-organization of the system [3]. In the setting of the quantum field theory (QFT) the following theorem has been proven [4]: a set of microscopic components (atoms and/or molecules) endowed with multiple internal configurations transits from a state by which the components are independent to a state characterized by lower energy levels wherewith a coherent relationship between them is established when the temperature is lower than a critical reading and the density exceeds a threshold. An intuitive view of theorem mentioned above is furnished in ref. [5] and may be summarized as follows: the atom (or molecule) the dimensions of which read in the Angstrom rank (i.e. 10^{-8} cm) requires the energy amount of some electron-volt (eV) to translate from one configuration to another. This transition may be induced by a fluctuation of the electromagnetic field of the vacuum, manifesting itself as a virtual photon the energy of which will correspond to the energy necessary for the configuration leap to occur. The size of this photon is defined by its wavelength, that amounts to about a thousand Angstrom in our example. In other words, the size of the object (the photon) capable of changing the configuration of the atom is thousand times greater than the size of the object (the atom) to be transformed. Given the usual density of gases in the environmental physical conditions on Earth, the photon emerging from the vacuum may hold in its volume thousands microscopic gas components. We will label such number as N and call P as the probability of the atom's capturing such photon emerged from the vacuum (a value that may read about 10^{-5} based on quantum electrodynamics): the probability that the photon be captured by at least one of the material components is $P \times N$. Should N be high

enough that this factor turns out as 1, the photon is permanently captured by the microscopic components and has no possibility of being emitted back. The set of particles turns therefore into a trap for electromagnetic fluctuations of the vacuum, giving origin to an electromagnetic field trapped by the set of particles and oscillating in phase with it. The result is a resonating system showing those microscopic components which are located in the region corresponding to the volume of the photon (defined in ref [4] as coherence domain), collectively oscillating between two individually defined configurations at the rhythm of the entrapped electromagnetic field. In agreement with an electrodynamics theorem [4, 5], each particle capable of resonating with this common frequency of the atoms and the electromagnetic field is strongly attracted inside the coherence domain. The entrapped electromagnetic fields are therefore responsible for the ordering of encounters between the molecules at the origin of chemical reactions. This ordering takes place via a frequency code by which only those molecules resonating with each other and with the entrapped electromagnetic field are strongly mutually attracted at great distances. The mechanism of molecular encounters, based on random movements of molecules and their fortuitous meetings, so far thought of by biochemists as the model for the dynamics of chemical processes, is thereby substituted with a mechanism by which molecule encounters inside the coherent region, determined by the electromagnetic field.

The coherent state shows energy lower than this of the original non-coherent state and physicists call it the difference energy gap. This quantity must be compared with the energy originated by thermal collisions between atoms, which, over a threshold quantifiable by the methods of statistical mechanics, severs the phase concordance between the microscopic components typical of a coherent state. Therefore it seems logical why coherence may exist only below a given temperature. In the case of living cell, observation shows that the temperature range in which the coherent cell functioning occurs without being critically perturbed by thermal fluctuations, is relatively wide. On the other hand, it has been also observed that coherent dynamics underlies photon transfer in photosynthesis process at physiological temperature [6], so that we may safely infer that standard environment temperature is not enough to force the living cell to leave their coherent dynamical regime. Moreover, the well known decoherence phenomenon of Quantum Mechanics is not active in Quantum Field Theory. For example, condensed matter physics systems, such as crystals and magnets lose their coherence at quite high temperatures (the melting temperature of a diamond is 3550°C). On the contrary, the critical temperature of some so-called high-temperature superconductors is as low as 92 K.

Amongst all atomic and/or molecular species, water takes on a unique role seeing as in its case the two configurations between which the coherent oscillation takes place are that of minimum energy where all electrons are strongly bound to the nuclei and an excited one where one electron per molecule is just

almost free. The coherence domain of water is therefore a *reservoir* of almost free electrons capable, because of coherence, of collective plasma oscillations (vortices) in case of external input of energy. The range of excited states corresponding to the collective oscillations of almost free electrons has been calculated. The possibility of further coherence on a wider scale is therefore manifested, in which the role of the microscopic components is played by the coherence domains of water. A set of coherence domains, the size of which is the wavelength of the electromagnetic field responsible for the correlation sprung among domains now gives rise to the coherence “super-domain” among coherence domains. The set of almost free electrons of the super-domain gives rise to an additional range of excited states capable of generating one more degree of coherence, etc. A hierarchy of coherence domains is therefore created, characterized by levels nesting each in the previous one, covering a wide interval of space-time scales, ranging in the space level from the tenth of micron of coherence domain among molecules to the meters proper for higher correlations and in the time frame from the very long lives of small coherence domains, inherent to the quantum fluctuations of the vacuum, to the shorter lives of higher correlations, fed by the environmental electromagnetic fluctuations. Each elementary component of the organism is therefore part of an ordered sequence of coherent oscillations, the whole of which covers a very wide scale corresponding to the set of oscillation sizes and rhythms of the microscopic structures to which the given component belongs. Therefore in water we can observe the birth [7] of a complex vertical structure of coherence domains, each nested in the previous one, giving origin to a hierarchy parallel to that which can be found in living organisms (organelles, cells, organs, apparatuses, tissue, individuals, species). At a practical level, it was found that it is possible to obtain, starting from normal water, super-coherent water in which the aforementioned phenomena could be observed [8]. The observation of the oscillations in the electromagnetic potential inside water that was permanently turned coherent, opened up the possibility of reading the structure of the oscillations. This structure was found characterized by fractals [9]. Fractals are mathematical structures in which every part of the structure is endowed with the peculiarities of the whole, meaning it is not possible to determine from the inside of the structure itself at which level of the ladder one is positioned. This result is extremely important in view of a theorem connecting fractal structures to coherent states [10], by which a fractal structure may be associated with a coherent state at the level of dynamics in the elementary components of the system.

The examination of fractal signals that can be found in aqueous systems brings to light the existence of correlations between the frequencies of the different coherence levels the system is comprised of. All these frequencies turn out to be similar to a music score. Therefore the set of electromagnetic oscillations of the coherence domains takes on two aspects. On the one hand it governs the

encounters between the molecules present in the field and determines the construction of the structure as a consequence. On the other hand, when viewed as a whole, it is, by our metaphor, a melody the content of which is the procedure underlining the construction of the structure itself: the latest manifesting on the outside by virtue of this inner music it has. This is that overlap between signifier and signified previously mentioned, attributing to music an intrinsic meaning to the music. Any oscillation resonating with this inner music of the organism bears its significance, while a non-resonating oscillation will be of no interest to it, therefore non-significant. By identifying the function with the dynamical behavior of the system, and the structure with the agents producing such dynamics, which in turn binds the same agents in a coherent motion as just mentioned, function and structure turn out then to be a unit [11]. An electromagnetic signal supplied from outside of the coherent structure does not need to bear an informative content corresponding to the mutation it stimulates in the structure. As a matter of fact, a signal capable of modifying any one element of the coherent hierarchical structure will determine an overall dynamics that will provoke mutations well beyond its specific content; this takes place because the coherent structure bears an intrinsic meaning capable of dialoguing with the external stimulus. Therefore, what is usually referred to as biological information is characterized by a different nature from the information covered in the theory of Shannon [12]. In the theory of Shannon, both informant and informed are passive objects incapable of self-organization, meaning the informative message must bear all of the details relating to the operation that will be put into motion, since that which will be informed cannot intuit them solely based on its own internal dynamics.

A confirmation of this last comes from the experiments led by the group under the guidance of Luc Montagnier [13], Nobel for Biology and Medicine in 2008. In these experiments, segments of DNA taken from microorganisms are suspended in water. When the degree of dilution, i.e. the quantity of water present, is over a certain threshold, low frequency electromagnetic signals appear, confirming the relationship between molecular dynamics and electromagnetism previously mentioned. These signals can be recorded and delivered by telematic means to a second distant laboratory, so as not to risk molecular contamination. The receiving laboratory will deliver the signals to a container of pure water. After a given time of exposure, a PCR (Polymerase Chain Reaction) kit, a set of all monomers comprising the DNA, along with a suitable catalyst (enzyme) is poured in the vessel. Surprisingly, in a very short time the original DNA appears. The final aqueous system has therefore built a structure as complex as DNA starting from an electromagnetic signal of much lower complexity.

We must therefore believe that the physical system based on water can generate a spontaneous dynamics capable of building up from relatively simple stimulus into highly complex structures, it is in other words a system that has the

ability to generate knowledge. The physical system is in other words capable of being “aware”, starting from its own internal dynamics, of the full potential of the signal received, even when its informative content is clearly limited. Can we then think of ourselves as being on the brink of understanding those dynamics capable of generating a psyche out of matter?

APPLICATION

Let us deal with some consequences of this Quantum Theory on the physiology of human beings.

When the human body is analyzed from an anatomical view, it can be described in separated parts. From the point of view of Far East Traditional Medicine, it is the result of a dynamic vital force called Ki or Chi, that flows among all tissues and organs of the body.

Meridians are defined as channels where Ki flows. Health is considered connected with a free and balanced flowing. Following this idea, different therapeutic approaches, using needles or pressures, want to reestablish Ki circulation all over the human body for improving health.

In the context of a quantum approach, the network of connections takes on relevant importance. We envisage the meridians as a particular form of coherence domain in the connective tissue, a sort of aqueous sheath encasing molecular chains [14].

The nature of this system is intrinsically dynamic. Correlations of different oscillations define properties connected with system functioning. So human health has to be seen in a collective view and is connected with the degree of coherence of the organism, depending on the phase correlations of different parts, not on the amount of the energy of the system [15].

To support this possibility very small stimuli are sufficient because they help the system to reorganize [16].

This kind of approaches include the onset of a link between the phases of the practitioner and the patient, so that the phase dynamics of the former affects the phase dynamics of the latter in the absence of any significant flow of energy.

This linkage allows some information to be shared without any brain interference. We are talking about no cerebral knowledge, we are in a sort of connection and field resonance where the therapeutic role is to testify healing processes to happen.

In the Japanese tradition Hado is the innate transforming power of each thing and each living being. The word “Shiatsu” means “finger pressure”. It is a discipline developed in Japan and connected with Traditional Chinese Medicine, martial art and meditation.

Hadoshiatsu is a therapeutic approach that uses the new meridian model inspired by Quantum Physics, named above [17]: thanks to the self- organization of the living system, an array of quasi-one-dimensional coherent domains appear. This array can be linked with functioning of energetic channels known as meridians in the Eastern medicine [18, 19].

The way of communication among energetic fields of different human beings depends on phase correlation. On the other side, external information are stimuli for the development of organism's spontaneous dynamics.

Hadoshiatsu is based on "empathic connections", that means phase resonance not energy exchange. A sort of "meditative state", where phase is no more chaotic, will allow both givers and receivers to be in phase also with healthy environments. We can envisage how important is for human beings to live in places with low levels of pollution for keeping in good health.

Through experience we learned that empathetic connections allow results to happen without any physical or mental exertion, that happens when we are in a relationship based on energy exchange. A better life quality will be supported, enhancing the coherence of the system.

If we espouse this vision of human systems functioning, we cannot talk any longer about Energy Medicine. Phase Medicine sounds more appropriate.

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