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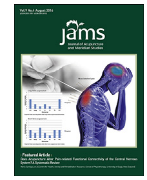

Perspective

Modeling Meridians Within the Quantum Field Theory

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Abstract
We present here a model of meridians in the formalism of the gauge theory paradigm of quantum field theory with spontaneous breakdown of symmetry. We discuss the origin and dynamic self-focusing propagation of the electromagnetic field in coherent states and the role it plays in our meridian modeling. Within this frame, we consider the formation of solitary waves on proteins and anatomical filamentary structures and discuss non-dissipative energy transport. Finally, we analyze the relation of meridians with anatomical filamentary structures, the reciprocal actions between meridians, and biochemical activity and the key role played by free energy, internal energy, and entropy.

1. Introduction

One common characteristic of the Traditional Eastern Medicine is the holistic, integrated vision of body and mind, not two separated facets, rather two entangled resonating expressions of the human being. In such traditional approaches, the cure of the health and its preservation are based on *meaningful* actions which are modulated according to the different finalities and objectives one wants to reach. Specifically, we are here interested in the

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approaches, disseminated throughout China, Japan, India, Korea, and other Eastern countries in Buddhist, and Hebrew medicine, that are centered on the concept of special channels carrying flows of energy or Chi/Ki/prana called meridians or nadis (see e.g., [1]).

These meridians are thought to develop their filamentary paths through the connective tissue and are identified by specific points, which in hundreds of years of practice have been found to have specific therapeutic properties. It is interesting to comment on the Chinese ideograms associated with the meridians, Jing and Luo (see Fig. 1 [2]), since this helps us to better grasp the concept of "channel", so rich in analogies and metaphoric suggestions in the Chinese philosophy. Especially interesting for us is the first ideogram, Jing, which is composed of two parts: on the left there is the representation of the cocoon of the silkworm, out of which the silk thread comes, so thin that one needs three of them to make the silk weave. The thread brings to mind the tissue, the web of the silk, its texture. On the right, it is represented the water flowing under the surface of the earth, and below is the man who observes and recognizes the flow properties. Formerly, the energy channels describing the Chi movements in the body were compared to the irrigation system of the fields (water sources, streams, rivers and lakes), where networks of water channels bring life to the earth. Changes may occur in the flux during the course of the year. However, the flow must not stop; it must be neither too small nor too large. In a similar way, in the body, life depends on the network of channels through which vital substances and energy flow.

The role of the meridians is so relevant in the conceptual foundation of Traditional Eastern Medicine that its holistic character would not be there without the meridians. These connect the top with the bottom, the center with the periphery, the inner with the outer, the human microcosm with the macrocosm (the environment, the Cosmos, any vital manifestation "out there"). The role of meridians is acknowledged not only in ancient medicine but also in its development in more recent therapies. For instance, a new Shiatsu style, called the Keiraku Shiatsu or meridian Shiatsu, was developed by Shizuto Masunaga in the second half of the past century. Meridians have a double nature in Keiraku Shiatsu; one has a higher density and is closer to the nature of matter; the other one is more immaterial, thinner, and more rarefied. Their matter aspect, predominantly Yin, is represented by their structure. In this respect, the meridians are energetic channels with specific paths and directions starting and ending somewhere. Their functions are instead related to their immaterial character, predominantly Yang, and expressions of life, of our being, and of the Ki movements that are essential for us to be alive.

Figure 1 The Jing Luo Chinese ideograms associated with the meridians (adapted from the Traditional Chinese ideogram [2]).

In the view of Masunaga, the meridians do not have precisely determined paths like those represented on the meridian maps; they may take variable paths, depending on a given individual and his individual conditions. Nor do they necessarily channel information on the current state of the subject. What is important is the meridian vibrational mode which may continuously change depending on changeable conditions. In this view, the meridian path which is drawn on the traditional meridian maps represents the most probable path for the energy flow (Ki) going through that meridian, rather than the definite location and path of the meridian. In this respect, the questions then arise of what is the mechanism of meridian formation. Can meridians be detected experimentally using conventional methods? If yes, how they are related to the anatomical structure? There are some theoretical approaches to the meridian description and modeling (see e.g., [3-5]). The goal of our article is to shed some light on these questions by resorting to the gauge field paradigm of quantum field theory (QFT) and to the theory of nonlinear systems. From this, we will develop a possible dynamical mechanism out of which the observed phenomenology of meridians appears to be generated.

Recent analysis has revealed specific electrical properties of the meridians and meridian-related points [6]. It is a well-established experimental fact that biologically active points (meridian-related points) have much higher electric conductivity, and their refraction index is different from the points beyond them [7, 8]. The difference between physical properties of the acupuncture points associated with the meridians and nonacupuncture points has been demonstrated by magnetic resonance imaging, infrared imaging, liquid crystal display thermal photography, and ultrasound studies [9-12]. Moreover, "Biologists have shown that the body's connective tissue network has a fluid crystalline composition and appears to be a high-speed, superconductive network for transmitting information throughout the body. For this reason and others, the "living matrix", as this is sometimes called, has been identified as the primary correlative to the Chinese meridian system..." [13].

"When I envisage the meridians as a particular form of coherence domain within the connective tissue, I see them as a sort of watery sheath encasing molecular chains. It is within this fluid that energy captured by the molecules is channeled." [14].

Access to the meridians is deeply tied to specific "points". One question concerns the relationship between the points of acupuncture, the meridians, and other "filamentary" structures, such as arteries and nerves. When looking for the specific point with the acupuncture needle, one tries to avoid these anatomical filamentary structures. Indeed, one looks for the fascia (connective tissue) that is made essentially of water and supports the epithelial cells and other organs. In this way, the mechanical stimuli, as in acupuncture, shiatsu, etc., reach the meridian point.

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These views of the meridian system are not in contrast with the Eastern tradition, according to which the vibrational character is a relevant property of the meridians. They represent the electromagnetic (EM) signal channeling system, detectable with highest probability in the locations indicated on the traditional maps. Vital processes and the body organization as a living system thus depend on the meridian network.

Along such lines of thought, we present in this article a dynamical model of meridians in the coherent states formalism and gauge theory paradigm of QFT [15-19]. In Section 2, we introduce the key notions of spontaneous breakdown of symmetry (SBS) and the dynamic formation of long-range correlations in the water content of the connective tissue. In Section 3, the self-focusing propagation of the EM field (EMF) in coherent states is discussed, and the meridian model is presented. In Section 4, the non-dissipative energy transport is considered, and the formation of solitary waves on proteins and anatomical filamentary structures is described. The relation of meridians with anatomical filamentary structures and the key role played by free energy, internal energy, and entropy are discussed in Section 5 and 6, respectively. Section 7 is devoted to conclusions.

2. Spontaneous breakdown of symmetry and coherence

It is useful for the following discussion to introduce the notion of SBS in QFT.

Let us start by observing that in QFT, the dynamics of the system under study is described by a set of field equations which are postulated to contain all the characteristic features of the system. The fields represent the elementary components of the system, e.g., the EMF, the atomic and molecular system's constituents, their electric charges, and dipole moments, etc. In general, one may consider transformations, e.g., rotations, translations, etc., of the fields such that the field equations do not change their form when the fields undergo the said transformations. The dynamics is then said to be invariant under the considered transformations, and these are named symmetry transformations of the dynamics. It may happen that under the action of some external perturbation, the state of minimum energy of the system, called ground state or vacuum, is not symmetric under the symmetry transformations of the dynamics. Then, the symmetry is said to be spontaneously broken. Spontaneously means that the system is driven into the nonsymmetric state by its own (internal) dynamics, not forced by the external perturbation which only acts as a trigger.

We also observe that in QFT, there exists the Goldstone theorem [9, 10] well confirmed by experimental observations stating that long-range correlations are dynamically generated when SBS occurs. These correlations produce the ordering of the system's elementary components. They are thus *collective modes* or waves responsible for the ordering in the system volume or system domains. Note that ordering arises as loss (breakdown) of the symmetry of the dynamics, i.e., "order is lack of symmetry". The quanta associated to the long-range correlation waves are called Nambu—Goldstone (NG) boson quanta.

The ordering is thus dynamically generated by the long-range correlations which propagate without destructive interference, i.e., *coherently*. In terms of the NG quanta, this is expressed by saying that there is *coherent condensation* of NG bosons in the system's minimum energy state. The ordering is described by a quantity called the "order parameter", which is independent of the quantum fluctuations characterizing the microscopic dynamics, and it is therefore a classical field describing the macroscopic behavior of the system. This is possible precisely because the ground state is a coherent state of NG quanta.

Let us now see how the SBS mechanism enters into our study of the meridians. We have seen that according to the general views mentioned in Section 1, meridians develop their paths within the connective tissue, whose principal constituent, in terms of quantity of molecules, is water. We thus focus our attention on a system of water molecules. They are characterized by the electric dipole moment, and the symmetry of the dynamics is the dipole rotational spherical symmetry. This means that, in general, in a system of water molecules, there is no preferred direction along which the molecular electric dipoles point neither do they oscillate *in phase*.

Suppose that some external or endogenous perturbation, such as for example an electric field or some variation in charge densities or ion currents, changes in electric potentials, etc., may trigger the alignment of the molecular dipoles along a preferred direction or induce their oscillations to be in phase, the state eventually reached by the water system is then characterized by the polarization density $P(\mathbf{r},t)$. In such a case, the original spherical symmetry has been spontaneously broken [11-14] by the triggering perturbations. We thus have spontaneous breakdown of the dipole rotational symmetry, with $P(\mathbf{r},t)$ playing the role of the "order parameter," and the NG quanta are now called dipole wave quanta (DWQ).

In conclusion, the dynamical scenario we have to consider in our discussion on meridians is the one of the SBS. It is worth to stress once more that SBS allows the transition from the microscopic scale of the elementary components (the molecular dipoles) to the macroscopic scale of the system behavior, characterized indeed by the order parameter (the polarization density). In the Section 3, we consider the propagation of the EMF in ordered medium and show its relevance in meridian modeling.

3. Modeling meridians: self-focusing propagation of electromagnetic field in ordered medium

We assume that, in the healthy body, the electrical dipole of the water molecules in the connective tissue may enter, as described in the previous Section 4, in a motion of in phase oscillations, triggered by external or by endogenous agents, and thus DWQ may be condensed in coherent states described by the polarization density $P(\mathbf{r},t)$. We thus also assume that triggering sources (EMF, ions, charge densities, etc.) are present in the connective tissue (endogenous sources). In the Section 4, we will see how relevant is, in this respect, the nonlinear wave (soliton) propagation on proteins and filamentary biological structures. In our discussion, we do not need to specify further the details of the mechanisms generating SBS in connective tissue. We assume that a number of such mechanisms may be indeed at work in healthy conditions. In this respect, we stress that even a *weak* perturbation or "*minimal stimulus*" may trigger SBS. The triggered ordering does not depend on the strength of the stimulus but on its being in phase with the possible oscillatory motion of the system's components [15-19]. This specific phase-matching feature operates as a very selective mechanism, a sort of filter discriminating among perturbations and stimuli acting on the system, thus protecting it against any noisy perturbative background or even strong actions, which, however, are out of phase with the oscillatory motions allowed by the system's inner dynamics.

Let us then concentrate on the dynamics of the EMF (the photon field) propagating in the regions where DWQ are coherently condensed. The detailed mathematical analysis [15-20] shows that the EMF acquires a mass M which is proportional to the polarization density $P(\mathbf{r},t)$. This fact implies that the EMF does not propagate in spherical waves, but it remains focused in "channels" whose transverse size d is inverse proportional to the mass M. In SBS, we have thus dynamical self-focusing propagation of the EMF as a result of the coherent ordering of the medium.

Since in general $P(\mathbf{r},t)$ is nonhomogeneous (i.e., it is space-time dependent), also the mass M and the channel size d are nonhomogeneous. The propagation dynamics is such that where the EMF penetrates, the DWQ boson condensation is destroyed. So, the EMF propagation is confined within these "channels". Sometimes this mechanism is referred to as the Anderson—Higgs—Kibble mechanism, see refs. [15, 17]. Moreover, the EMF gets dynamically tuned with the DWQ oscillatory frequency:—phase locking takes place [15-19, 21]. The topologically nontrivial geometry of the connective tissue, due to the presence of biological units and structures, implies the complexity of the structure of the network formed by the filamentary paths of the EMF. Our main proposal in this article is that the dynamical network made by the self-focusing EMF propagation provides a model for the meridian network so essential to the basic concepts and practice of the Eastern Medicine.

We also remark that the long range dipole correlations acting as carrier waves in the connective tissue may "capture" in their coherent oscillations other neighboring molecules, cells, and biological units which are able to tune on the coherent DWQ frequencies. Reciprocally, impurities present in the medium or sources of other kinds, external or endogenous, may operate as de-tuning agents, destroying the coherence of the DWQ condensation, and in a chain of effects, destructing the ordering of the system and the filamentary propagation of the EMF, thus restoring its spherical-like wave propagation, with the final result of the appearance of system pathologies.

Let us denote by E_M the energy corresponding to the mass M of the self-focused propagating EMF. One possible value is [22] $E_M = 13.60$ eV, namely the hydrogen ionization energy. It corresponds to the channel transversal size d of the order of 146 Å [22]. The energy E_M can be considered to be a threshold. A single photon of energy $h\nu$, with h the Planck constant and ν the frequency, equal or larger than E_M has enough energy to open its way and propagate in a self-focusing fashion through the condensate of DWQ. More energetic ($E >> E_M$) photons may have a destructive action on the condensate, breaking the coherence of the dipole oscillations, restoring the spherical-like propagation of the EMF, and possibly resulting in pathological states of the system. Finally, photons of energy lower than E_M will not be able to open their way through the condensate by themselves. However, their energy may concur in an increase of the medium polarization. Adding up many contributions supplied by many low-energy photons may then result in reaching the threshold value E_M. Then the polarization mode so obtained would convert into an EMF corresponding to that mass value, with the consequent opening of a new channel branch for the filamentary EMF propagation. Coherence thus offers the possibility of energy storage in the system, which may be used for its metabolic needs and/or building up propagation channels for the EMF. However, an excessive, stressful energy charge may produce negative effects as described above. Summing up, as already observed in ref. [22], we have some "anomalous properties", namely, (i) weak fields are absorbed, their energy is stored, and when an energy threshold is reached, EM propagation occurs (delayed propagation and emission); (ii) the field becomes coherent through propagation; and (iii) the field, by propagating through correlation and not scattering, is not attenuated. Interestingly, these features may account for some aspects of experiments on optical properties of living matter [23-24].

4. Energy transport and solitary waves

As stated in the Section 3, nonlinear (solitary) waves on proteins and filamentary biological structures may play a crucial role as endogenous EM sources which are able to trigger SBS in the connective tissue. Moreover, they are connected with nondissipative energy transport in biological structures. Let us discuss therefore in this Section 4, how nonlinear wave formation and propagation enter our meridian modeling.

Since meridians are associated with the energy flows in the organism, it is natural to expect that they are connected with the bioenergetics of cells. It is well known that the main quantum of biological energy is the energy released in the hydrolysis of Adenosine Triphosphate (ATP). This energy is stored in the so called AMID1 vibrational excitation of the nearest peptide group of the corresponding protein. In the case of proteins in alpha-helical conformation, this AMID1 excitation (that is a collective excitation, which is mainly the vibration of the double C=O bond of the peptide group, HNCO) causes a local distortion of the hydrogen bonds with the nearest peptide groups. This distortion in its turn acts as the potential well for the excitation, and as a result they form a bound localized state, as it has been proved by Davydov [25]. These processes are described by a system of nonlinear equations that can be reduced to the nonlinear Schrödinger equation, which is one of the basic equations in nonlinear physics. It admits the solution in the form of a soliton. Thus, a molecular excitation in a deformable polypeptide chain is self-trapped in a soliton state, called also a molecular soliton or

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Davydov's soliton. It is worthwhile to recall that the term "soliton" or solitary wave, means a nonlinear localized wave which remains stable under the collision with another soliton. Owing to their nonlinear character, molecular solitons dissipate very little energy and can propagate on macroscopic distances. A similar picture takes place for the electrons released in the redox processes. In this latter case, solitons have a charge and are called electrosolitons.

In proteins, as in discrete systems, electrosolitons move in the periodical potential relief. Because of this relief, the soliton's velocity is an oscillating function of time [26]. Hence, electrosolitons emit EM radiation according to the Maxwell equations, whose solution shows that this is the radiation of the characteristic frequencies determined by the dynamics of solitons. The radiation from each soliton affects the dynamics of other solitons on other proteins, which results in the synchronization of the dynamics of solitons; they attain equal velocities and emit EM radiation at the same frequencies [27]. Owing to this, the total intensity of the eigen radiation is proportional to the square of the total number of solitons, not to the number of solitons as it would be the case of not synchronized solitons. Thus, the general EMF emitted by solitons can constitute one of the sources of the endogenous EMF in the living organism, able to trigger the SBS in connective tissue. This EMF has a complex structure due to the complex anatomical structure of the body, variety of proteins, tissues, organs, different types of solitons formed in proteins, DNA, cellular water, etc. Also the symmetry of biological macromolecules, such as helicity of proteins and DNA, determines different polarization components of the EMF and thus contributes to the complexity of the pattern of EMF and richness of the information stored in it.

In addition to the role of triggering the SBS, the EMFs emitted by solitons are themselves subject to the self-focusing propagation in the surrounding ordered medium, according to the analysis presented in the Section 3, provided their energy is comparable to the threshold energy E_M corresponding to the medium polarization. In this respect, we remark that biological tissues are highly nonlinear structures, which resemble liquid crystals to a certain extent. They possess different optical properties, so that in general the biological matter is a nonlinear medium. The self-focusing propagation of EMFs described in our meridian model in terms of the QFT formalism accounts for aspects of EM wave propagation in nonlinear nonhomogeneous media which are well known in classical nonlinear optics [28-30]. It is known that in a nonlinear system, EMF can be self-focused in soliton state [31], which can propagate along the elongated paths, similar to the optical waveguides and thus can be compared with the meridians.

We thus again conclude that self-focused EMF, as the optical waveguide, can provide the nondissipative flow of energy and information over the whole organism [32]. The form of the waveguides ("meridians") is determined (i) by the physical properties of the tissue, (ii) by the boundary conditions, i.e., by the geometrical or better to say anatomical properties of the body, and (iii) by the physical conditions and physiological state (the rate of metabolism, the water content in tissues, stress of muscles, etc.) Therefore, these waveguides are not stationary formations but are rather dynamical channels. They possess some special nodes located in specific points, close to the skin, where the skin electroconductivity and refractive index are very different from the surroundings. The skin has indeed specific optical properties, it acts as a screen for the endogenous EMF, with nonhomogeneous properties, and it presents specific points such as those where one can affect the channels of energy and information flow, as is evident from hundreds of years of practice. In this way, we can understand the physical mechanisms of Eastern medicine, such as acupuncture, shiatsu, *etc.*, as well as the mechanisms of therapies based on weak stimuli (magnetic, low-frequency (LF) and radio-frequency (RF) EM nonthermal resonance therapies, etc.).

5. Anatomical filamentary structures and meridians

In the Sections 3, 4, we have shown that the endogenous EMF can constitute one of the sources of meridian formation. It provides the mechanism of the self-controlled long-range correlations over the whole organism, sustaining the self-organized functioning of this multicomplex highly hierarchic system. In such a process, a very important role in self-organization and functioning of living matter belongs to water, which under certain conditions can form coherent domains (CD) [15-22]. We have also considered solitary waves forming on proteins and other anatomical filamentary structures and their role in energy transport in the system and the EMF generated by them.

We consider now another aspect of the relationship between the meridians modeled in the Sections 2, 3, 4 and the dense nets of arteries, nerves, and other anatomical filamentary structures in the body. In our model, meridians are dynamical formations not "anatomical" structures because they are present only in the living system, disappearing as soon as the coherence of the DWQ and the consequent EMF self-focusing propagation disappear, namely in the dead organism.

To understand the relationship between the meridians and anatomical filamentary structures, we note that it has been recently observed [33], by use of spectroscopic methods, that under ambient conditions water forms a robust superstructure of a biomolecule (DNA, in the specific experiment [33]). McDermott et al [33] report that they "indeed observe that DNA imprints its chirality on the surrounding water molecules,... [which] shows that the chiral structure of biomolecules can be imprinted on the surrounding solvation structure". The water superstructure thus constitutes a detailed mold of the biomolecule generating molecular electric dipole interactions in the surrounding water environment [34-35]. Such a mold, presenting specific arrangements and oscillations of the water molecular dipoles, corresponding to that specific biomolecule, therefore produces the biomolecule "EM image" [34-35]. Our contention is that the EM image of the anatomical filamentary structures in the connective tissue acts as a trigger for the SBS mechanism and the consequent EMF self-focusing propagation, as explained in the Section 4. In other words, the coupling of the quasi one-dimensional CDs formed by the water, surrounding long molecules in the connective tissues, such as, e.g., collagen fibers and other

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filamentary structures, produces long pathways, whose array supports self-trapping of the endogenous EMF in the meridian-like system [32].

It might be not surprising, therefore, that sometimes paths and specific points of the meridians might be found in regions not so far from the anatomical filamentary structures. However, the physical and functional (dynamical) distinctions between these anatomical structures and meridians are very clear and definite.

It is also remarkable the laboratory observation that "a change in the hydration state can lead to dramatic changes to the DNA structure" [33]. This suggests that a *dynamical* interdependence exists between meridians and the anatomical filamentary structures, mediated by the changes in the EM images of the anatomical biostructures. Actions on the meridians may indeed have effects on the molecular bioactivity *and vice-versa,* according to the following causal chain of steps: actions on meridians (e.g., by acupuncture or shiatsu or other weak stimuli) ↔ changes in the EMF self-focusing propagation and DWQ condensate ↔ deformation of the EM image (the hydration state [33]) of neighboring anatomical filamentary structure ↔ changes in the conformational and/or functional properties of these structures ↔ changes in nondissipative (solitary) energy transport and biochemical functional activity.

We thus reach an understanding of the *reciprocal* actions between meridians and molecular biochemical activity, which, although observed in practice, has been always difficult to understand on a purely biochemistry basis.

A different mechanism, also relating meridians to biochemical activity, is the formation of temporary (or else permanent) molecular coating of the EMF propagation paths. As stated, the EMF is confined within the region (path) where no DWQ condensate is present. Field gradients transverse to the path are thus present. Then, transverse and frequency-dependent forces, proportional to the field gradient, develop [22]. These forces may be attractive or repulsive, acting on neighboring molecules, ions, and other particles external (to the path). The forces have indeed a frequency resonant character so that they act selectively on the external particles, i.e., provided the frequencies of the EMF and of the oscillatory particle modes are matching (resonate). The intrinsic fine tuning of the process allows that tiny fluctuations or changes of the frequencies may produce attraction or repulsion of different molecules. As a result, a dynamically guided "polymerization" process sets in, leading to the molecular coating of the channel. If the attracted molecules may form stable chemical bounds, the molecular coating will survive even in the absence (disappearance) or weakening of the propagating EMF; otherwise, it will disassemble (formation or depletion of network branches).

6. Free energy, energy dissipation, and coherence

The physical meaning of weak perturbations or minimal stimuli is the one of triggering the transitions of the system from the dynamical regime where symmetry is not broken to the dynamical regime where SBS occurs [15-19, 22]; they also trigger transitions through different SBS regimes, labeled by different values of the order parameter. In QFT, such dynamical regimes are referred to as "phases". Thus, the "life," or history, of the system is described by it going through phase transitions, namely by the time evolution of the order parameter. (Note that the word "phase" is referred to the rotation angle and to the dynamical regime in which the system lives at a given stage of its evolution. From the context, non confusion arises between the two different meanings).

The system appears thus to be a far-from-the-equilibrium system. It is indeed known [36] that symmetry breaking phase transitions are nonequilibrium dynamic processes characterized by criticality. The long-range correlations are described in fact by condensation functions with diverging or topological singularities [36, 37]. These condensation functions also control the transformation properties of the EMF, known as gauge transformations. One can show [15-19, 36] that in order to create some observable effect in the system, the gauge functions indeed have to carry a singularity. The self-focusing propagation of the EMF is an example of such a topologically nontrivial structure: the core of the channel where the EMF is confined cannot be reduced to zero transverse size, $d = 0$, unless the EMF is squeezed out, in this way destroying the whole system structure. The dynamics of the meridians turns out to be a critical one, with topologically nontrivial properties.

The process of phase transition can be formally described [37] in the quasi-stationary approximation, as a time ordered sequence of quasi-equilibrium states. Assuming negligible variations of volume and temperature T, in each one of these states the free energy F is minimized, $dF = dU - TdS = 0$. Here, U denotes the energy stored in the system and S is the entropy. Heat exchange dQ is $dQ = T\,dS$.

One finds [15, 16] $dU = (dN/dt)dt = T\,dS$, with dN/dt the variation in time of the condensate density. Thus, dU and dS have the same sign, and both are equal to the rate of change of the DWQ condensate. For example, at constant T, a decrease (dissipation) of the system internal (stored) energy turns into a corresponding decrease of the entropy, namely a decrease of the losses in the condensate, i.e., in the loss of coherent ordering, and vice-versa. This shows that energy storage/dissipation is a crucial feature of living systems; it controls the variations of the system degree of coherence in its continual undergoing through phase transitions in order to keep the dynamical stability of the living organism as an open dissipative system.

7. Discussion

Within the gauge theory paradigm of QFT, we have modeled the meridians of the Eastern Medicine, in its various traditions (China, India, Japan, Korea), in terms of the self-focusing propagation of the EMF in the coherent water medium of which most of the connective tissue is made. The relationship of the meridian network with the anatomical filamentary structures has been discussed, and their differences and distinctions have been stressed. The role played by the solitary waves propagating over proteins and other biological filamentary structures has been analyzed. The scenario resulting from our discussion is the one of nonequilibrium dynamical processes with continual local rearrangements of the meridian paths in their transverse size and in their percolation through the coherent medium, turning into reciprocal actions between meridians and biochemical activity. Depending on local nonhomogeneities and metabolic activities, local changes of the meridian network are consistent, however, with the possibility of a general configuration describable in terms of (meta-)stable maps. An interesting connection may be made here with the recent discovery of fluid-filled interstitial formation supported by a complex network of thick collagen bundles [38] different from the primo vascular system, known also as the Bonghan system [39]. This network *plasticity* might be one of the reasons of the differences in meridian maps we have inherited from different medical traditions.

It is worth stressing that our model is a fully dynamical model. Meridians depend on local and global dynamic interactions with and within the richness of the medium of which they, by themselves, are part, although not as an anatomical part.

Minimization of free energy, in quasi-stationary conditions, implies that changes in the system's internal energy are compensated by changes in entropy (in coherence) and vice-versa. In the healthy state, the organism is in the optimal regime without any excess or lack of energy in the energetic channels. On the contrary, in the case of some degree of disease or pathology, the organism is in a metastable state separated by the potential barrier from the healthy state. In a pathological state, the energetic balance may be lost due to the malfunctioning of the dissipative structures. For a transition to the healthy state, extra energy has either to be released, which can occur via some reaction of the organism, like fever, or via stimulating the energetic pathways from outside, or it needs to be supplied in the necessary amount, in such a way as to recover the coherence of the system via some resonant mechanism.

We conclude by observing that in our meridian modeling, the metabolic activity appears to be organized on different hierarchical levels, interacting among themselves under reciprocal constraints, ruled by the basic dynamical law of coherence.

Disclosure statement

None declared.

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