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Towards a Quantum Physics of the Living State

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Abstract. In this paper, we review the concepts, based upon experimental results, which allow us to conclude that living matter is one of the steps of the 'Weisskopf quantum ladder'. Some necessary conditions for responding selectively in frequency to low intensity microwave EMR are formulated. A model of an organism's 'electromagnetic frame' is used for interpretation and to reveal the nature of Chinese meridians and the laws of papillar pattern formation in embryos. The statement has been made that an organism's macroscopic stability is determined by its functional coherent microwave field. The complementarity of synergetic and quantum mechanical approaches towards the problem of the variable, differential stability of living organisms is discussed.

Key words. Weisskopf quantum ladder, quantum theory, molecular organization, many-body problem.

The necessity of viewing a living organism functioning as a whole is no longer discussed in physiology and medicine, because this question was answered positively (at least at the level of declaration) long ago. In terms of physics, however, the last fundamental level of the structural organization of matter (the so-called 'Weisskopf quantum ladder') is considered to be the molecular organization. It corresponds to the belief that viewing any macroscopic object (living ones included) on fundamental grounds presupposes the analysis of its molecular structure. Quantum mechanical approaches for the microscopic viewing of multimolecular systems were regarded as inexpedient because of the difficulties in solving many-body tasks, though in a number of cases, e.g. in the theory of solids and in gas laser theory, phenomenological approaches allowing the solution of many-body problems in the form of single-particle ones in different collective variables, were developed.

However, a successful application of quantum mechanical concepts to the description of macroscopic systems (superconductivity, superfluidity, Josephson effect) showed that an object's small size is not a criterion for the application of quantum mechanics and, therefore, for the possibility of its fundamental description.

We consider these criteria to be as follows: (1) the presence in the system of narrow discrete states of the 'single particle type', the transitions between which (taking into account the rules of selection) make a spectrum of systems of characteristics eigenfrequencies in a limited range of energies, and (2) the manifestation of multiform differential stability of natural structural units of matter (i.e. of the 'Weisskopf quantum ladder'). In other words, the universality of the two basic prin-

ciples of quantum mechanics, discreteness and identity, from the point of view of their applicability to living organisms, is assumed.

We arrived at this conclusion as the result of the experimental detection of the characteristic eigenfrequencies of the human body in mm-band range [1] and the realization of the fact that the same varied differential stability can be observed in living nature (animal and plant species) as is observed at other quantum ladder steps. Thus, the hypothesis was proposed that living matter is the next step after the molecular level of the structural organization of matter, i.e. living functional objects belong to the whole quantum system, in the same sense as we speak of the quantum nature of nuclei and molecules which form 'Weisskopf quantum ladder' steps [2].

Let us briefly reconsider the experimental results which served as the basis for such radical conclusions. In 1982, it was established that a 'diseased' organism monitored at biologically active points (BAP) in functionally defective organs by acupuncture cartography, not only acquired an extremely high and frequency-selective sensitivity to the electromagnetic fields in the mm-band range, but was also 'treated', i.e. the functioning of the affected organ was gradually restored up to its normalization, which corresponded to the lack of any reaction on external electromagnetic radiation (EMR) action. These experiments were described in detail in [3]. It may be recalled that mm-band EMR has a contact-free input by means of a waveguide to the biologically active point (BAP), or points, connected by acupuncture cartography to the injured organs. In this instance, at a definite frequency (or in a band of frequencies) the organism reacts in a sensory manner (generally in the area of the injured organ, it being some distance from a zone exposed to EMR). This reaction is accompanied by a restructuring of its functioning, recorded by means of medical diagnostic devices. In certain BAPs, an alteration to the characteristics is also observed (Figures 1 and 2).

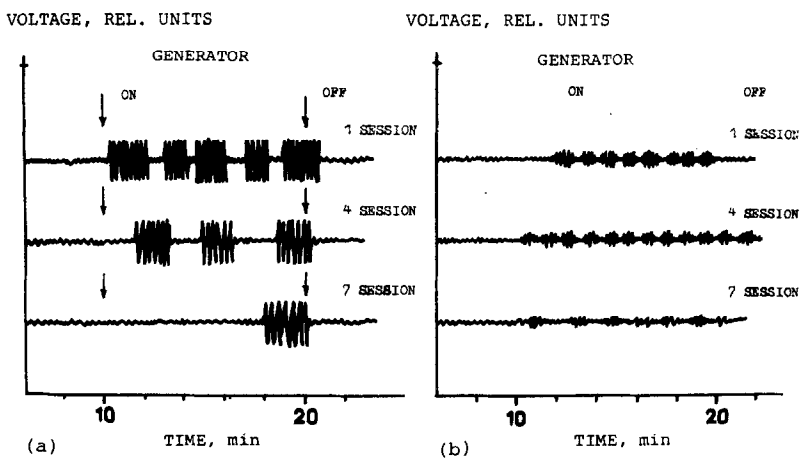

Fig. 1. Dynamics of organism reaction changes under the MRT effect in the course of its recovery in the case of a duodenal ulcer detected in the electric activity in BAP E36 (a) and E25 (b) [19].

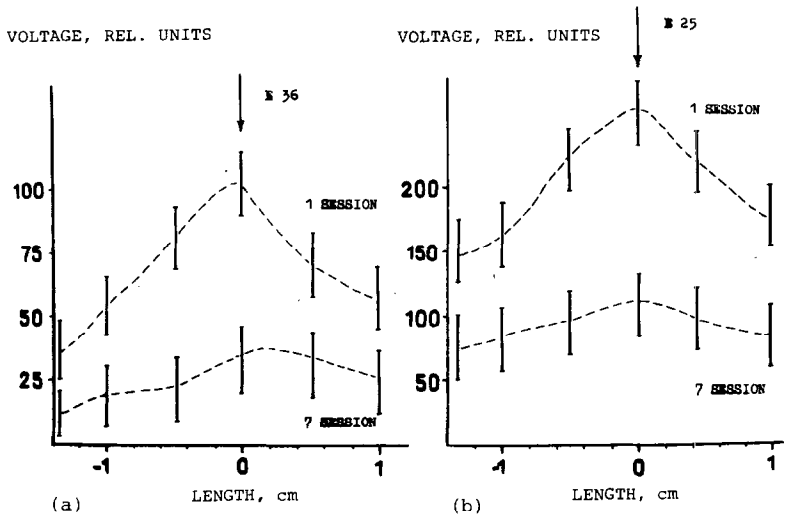

Fig. 2. The influence of an organism's physiological state (before and after an MRT course of treatment for a duodenal ulcer) on the electric profiles of BAP E36 (a) and E25 (b) [19].

According to our theory, this reaction signifies the system's transition from a metastable state ('disease') to a stable ground state ('health'). At the same time, the data obtained were outside the framework of existing physical ideas and so demanded new approaches based upon the ideas of quantum mechanics, nonlinear electrodynamics, and the modern theory of self-organization (synergetics) which is nowadays described as the *physics of the living state.*

The first steps in this branch of science were taken more than 20 years ago. In 1968, the first experimental results on resonance peculiarities in mm-band electromagnetic wave absorption spectra of the simplest living organisms were published by Webb and Dodds [4], and Zalyubovskaya [5] formulated the concept of spectral resonances of the action of the same electromagnetic field upon various living systems. Since then, interest in this area of research has steadily grown. As has been repeatedly emphasized (first of all by Fröhlich [6]), the physical characteristics of cellular and sub-cellular structures give one grounds to expect that they might serve as a source of electromagnetic radiation in the 10^{10}–10^{11} Hz range. Generally, however, as a result of a strong coupling effect in nonliving condensed matter, a widening of lines should take place (and indeed it does) to the extent that the spectrum becomes quasi-continuous. That is why, irrespective of the specific mechanism of the formation of discrete high-Q states observed in the environmental thermal background, the very fact of the lines' existence may be regarded as a characteristic indication of matter being alive.

Irrespective of the model of isolated states in the living cell used for explaining resonance microwave biological effects (Fröhlich's model of Bose-like condensation into the lowest state of the system of coherent oscillators with a nonlinear bond [5] or the spin-spin splitting model of protein molecule triplet states in a zero-exter-

nal field, independently suggested by Sitko and Sugakov [7] and Keilmann [8]), the suggestion that a metabolic pumping of corresponding nonequilibrium states is important. We believe that the nonequilibrium character of the states responsible for resonance biological effects in the EMR mm range shows a close link between the organism's 'synergetic' description in the form of a dissipative structural hierarchy and its description from the point of view of quantum mechanics as an integral quantum system. In a rather general form, this theory was applied by us to the construction of a Chinese meridian system physical model assumed as a basis for understanding MRT effects [9].

However, before explaining this model and discussing its specific and general effects, it seems necessary to dwell upon the MRT experimental features which we believe to be essential for understanding the inadequate reproducibility of microwave resonance biological effects [10].

An experimental application of MRT showed us that 'to be living' is not a necessary condition for a low intensity mm-range EMR response by a biological object. At the very minimum, to obtain the effect, it is necessary to have

(1) The presence of functional disturbances within the whole system;
(2) EMR flux locality;
(3) Action upon the organism's particularly sensitive (biologically active) zones.

In the case of a human organism (when MRT is applied), especially EMR-sensitive zones coincide with the classical acupuncture 'points'. We believe that the existence of human acupuncture cartography served as a favourable circumstance that played the principal part in the process of the realization, comprehension, and generalization of MRT laws.

The applicability of these conditions to all living organisms is being confirmed both experimentally and theoretically, e.g. the organism's sensitivity increases by a factor of at least 10^5–10^6 as compared to integral irradiation methods [11]. The model experiments carried out by Kurdiumov [12], showed that the presence of areas with a high sensitivity to the governing signal may be a characteristic feature of spatially self-organized structures.

In [9], we suggested a physical model of a Chinese meridian system which we approximated by starting from the idea of quantum states of living cells capable of interacting with mm-range EMR, through the assumption of the inverse population of these states taking into account two important circumstances for the mm range: the saturation of quantum irradiation transitions and the strong distributive absorption of the biological organism's water content.

Thus, a multi-cellular organism was regarded as an active media in the mm range whose nonlocal absorption was compensated by metabolic pumping. If the condition $\lambda \gg a$ is observed, where λ is the irradiation wavelength and a is a characteristic dimension of active cellular structures, the transition to the generation of coherent millimeter irradiation, as is known, may be regarded as a nonequilibrium

phase transition [13]. In this case, the electromagnetic field with reference to which a nonlocal, self-coordinated synergetic type potential may be defined, performs the role of an order parameter. It is important to note that, in the case of metabolic pumping, eliciting the inverse population of active centres, the condition $kT \gg h\nu$ provides a unique possibility of creating coherence on a thermal (Planck) level of intensity at the expense of exceeding the probability of induced transitions 100-fold over spontaneous ones. Providing a dynamic nonlinearity of media in a system with distributed absorption, transition saturation ensures the emergence of the stable periodic solutions we are interested in – limit cycles with different structures.

According to our ideas, one of these limit cycles – a coherent propagating wave with a definite amplitude – may be associated with the system of Chinese meridians. This idea is illustrated in Figure 3 by the trajectory of the electromagnetic wave propagating in the organism with minimal losses due to reflections from the bones, and (in BAP on the meridian) from cutaneous tissue. It is clearly shown in dorsal meridians – Du Channel and two Urinary Bladder Channels,

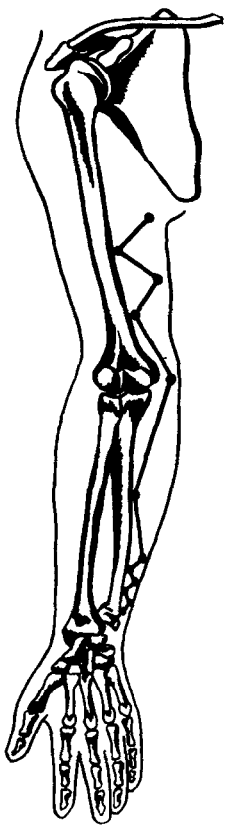

Fig. 3. The trajectory of the external course of the hand meridian (fragment) regarded as a limit cycle for a propagating wave in the microwave coherent field of an organism.

where a BAP of equidistant order reflects a 'recalculation' of ribs and verterbrae. In every meridian, the presence of a BAP in the extremities' joints may be regarded as one more example; this fact results from the condition of the structural stability of active modes relative to the organism's motor activity.

From this standpoint, BAP supersensitivity to EMR is determined by the maximal close proximity of the limit cycle trajectory to the body surface detected from a BAP, and irrespective of large absorption by water content, EMR having a resonance frequency may effect a limit cycle structure, e.g. interrupt the propagation of standing or solitary waves, in all probability, matching satellites in cell EMR absorption spectra to malignant tumors [14]. Additional losses introduced in BAP by needle acupuncture, tsubo-therapy, and massage may result in similar effects.

The concept of an organism's coherent field presents a number of verifiable consequences, e.g., when trying to draw a mental trajectory of a coherent wave along the meridian in the area of palm, we noticed that all the observed general laws of papillar line patterns may be explained within the framework of the hypothesis that papillar lines are formed along the interference lines of direct and reflected propagating waves from the nails (Figure 4).

The formation of papillar patterns on embryo digits starts from the moment of cartilage hardening (formation of an osseous tissue as a surface of reflection), and the hologram pattern with this is governed by the laws of the creation of an inter-

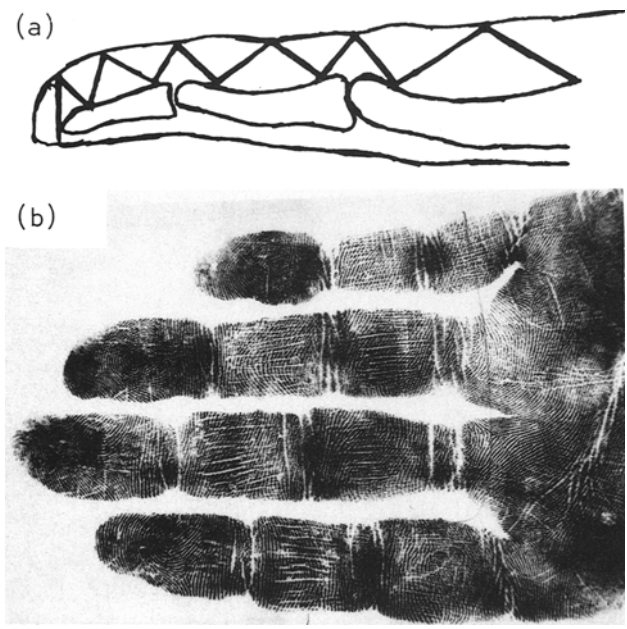

Fig. 4. (a) Meridian propagation wave along the finfer (diagram). (b) Papillary lines of the hand.

ferential image, for a real digital surface forms at that moment, and by the cross-section of an EM beam (Figure 5).

Most probably this type 'set' interferential map on the cutaneous surface plays the role of self-regulation between tissue growth processes and the body's own electromagnetic field radiation.

This proposed hypothesis has been proved by analysis of the deformation of papillar lines in the area of profound cutaneous lesions (scars). Their form corresponds to the laws of interferential spectroscopy (Figure 6).

In terms of the above-mentioned results and ideas, we see that living systems can be described simultaneously in terms of synergetics as a hierarchy of dissipative structures and, in terms of quantum mechanics, as intact quantum systems. Such dissipative structures are called stable. Their spatial-temporal stability is a dynamic one which is conditioned by openness to the physical vacuum. This approach is

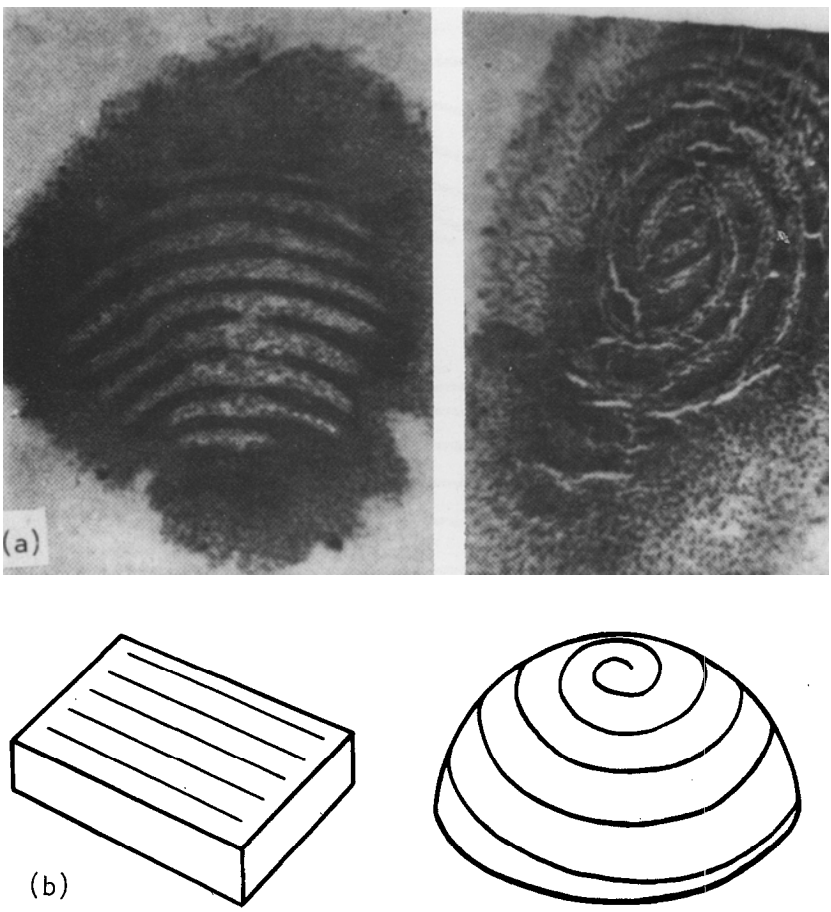

Fig. 5. Two types of papillar lines formed in cartilage induration in the embryo development stage: (a) A photo. (b) Calculation within the framework of the given model.

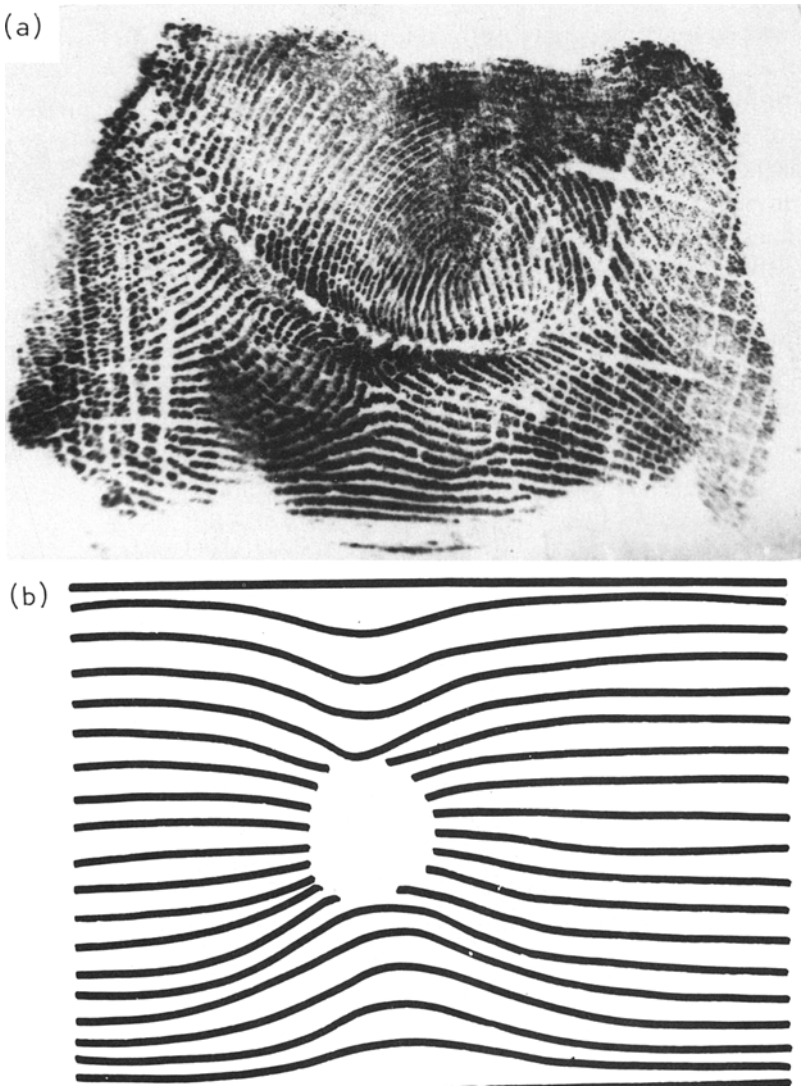

Fig. 6. (a) Papillary lines deformation in the circatrix area. (b) Model imitation of such a distortion of the interference pattern in media boundaries with a different refraction ratio.

presented within the framework of modern field theory [15, 16]; the role of physical vacuum is played by water.

The universality of this methodological approach towards various levels of structural organization of matter – adequate for notions in quantum mechanics – also permits the extension of a synergetic approach, as applied to living matter, to nucleus, atoms and molecules [2]. This permits the description of a nucleus shell structure which is new in terms of 'magic' numbers, and the problem of atom stability, which produced heated discussions in the epoch of the birth of quantum

mechanics, and which was ignored by the 'Schrödinger equation formalism', now takes on a new dimension: the dynamic stability of an atom, as of a dissipative system, is created at the interchange between virtual photons with the physical vacuum.

Within the framework of the above-mentioned ideas, it is necessary to underline a special self-coordination condition between the limit cycle structure of the coherent microwave eigenfield and multicellular organism characteristics, particularly the form of body surface (at least up to parts of wavelengths). Taking into consideration this condition, as well as the idea of the role of coherent waves in the formation and regeneration of papillar pattern, we can conclude that a microwave irradiation coherent field should be considered when fundamental problems in modern biology such as cell division regulation and morphogenesis are discussed. We believe that the problem of cell definition can be defined here, thus covering both the problems of the stability and development of living systems.

It can be suggested that DNA molecules participate in the creation of an organism's coherent field, thus providing a retranslation of a gene code into the language of intact organism construction and functioning.

In view of this, it can be expected that helicity will be represented in the form of a 'good' quantum number when the selection rules for the transition between the quantum states of living systems are investigated.

It may be noted that it is the presence of selection rules that transforms a continuous spectrum into a characteristic frequency spectrum of a particular living system.

Indeed, in the 'Otklik' experimental department at the Moscow Institute of Physical Engineering, transitions with definite circular polarization (left or right) were discovered in *E. coli* cells. These results testify to the applicability of the selection rules, according to the tenets of quantum spectroscopy, to living organisms, as well as to the existence of helicity in the quantum characteristics of the wave functions of a living system's discrete states.

In conclusion, it may be said that we hope the results and ideas discussed in our work may be regarded as an extension of the Schrödinger program – the creation of physics of the living state, based upon quantum physics.

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