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The Whole as a Result of Self-Organization

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ABSTRACT: On the basis of the experimental discovery of characteristic eigenfrequencies of the human body, the living organism is considered as a quantum system and a dissipative structure, the long-range coherence of which is provided by electromagnetic interaction.

Among dissipative structures a special class is discerned for stable intact systems. Included along with living objects in this class are other fundamental structural material units with discrete characteristic frequencies of single-particle type (the nucleus, atom, molecule).

Some years ago (Andreev, Beliy and Sitko, 1984; Andreev, Beliy and Sitko, 1985; Sitko, Sugakov and Dokl, 1984; Andreev, Sitko, et al., 1985) the first results of investigations were published in which were found indications of "the special characteristic frequencies of man". At that time the utilization of spectroscopic terminology from quantum physics applied to a macroscopic and living object was a result more of the emotional perception of the experimental results obtained rather than necessitated by the realization of their methodological significance. The experiments showed that a human organism with functional disorders can distinguish insignificant frequency changes of external electromagnetic radiation in the mm band range. Under the effect of low intensity (from ~ mW/cm^2 to ~ fractions of mcW/cm^2) electromagnetic fields incident on acupuncture zones connected with "malfunctioning" organs (by meridians in accordance with acureflexotherapy cartography at definite frequencies within the range 50-70 GHz), an organismic sensory response is noticed. It is accompanied by a strongly pronounced therapeutic effect. (The method was tested more than 4000 patients for some pathologies).

The organismic sensory response and experimental registration of momentary changes of its physiological state in real time permits the achievement of a "therapeutic" frequency tuning. The following observations are of importance:

1. The zones of influence may be at a great distance (1m or even more) from a "malfunctioning" organ and, correspondingly, from a region of registered sensation;

2. The organism's response to the "resonant" frequency influence may be either trigger or Lorentzian form. In the latter case the relative Gaussian peak width is sometimes ~ parts of a percent;

3. When recovery is taking place, the organism's sensory response to local electromagnetic influence weakens and healthy persons are almost insensible to the fluxes at such levels;

4. Estimations show that large protein molecules, taken separately, can have oscillating levels in the range: $10^{10} - 10^{11}$ Hz. However, in a condensed medium, *in vitro*, their energy spectrum can become quasi-continuous without discrete states and capable of resonant absorptions within the previously stated frequency band. Experiment testifies to the discreteness of energy states in living organisms in striking analogy to the discreteness of the energetic states of such fundamental systems as the nucleus, atom, and molecule. In addition, living organisms and the enumerated physical systems can be compared according to one more distinguishing feature: they all demonstrate a high stability to outer influences (to a definite energy limit, of course). The ability to preserve a holistic response in spite of internal complexity permits these complex objects to play the role of elementary components in other complex systems. Quantum mechanics explains the nucleus', atom's and molecule's stable integrity on the basis of notions concerning the discreteness of their energy states. Quantum mechanics also explains the existence of characteristic levels of energy quanta which can interact with a quantum system. These characteristic values differ for nuclei, atoms and molecules by orders of magnitude and this fact defines the existence of "hierarchical levels in the structural organization of matter" (D. Bohm et al.) or "a quantum ladder " (W. Weisskopf). The specific character of all these fundamental stable integrities in quantum systems is apparent in the presence of specific characteristic spectral frequencies of radiation and absorption and in the narrowness of spectral lines (i.e., the so-called "single-particle" spectral character).

The fact that the spectral response of living organisms has just this character evokes the possibility that the physical basis of the stable integrity of living organisms is the same as that for the other steps of the quantum ladder: the living organism is a quantum system. In which case the presence of

eigenfrequencies may be a universal physical criterion indicating the stable integrity of fundamental units in structural matter.

The possibility of applying concepts from quantum physics (the wave function, its phase, step-function response, level-degeneracy and so on) to describe macroscopic phenomena is determined by the global coherence of behavioral elements in the system. This coherence may be achieved with phase transitions of the second order (superconductivity, superfluidity) or with nonequilibrium phase transitions (laser radiation coherence, Josephson effect) due to self-organization.

Fröhlich (1985) was the first to introduce the idea of coherent excitation in biological systems. He showed that because of metabolic pumping, a mode of collective oscillations of similar-type cell ensembles is formed at a frequency corresponding to the lowest single-particle oscillating condition.

Experimental verification of living organism characteristic frequencies manifested in resonance effects and the theoretical indications of the possibility of their explanation on the basis of self-organization concepts, reveal the fundamental significance of a synergetic approach to the description of biological systems. The possibility of this approach is not restricted to the creation of mathematical models of self-organization processes in homogeneous organismic systems such as the systolic rhythms (Krinski and Mikhailov, 1974) or electrical brain activity (Kaiser, 1985).

Both experimental (model) data as well as existing concepts of biochemical reactions in organisms demonstrate that organismic autowave processes can exist (Mysil, Novakova, and Kunts, 1984). The question now is: in what volume? Due to common diffusion such processes are possible only in limited volumes (for example, within a cell), for an organism represents an exceptional nonuniform medium and nonuniformities influence considerably the character of process development.

These considerations are in favor of the often mentioned hypothesis about the role of electromagnetic fields proper in regulating and synchronizing intracellular processes in the whole organism.

A combination of long-range acting electromagnetic fields with diffusion processes may be a factor providing cooperativeness of information processing in the organism in large volumes. It is possible that the so-called "meridians" known in acureflexotherapy are, in fact, an electromagnetic information frame of the organism (three-dimensional metabolic autowave "eddies").

Analyzing the numerical solutions of the model equations written for the simplest cases, Kaiser (1985) showed a strong dependency of the limit cycle positions and forms on the initial conditions, frequency of external signals and on their intensity, especially in the regions of particular points which in our case may be identified with acupuncture points.

Certainly, a strict analytic solution of the experimental response requires knowledge of a concrete microscopic mechanism responsible for a coherent electromagnetic field formation. On the basis of the experimental data we may exclude a number of models, since as was stated above, the discrete transitions in the region of $10^{10} - 10^{11}$ Hz in non-living multiparticle systems should be absent. In living matter these frequencies are possible only in cases when the states generating these transitions are separated from a thermal background. Several theoretical models providing such a possibility are known.

Besides the already mentioned Fröhlich conception (Fröhlich, 1985), a model of soliton energy transport along protein molecules has been suggested by Davydov (1983). A resonance photodissociation of a longliving soliton to an exciton and a local deformation with external field frequency values of $3 \cdot 10^{10} - 7 \cdot 10^{10}$ Hz is theoretically supported, i.e. there is a possibility of such kinds of interference in a metabolic process.

Furthermore, a conjecture was made (Sitko and Sugakov, 1986) that an informational connection with an external field and energy transport along limit cycle space trajectories may be conditioned by protein spin states. This hypothesis has recently found experimental confirmation (Andreev and Sitko, 1985). (See Figure 1.)

A short description of the conjecture is as follows. Electromagnetic waves in the range 45-65 GHz, arising in the organism owing to transitions between sublevels of a triplet spin-spin splitting, provide a universal long-acting coherence which is not limited by nonuniformities of real living structures. The role of short-acting activators may be played by enzyme complexes, as their activity is known (Buchachenko, Sagdeev and Salikov, 1978) to depend on spin orientation of the external electrons in active centers in a trigger way.

Thus we consider the living organism to be a quantum system and a dissipative structure formed as a result of a nonequilibrium phase transition which constantly reproduces itself due to self-organization processes.

This approach permits the isolation of a special class of stable integral systems among dissipative structures. Such fundamental structural matter units as nuclei, atoms and molecules can thus be regarded as paralleled functionally by living objects.

Therefore, the formation of chemical element atoms can be considered as not only a process of self-organization, but the existence of a stable atom itself may be interpreted as functioning as a dissipative structure open with respect to the physical vacuum (Lamb shift). In this way the ideas of self-organization can be introduced to nuclear physics. So methodological difficulties in the explanation of the formation of nucleus shell structure which were reflected, in particular, in historically derived terminology (e.g., "magic" nuclei, "magic" numbers) may be obviated. The question considered here is the methodologic basis for the spontaneity of formation of a self-coordinated potential of strong-interacting nucleons in the absence of a force center. The theory of the self-coordinated nuclear potential is the basis of

nucleus shell models which not only explain the "magic" phenomena, but at the same time are a theoretical basis for quantitative methods in nuclear physics predicting the values of the nuclear transitions, spins and parities of such of nuclear discrete energy states as occur in stable quantum systems.

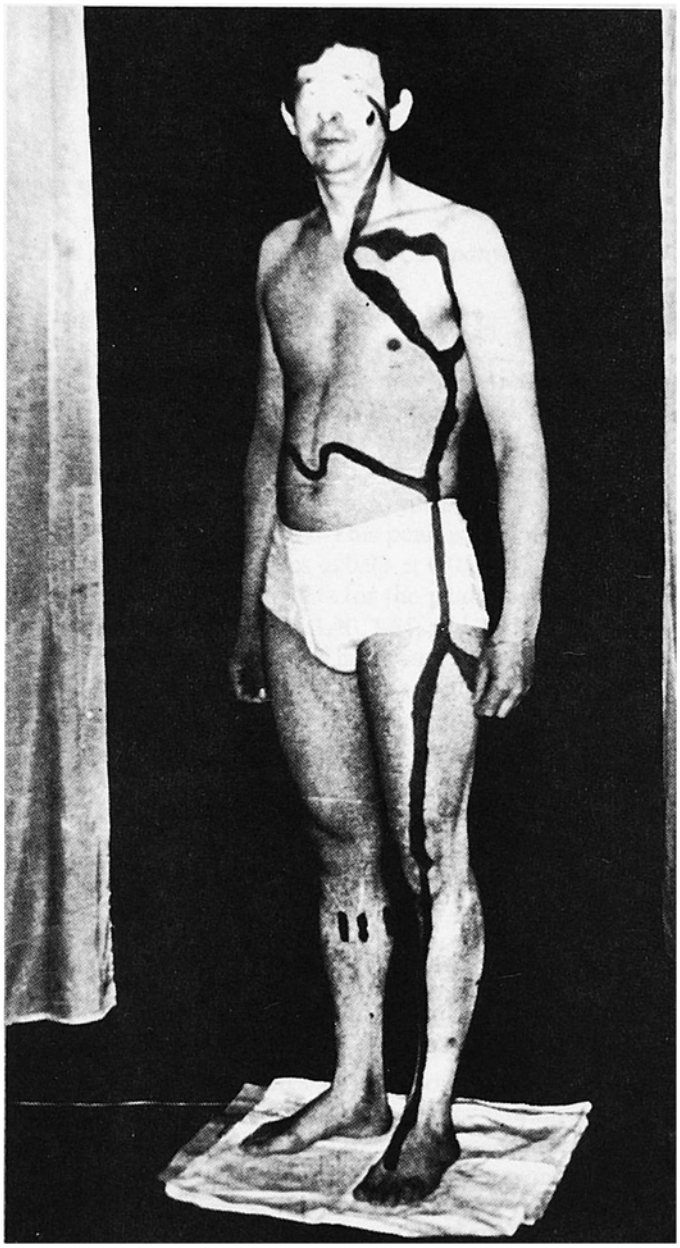

Figure 1. The fragment of electromagnetic human frame "displayed" when scanning a magnetic pencil (H = 40 Oersted) near the patient R. body surface to block the process of spastic contraction of musculus quadricepts femoris (NA), illustrating "tuning to resonance" when affecting the distal point of stomach meridian (45 E) with EMF having the frequency of 56.46 GHz (Rudenko effect).
Half-width of the resonance curve was 20 MHz. The patient was suffering from a duodenal ulcer. The outer meridian path is seen to go around the surgical scar. The magnetic field effect shown above was predicted to exist by the spin-spin splitting model (Sitko and Sugakov, 1984).

In investigations of the mathematical characteristics of irreversibility in physical theory, Prigogine emphasized that the existence of a Liouville operator to a continuous spectrum both for the classic as well as for quantum systems is the necessary condition for application to the system of a Liapounov function description (expressing irreversibility of the changes): "If a hamiltonian has a discrete spectrum, then a change of the wave function is periodic" (Prigogine, 1985). The existence of discrete energy states in a system becomes apparent, in its turn, in discreteness of its radiation and absorption spectrum; and periodicity of the wave function testifies to the stability of the system regenerating itself as a whole. Thus Prigogine closely approaches formulating the physical criterion of stable integrity of systems proposed in our work.

It should be emphasized that this criterion is applicable to systems which have already become a functioning whole during the evolutionary process. However, the whole in the present case is considered from the point of view of its formation. The observation of the incomparable Hegel may apply here: "The real whole is not a result, but the result together with its becoming" (Hegel, 1959).

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