

SYSTEM MODELLING OF FUNCTIONAL PROCESSES IN LIVING ORGANISMS

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Global tasks, the solution of which has led to the development of systems ways of acquiring knowledge, ultimately aim at conserving and developing life on the Earth. In this connection the techniques of system modelling of complex objects being developed at present are expedient to use to describe definite processes in the most complicated natural system such as a living organism.

Functional processes in a healthy organism can be assumed to have optimal character and any deviation from it in either of its systems determine their pathology. Treating a living organism in definite relations either as a distributed system or as a structural system or as a stochastic system we get the opportunity to use the techniques of optimizing appropriate systems to study this or that aspects of functional processes. One of the main methods of system studies to be known is the presentation of complex objects as multi-level hierarchical systems. Uniting chosen levels is carried out following the law common to all of them. We consider the wave dynamic system as a common model for all the levels of hierarchy of natural dynamic systems.

Mathematical theory of wave dynamic systems [1-3] determines the existence of elite states of systems. These are stationary, stable own solutions of the above systems, possessing quantum properties that express the way of energetically advantageous and continual existence of states and motions in the wave dynamic systems.

Applying these conclusions to the celestial mechanics A.M. Chechel-nitsky [3] suggested the foundation of a resonant character of the Solar system and a number of other phenomena.

The effectiveness of the suggested theory of the wave dynamic systems applied to such a megaobject as the Solar system allows to hope that it may be effective while describing structure - functional hierarchical systems (SFH) of living organisms as it seems that functional

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systems correspond to the physical aspects of wave dynamic systems to the same extent as the Solar system: the presence of the physical continuum; material density of the medium as a transfer of deviation; the wave character of the spreading of deviations in it; frequency, amplitude, phase, wave vector and other characteristics of the wave movement, etc.

For confirming such approach to functional processes in the organism we'll choose as its SFH levels the objects of the microspace (elementary parts, nuclears, atoms, molecula); intracellular structures, cellulars and groups of cellulars; organs and groups of organs; an organism as a whole. This separation is possible not only because of the effectiveness of their mathematical description, but also in accordance with the phylosophical presentations on the unity of structure and function.

According to quantum-wave mechanics [1,2] the objects of microspace should be treated as the wave dynamic systems which are described by wave equations.

The data of the electron radioautographic study depict that at every certain moment only part of cell organells, cells themselves and also larger structures are active. The next moment other of the mentioned structures become active while the previous ones appear in the phase of functional rest [4].

The rhythm of the functional activity of organs and organism as a whole is considered as a fundamental characteristic of the activity of biological systems and the basis of their regulation and whole-ness [5].

These rhythmical changes of the functional activity allow to suppose the effectiveness of applying the wave equations for the description of functional processes at any SFH level of an organism.

The universal principle of the regulation of an organism is that any function at any SFH level is controlled continuously, on the one hand strengthening, and on the other hand suppressing influences beginning with inhibition and excitement in ferment systems and up to the psychical human activity. This principle may be used as one more preference for modelling functional processes by wave dynamic systems.

It is interesting to apply the systems approach for the description of such an ancient model of an organism which is used in traditional Chinese acupuncture (ACP) theory.

Using the mentioned approach to modelling functional processes of an organism allows to put forward the hypothesis [6] of one more possible ACP mechanism: acupuncture points (AP) and channels are stable elite states of wave functional processes on the intracellular and organs levels of SFH of an organism accordingly, being the indicators of the energetically advantageous continual existence of functional processes in the organism.

Such approach conforms with the idea of A.A. Ukhtomsky that an organ is just the composition of factors and functions leading to the result, and with the theory of functional systems [7].

The special diagnostic and therapeutic AP role becomes evident because of the hypothesis. On the one hand, the deviation of an AP state from the energetically advantageous level makes it possible to determine hyperfunction or hypofunction of the corresponding system of an organism and, on the other hand, the way of effecting AP while curing depends on which direction from the optimal condition the disturbancy of an organism's function happened. Because of the quantum wave character of processes into AP and channels and taking into account the universal principle of function regulation (Yin-Yang relations in ACP theory) one can get explanation to the effectiveness of a variety of ways and techniques of effecting AP leading to the normalizing result (electropuncture, laserpuncture, etc.).

There are facts indicating that there is a vibration of the needles inserted into AP with its main frequency of 10 Hz [8] and other data where the effectiveness of selected frequencies is stressed [9]. This allows to suppose the presence of a type of resonant relations between every AP, the channel as a unity of AP, the system of channels as a whole, and the environment.

In fact, as early as 1933, A.A. Ukhtomsky published the work on resonant interactions between nervous centers during reflection of the environment by the brain [10]. This idea has been developed and confirmed experimentally [11] and nowadays the idea of wave psychophysics is shared by many specialists [12].

To prove the suggested hypothesis we have undertaken an attempt to find numeric relations in ACP which can be treated as resonant ones. Besides, the regularities revealed should reflect the postulates of the modern multilevel theory [13].

According to the postulates of ACP theory [14] there exists the twenty-four-hour circulation of integral energy named Chi from channel

to channel, two hours for each channel in turn, although there is a variety in lengths and quantities of AP for the channel beginning with number I (Lungs Channel) to number XII (Liver Channel) (using Int. classification).

I (Lungs) - 11 AP; II (Large Intestine) - 20; III (Stomach) - 45; IV (Spleen-Pancreas) - 21; V (Heart) - 9; VI (Small Intestine) - 19; VII (Bladder) - 67; VIII (Kidney) - 27; IX (Heart Constrictor) - 9; X (Three Heaters) - 23; XI (Gall Bladder) - 44; XII (Liver) - 14.

According to the ancient Chinese monada-scheme which reflects both the wholeness of Chi energy and complex character of energetic processes with their Yin-Yang interactions, when Yin contains a Yang element and Yang contains a Yin one, we group the channels in two rows.

The row of Yin channels: V, IX, I, XII, VI - (Yang element), VIII. (1)

The row of Yang channels: II, IV - (Yin element), X, XI, III, VII. (2)

According to these (1), (2) rows there are numeric rows of AP quantity:

$$U_1 = U_2 = 9; U_3 = 11; U_4 = 14; U_5 = 19; U_6 = 27 \quad (3)$$

$$V_1 = 20; V_2 = 21; V_3 = 23; V_4 = 44; V_5 = 45; V_6 = 67 \quad (4)$$

We have found a formula to represent the members of row (3) beginning with the third member.

$$U_n = U_{n-1} + F_n; \quad n = 3, 4, 5, 6; \quad (5)$$

where F_n - the members of Fibonacci's row:

$$F_1 = F_2 = 1; F_n = F_{n-1} + F_{n-2}; \quad n \geq 3. \quad (6)$$

Accordingly, the second and the third member of row (4) may be represented as:

$$V_n = V_{n-1} + F_n; \quad n = 2, 3; \quad (7)$$

and the members V_4 and V_6 may be represented as:

$$V_4 = V_2 + V_3 \quad (8)$$

$$V_6 = V_3 + V_4$$

It is well known that the Fibonacci's row has closed connection with the so called "gold section",

$$\alpha = \frac{1 + \sqrt{5}}{2} = 1,618... \quad (9)$$

that is widely spread in living organisms.

The unusual character of appearance of the Fibonacci's members in the relations revealed is explained by complexity of an organism's SFH systems, so that there are other numeric consequences and their invariants [15].

The row of "a" transformations was revealed in the investigations of biophysical parameters of AP during rest and exertion [5], as well as when AP were effected by current.

Both the quantity of AP relations with the channels and the deviations in the properties of each AP correlate with the above mentioned numeric relations. Therefore, the point of view that the function of an organism as a whole is based on the principle of harmonic ratios as a main principle of homeostasis, gets one more proof.

The geometry of biological objects depending upon the conditions of the environment (the presence of electromagnetic, gravitational fields, etc.) causes the close connection of structure and function which is represented in similar numeric relations.

These structural and functional relations are formed originally while considering the channels relations during the twenty-four-hour cycle (see Figure 1).

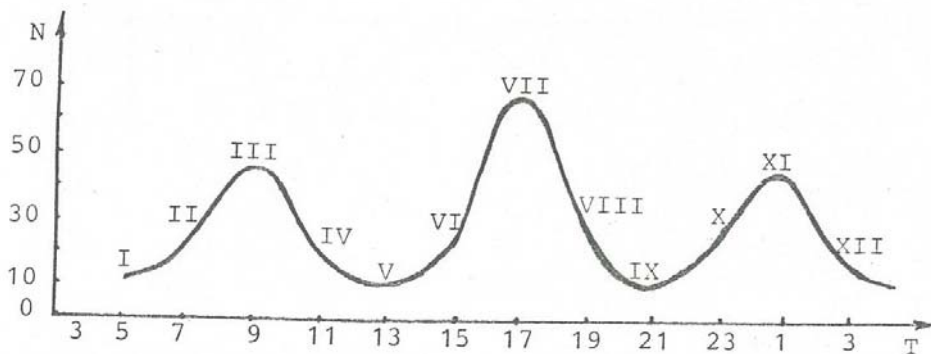


Figure 1: Twenty-four-hour cycle with a two-hour maximum activity period for each channel (T) versus the quantity of AP within the channel (N).

This also may be applied for evaluation of the topography of the AP (or channel) in the regions of the organs projection (ear, nose, etc.). Therefore, there may be found the sections which correspond to the curve so that the points of AP projections (channels) are situated according to the maximum and minimum of the curve.

The mentioned above Khakimov's general multilevel model (GMM) [13] was worked out to investigate any system of the Nature. Along with the

other principles of harmonic ratios it contains also the principle of symmetry - asymmetry relations.

This principle in traditional ACP theory is represented not only as Yin-Yang interactions in general, but also as their interactions in space-time coordinates. There is an upper part of the body marked as Yang and the lower part marked as Yin, the front one marked as Yin and the back one marked as Yang, the left one marked as Yang and the right part marked as Yin.

The numeric symmetry-asymmetry expression becomes evident from Table 1.

Table 1.

<u>Back Yang</u> (the channels of the external surface of a body)	<u>Front Yin</u> (the channels of the internal surface of a body)	<u>Apper Yang</u> (the channels of upper limbs)	<u>Lower Yin</u> (the channels of lower limbs)
VI-19 (AP)	V-9 (AP)	V-9 (AP)	XII-14 (AP)
A II-20	C IX-9	C IX-9	D IV-21
X-23	I-11	I-11	VIII-27
XI-44	XII-14	VI-19	XI-44
B III-45	D IV-21	A II-20	B III-45
VII-67	VIII-27	X-23	VII-67
<u>218</u>	<u>91</u>	<u>91</u>	<u>218</u>

There may be revealed another appearance of symmetry in the groups reconstructed:

$$\begin{aligned}
 A &= 62; B = 156; C = 29; D = 62 \\
 A + B &= 218; C + D = 91 \\
 C + A &= 91; D + B = 218
 \end{aligned}
 \tag{10}$$

The next fact we have found concerns the configuration of AP along the spinal column that corresponds to channel VII position which is a kind of interface where each of 12 coupled channels has its representative AP (see Figure 2).

These postulates and constructions of ACP theory correspond to modern information about segmental organization of the spinal cord and regions of internal organ projections that is revealed in AP names (Lung point, Heart point, etc.).

Figure 2 shows that the point representing channel VIII divides the total number of vertebrae (34) in gold section as 21:13 while the similar point of channel VII divides the remaining right part as 5:8,

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- [2] Schrodinger E., Collected papers on wave mechanics, London, 1928.
 - [3] Chechel'nitsky A.M., Extremity, stability, resonance in astrody-
namics and cosmonautics. Mashinostroenie, Moscow, 1960.
 - [4] Structural fundamentals of adaptation and compensation of impaired
function. D.S. Sarkisov (ed.), Meditsina, Moscow, 1987.
 - [5] Dubrov A.P., Symmetry of biological rhythms and reactivity.
Meditsina, Moscow 1987.
 - [6] Vorontsov N.V., Perezhogin A.A., System modelling of functional
processes in living organisms. Moscow, Dept. VINITI, 4.05.89,
No. 2854-B-89.
 - [7] Anokhin P.K., An assay on physiology of functional systems. Meditsi-
na, Moscow, 1975.
 - [8] Frolov K.V., Mirkin A.S., Mashansky V.F., et al, Vibrational me-
chanics. The use of vibration in biology and medicine. Nauka,
Moscow, 1989.
 - [9] Ludwig V., The new method of light therapy. Am. J. Acupuncture, 14,
1, 35 (1986).
 - [10] Ukhtomsky A.A., A resonant theory of nervous conduction. Complete
works, 6, Leningrad University Press, 1962.
 - [11] Kratin U.G., The electrical reactions of the brain to the suppress-
ing signals. Nauka, Leningrad, 1967.
 - [12] Avramenko R.F., Balubova D.V., et al., Information energy and hypo-
thesis of wave psychophysics. In: The questions of psychohygiene,
psychophysiology, sociology in coal industry. Moscow, 169 (1976).
 - [13] Khakimov A.M., Modelling of hierarchical systems (theory and metho-
dological aspects). Kazan University Press, 1986.
 - [14] Tabeyeva D.M., A manual of acupuncture reflexotherapy. Meditsina,
Moscow, 1985.
 - [15] Bochkov V.G., Multivariant regulation in biological systems and
new physiological constants. Summary of the scientific thesis for
Candidate of Biological Sciences, Kiev, 1986.
 - [16] Radyuk M.S., What is behind the gold section? Zh. Khimiya i Zhizn,
7, 66 (1988).
 - [17] System, symmetry, harmony. V.S. Tuchtin, U.A. Urmantsev (eds),
Mysl, Moscow, 1988.
 - [18] Weiers H., Akupunktur und Bioscillatortherapie. Theor. u. Prax.,
11, 3, 133 (1983).
 - [19] Wirya R., Bioquantum mechanical theory of the mechanism of acu-
puncture and related modalities. Am. J. Acupuncture, 16, 3, 235
(1986).
 - [20] Petukhov S.V., Biomechanics, bionics and symmetry. Nauka, Moscow,
1981.
 - [21] Kurdyumov S.P., Malinetsky G.G., Synergetics - the self-organiza-
tion theory. In: Computers, models, computer experiments. Nauka,
Moscow, 1988, p. 79.
 - [22] Asimov M.S., Tursunov A.T., Relationships of microcosmos and
macrocosmos as a philosophical problem. In: Philosophy, Natural
Sciences Nowadays. Mysl, Moscow, 1981, p. 44.