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QUANTUM CODE BIOLOGY AND THE DOCTRINE OF ENERGY-INFORMATION EVOLUTION BASED ON BIO-ANTENNA ARRAYS

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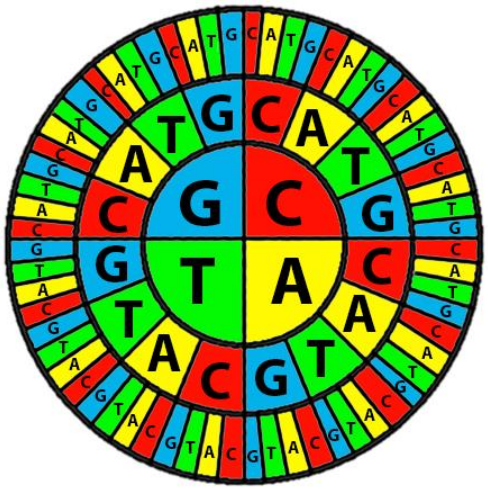
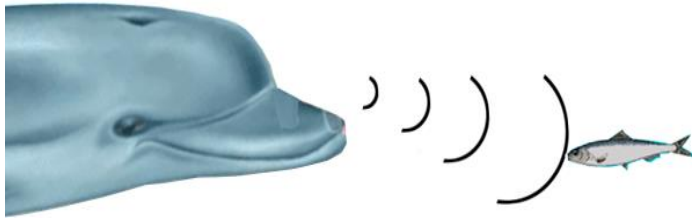




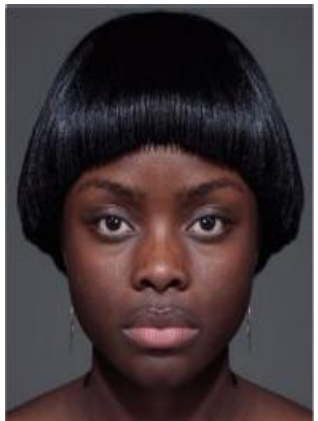
Dualism "probability-vs-determinism" in genetics

Genetics as a science began with Mendel's discovery of the stochastic rules of inheritance of traits in experiments on the crossing of organisms. Many processes in living bodies are a stochastic nature. The well-known expressions "gene noise" or "cell noise" reflect the fact that even genetically identical cells within the same tissue exhibit different levels of protein expression, different sizes, and structures due to the stochastic nature of interactions of individual molecules in cells.

Gr. Mendel (1822-1884)

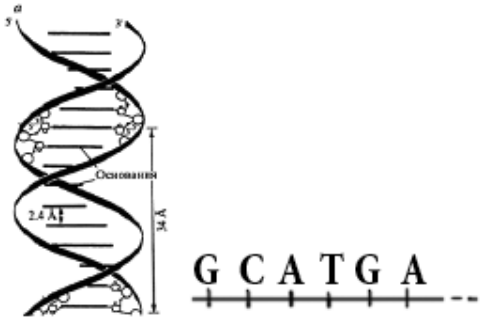
The stochastic nature of genetic processes in the "small" does not interfere with the inheritance of the traits determined in the "big” (so-called Gestalt phenomena). For example, fingerprints are different for all people, although fingers in the whole have a typical shape and composition (3 phalanges, etc.).

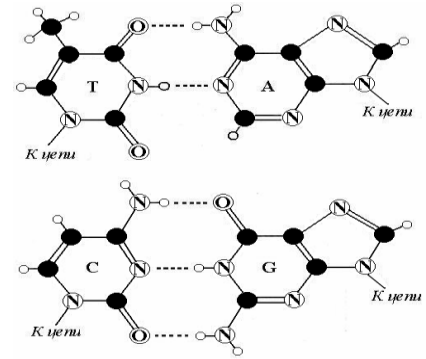
According to Mendel's law of independent inheritance of traits, information from the level of DNA molecules dictates the macrostructure of living bodies through many independent channels, despite strong noises. Thus, hair, eye and skin colors are inherited independently of each other. Accordingly, **each organism is a machine of multichannel noise-immunity encoding**.



All physiological systems are genetically inherited through their genetic coding. Therefore, one should look for the origins of these phenomena in the genetic system of DNA informatics.

In the course of such searches, the speaker discovered that already in the information system of DNA molecules of the genomes of higher and lower organisms, universal gestalt phenomena of their stochastic organization are embedded.
Let us explain this.





Genetic information on DNA molecules is written in sequences of 4 nucleotides: adenine A, guanine G, cytosine C and thymine T.

DNA also contains alphabets of 16 duplets, 64 triplets, 256 tetraplets, etc. All these interrelated alphabets are represented in matrix form as members of a single tensor family of matrices $[C, A; T, G]^{(n)}$:

	1	0
1	C	A
0	T	G

	11	10	01	00
11	CC	CA	AC	AA
10	CT	CG	AT	AG
01	TC	TA	GC	GA
00	TT	TG	GT	GG

	111	110	101	100	011	010	001	000
111	CCC	CCA	CAC	CAA	ACC	ACA	AAC	AAA
110	CCT	CCG	CAT	CAG	ACT	ACG	AAT	AAG
101	CTC	CTA	CGC	CGA	ATC	ATA	AGC	AGA
100	CTT	CTG	CGT	CGG	ATT	ATG	AGT	AGG
011	TCC	TCA	TAC	TAA	GCC	GCA	GAC	GAA
010	TCT	TCG	TAT	TAG	GCT	GCG	GAT	GAG
001	TTC	TTA	TGC	TGA	GTC	GTA	GGC	GGA
000	TTT	TTG	TGT	TGG	GTT	GTG	GGT	GGG

These matrices are used in our studying the stochastic organization of genomic DNAs. For example, let's turn to the DNA of the first human chromosome, which contains a sequence of about 250 million nucleotides. Calculating in this DNA the percentages of each member of the DNA **alphabet of 4 nucleotides**, we obtain a table of their probabilities:

%C	%A		0.2085	0.2910
%T	%G	=	0.2918	0.2087

Then we represent the same DNA as a text of two-letter words (such as CA-TT-GA-) based on the **alphabet of 16 duplets** and calculate a table of percentages of 16 types of duplets:

%CC	%CA	%AC	%AA		0.05409	0.07274	0.05033	0.09504
%CT	%CG	%AT	%AG	=	0.07134	0.01031	0.07429	0.07137
%TC	%TA	%GC	%GA		0.06008	0.06312	0.04402	0.06008
%TT	%TG	%GT	%GG		0.09568	0.07286	0.05046	0.05419

Similarly, presenting the same DNA as a text of three-letter words, and then as a text of four-letter words, etc., we obtain the corresponding tables of percentages of 64 triplets, 256 tetraplets, etc.

%CCC	%CCA	%CAC	%CAA	%ACC	%ACA	%AAC	%AAA
%CCT	%CCG	%CAT	%CAG	%ACT	%ACG	%AAT	%AAG
%CTC	%CTA	%CGC	%CGA	%ATC	%ATA	%AGC	%AGA
%CTT	%CTG	%CGT	%CGG	%ATT	%ATG	%AGT	%AGG
%TCC	%TCA	%TAC	%TAA	%GCC	%GCA	%GAC	%GAA
%TCT	%TCG	%TAT	%TAG	%GCT	%GCG	%GAT	%GAG
%TTC	%TTA	%TGC	%TGA	%GTC	%GTA	%GGC	%GGA
%TTT	%TTG	%TGT	%TGG	%GTT	%GTG	%GGT	%GGG

=

0.01385	0.01878	0.01524	0.01861	0.01183	0.01977	0.01447	0.03693
0.01853	0.00291	0.01789	0.02104	0.01622	0.00254	0.02375	0.01988
0.01758	0.01275	0.00251	0.00227	0.01317	0.01942	0.01441	0.02237
0.02009	0.02088	0.00259	0.00291	0.02388	0.01781	0.01614	0.01848
0.01588	0.01964	0.01103	0.01986	0.01255	0.01456	0.00962	0.01960
0.02226	0.00233	0.01939	0.01284	0.01437	0.00253	0.01327	0.01756
0.01972	0.01981	0.01457	0.01947	0.00956	0.01115	0.01256	0.01600
0.03725	0.01884	0.01988	0.01895	0.01445	0.01534	0.01185	0.01382

At first glance, the resulting sets of percentages of n-plets in these n-plets DNA-texts are quite chaotic.

%C	%A
%T	%G

=

0.2085	0.2910
0.2918	0.2087

0.05409	0.07274	0.05033	0.09504
0.07134	0.01031	0.07429	0.07137
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But in this seeming chaos, there are many universal rules for n-plet groupings that are valid for all studied genomes: special n-plet groupings in matrices of probabilities for different n-texts of the genomic DNA are numerically interrelated.

(See Petoukhov's articles on http://petoukhov.com/)

For example, with high precision, %C is equal to the sum of the percentages of 4 duplets starting with C (i.e., %CC+%CA+%CT+%CG), and also the sum of 16 triplets starting with C, and also the sum of 64 tetraplets starting with C, etc.

Similar equalities hold for the probabilities of each of the remaining three nucleotides %A, %T, %G and the sums of the percentages of 4 duplets, 16 triplets, and 64 tetraplets starting at this nucleotide.

%C	%A
%T	%G

=

0.2085	0.2910
0.2918	0.2087

0.05409	0.07274	0.05033	0.09504
0.07134	0.01031	0.07429	0.07137
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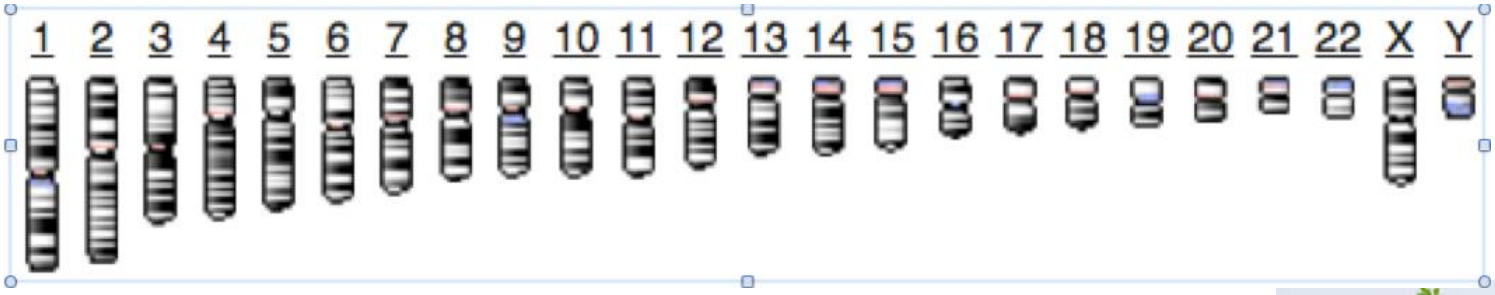
In different genomes, the percentages of nucleotides %C, %G, %A, %T, which determine the values of the sums of percentages in the above groupings of n-plets, can vary greatly. But this gestalt rule of interdependence of the sums of percentages of n-plets in n-plet layers of genomic DNA-texts is invariably repeated for all genomic DNAs tested by the author (n = 1, 2, 3, 4, 5,…., but much less than the length of genomic DNA).

GENOMES OF EUKARYOTS AND PROKARYOTS

These rules of stochastic organization of genomic DNAs holds for all already analyzed DNA sequences:

- 1) all 24 human chromosomes; 2) all chromosomes of Drosophila, mouse, worm, many plants; 3) 19 genomes of bacteria and archaea; 4) many extremophiles living in extreme conditions, for example, radiation with a level 1000 times higher than fatal for humans.



These universal rules in genomic DNAs indicate the existence of nontrivial algebraic invariants of a **globally** genomic nature, which remain unchanged over million years of biological evolution, during which millions of species of organisms die off and new ones appear (although **locally** genomic sequences are modified by mutations, natural selection mechanisms, etc.). This seems to be connected with the question of the origin of life since these patterns are presented also in archaea and bacteria.

THE MAIN DIFFERENCE OF LIVING BODIES

The creators of quantum mechanics P. Jordan and (later) E. Schrödinger pointed out **the main difference between living bodies and inanimate ones**: in living bodies, **genetic molecules play a dictatorial role** (inanimate objects have no such dictatorial molecules since they are governed by the average random motion of millions of particles). The study of properties of DNA informatics is some of the key tasks of modern science (see the history of "quantum biology", 2018, https://royalsocietypublishing.org/doi/full/10.1098/rspa.2018.0674)

Pascual Jordan

Erwin Schrödinger

P. Jordan, who was also the author of the first article on quantum biology, stated:

"***life's missing laws are the rules of chance and probability of the quantum world***"

(see the history of "quantum biology", 2018, https://royalsocietypublishing.org/doi/full/10.1098/rspa.2018.0674)

Pascual Jordan

The speaker proposed a new modeling approach in quantum code biology by considering each of genomic DNAs as a concrete quantum state of a multi-level quantum system (https://www.preprints.org/manuscript/202203.0100/v2).

This approach uses qubits as units of quantum informatics.

Briefly speaking, a quantum state $|\psi_4>$ of each genomic DNA under its consideration as a sequence of 4 nucleotides (whose percentages are denoted %C, %A, %T, %G) can be presented by the following **2-qubit** expression:

$$|\psi_4> = \%C^{0.5}|00> + \%A^{0.5}|01> + \%T^{0.5}|10> + \%G^{0.5}|11>,$$

where %C+%A+%T+%G = 1, and symbols |00>, |01>, |10>, |11> traditionally denote computational basis states.

Similarly, a quantum state $|\psi_{16}>$ of each genomic DNA under its consideration as a sequence of 16 duplets (whose percentages are denoted %CC, %CA, %CT, ….) can be presented by the following **4-qubit** expression:

$$|\psi_{16}> = \%CC^{0.5}|0000> + \%CA^{0.5}|0001> + \%CT^{0.5}|0010> + \%CG^{0.5}|0011> + \%AC^{0.5}|0100> + \%AA^{0.5}|0101> + \%AT^{0.5}|0110> + \%AG^{0.5}|0111> + \%TC^{0.5}|1000> + TA^{0.5}|1001> + \%TT^{0.5}|1010> + \%TG^{0.5}|1011> + \%GC^{0.5}|1100> + \%GA^{0.5}|1101> + + \%GT^{0.5}|1110> + \%GG^{0.5}|1111>,$$

where the sum of percentages of all duplets is equal to 1.

Similarly, a quantum state $|\psi_{64}>$ of each genomic DNA under its consideration as a sequence of 64 triplets can be presented by corresponding **6-qubit** expression, etc.

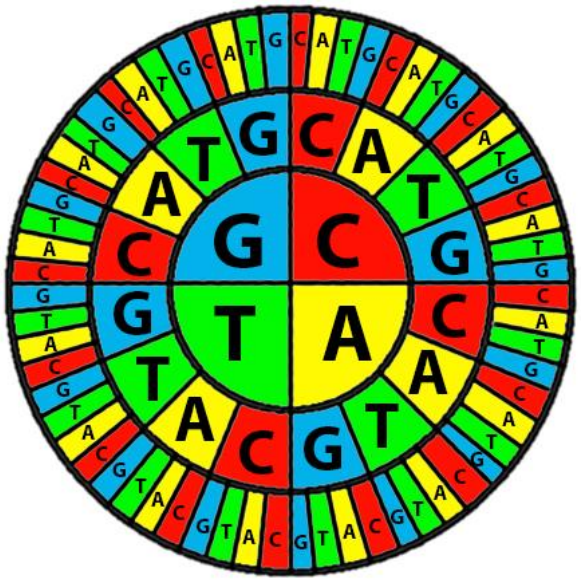
The described universal rules of stochastic organization of genomic DNAs testify that these quantum states $|\psi_4>$, $|\psi_{16}>$, $|\psi_{64}>$, etc are interconnected. The speaker discovered that these interconnections are expressed by means of a component-wise tensor product of each computational basis state by a corresponding 2-qubit. In this approach, the described universal stochastic features of genomic DNAs reveal that **each of these DNAs is a regular multilevel web of 2-qubit states** (details are given in https://www.preprints.org/manuscript/202203.0100/v2.

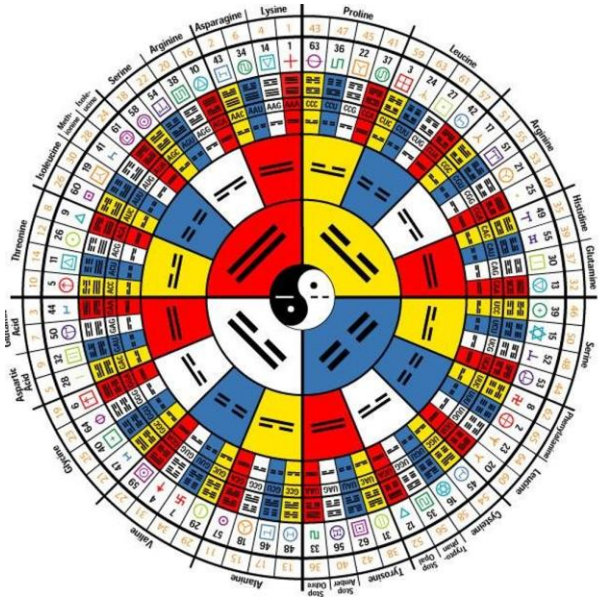
These results in quantum code biology lead to new quantum information algorithms.

GENOMIC QUANTUM-INFORMATION MANDALAS

Many authors noted that the system of DNA alphabets of 4 nucleotides, 4^2 duplets, 4^3 triplets resembles the Yin-Yang mandalas of the ancient Chinese book “I-Ching" and is naturally represented by a 4-section multi-tiered circular diagram. The inner tier of the diagram contains 4 nucleotides, the second tier contains 16 duplets, the third tier contains 64 triplets, and so on.

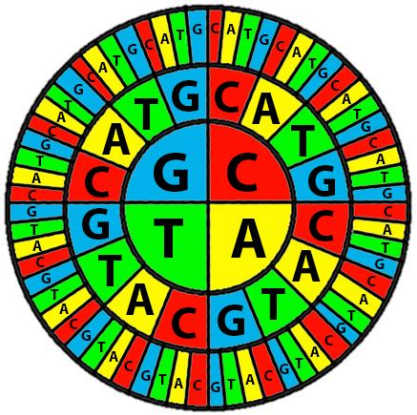
These figures are taken from Internet:

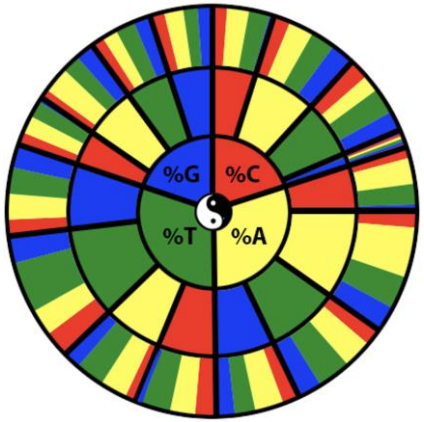




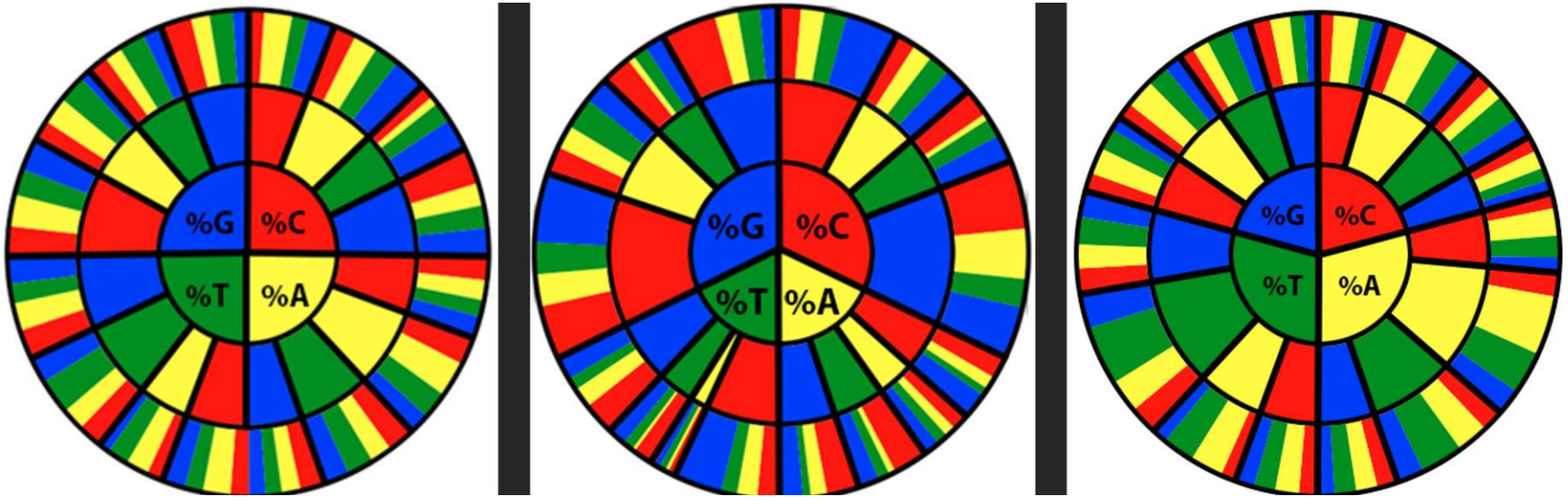
This representation is interesting since for thousands of years, millions of Buddhists, Hindus and other believers have created mandalas, feeling in them a meditation tool to achieve "enlightenment" and healing. The creator of analytical psychology, K. Jung, and his colleague, Nobel laureate in physics, W. Pauli considered the mandala to be an innate archetype of the unconscious and a conjugation of the cosmogram with the psychogram.

Revealing the universal rules of genomic DNAs stochastics makes it possible to construct mandalas for the quantum-information regularities of genomic stochastics. On the inner tier of these mandalas, the probabilities of 4 nucleotides are represented, on the second tier - the probabilities of 16 duplets, on the third - the probabilities of 64 triplets, and so on. In this case, the width of each cellule on each tier corresponds to the probability of its n-plet. These mandalas are called quantum-information mandalas, since these probabilities are conjugated with the probability amplitudes in 2n-qubits that model the stochastics of these DNAs. The drawing on the right shows the DNA mandala of the first human chromosome.





Different genomes can differ greatly in the appearance of their quantum information mandalas due to the different width of the cellules on the tiers, which is demonstrated by the shown mandalas of the genomes of two bacteria - Escherichia coli and Bradyrhizobium japonicum (at left) -, and of chromosome 2L of the fruit fly Drosophila melanogaster.



But in the ratios of the width of the cellules on different tiers of each of these genomic mandalas, the universal rules for tetra-grouping the probabilities of n-plets in the genomic DNA stochastics are presented, for example:

%C ≈ %CC+%CA+%CT+%CG,

%A ≈ %AC+%AA+%AT+%AG,

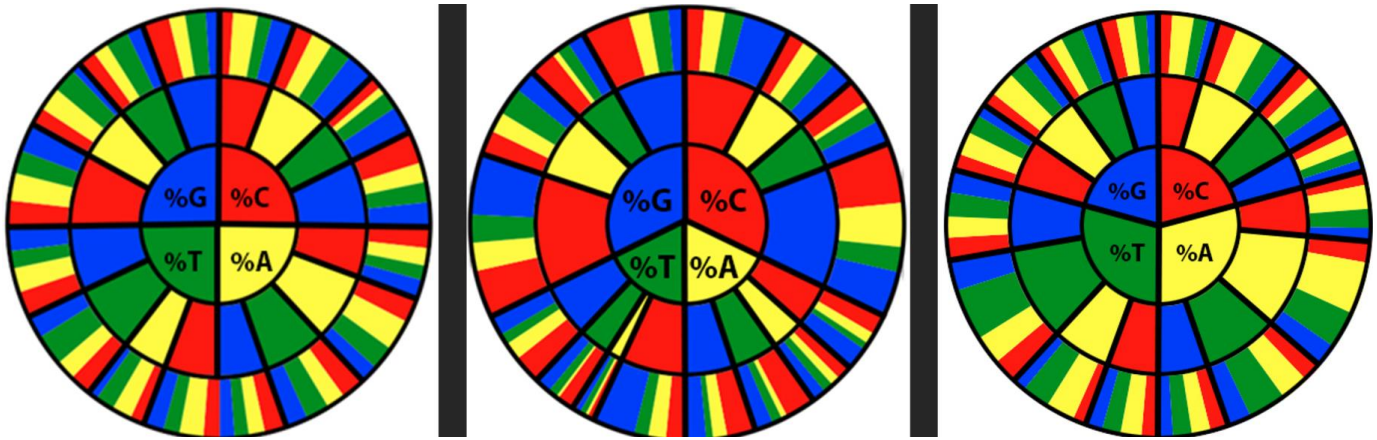
%T ≈ %TC+%TA+%TT+%TG,

%G ≈ %GC+%GA+%GT+%GG,

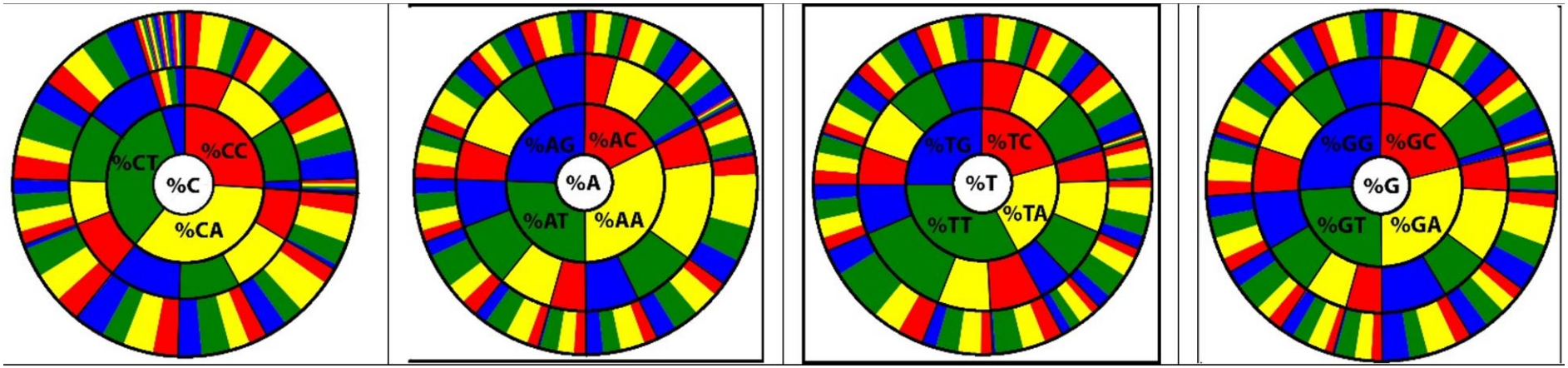
%CC ≈ %CCC+%CCA+%CCT+%CCG,

%CCC ≈ %CCCC+%CCCA+%CCCT+%CCCG,

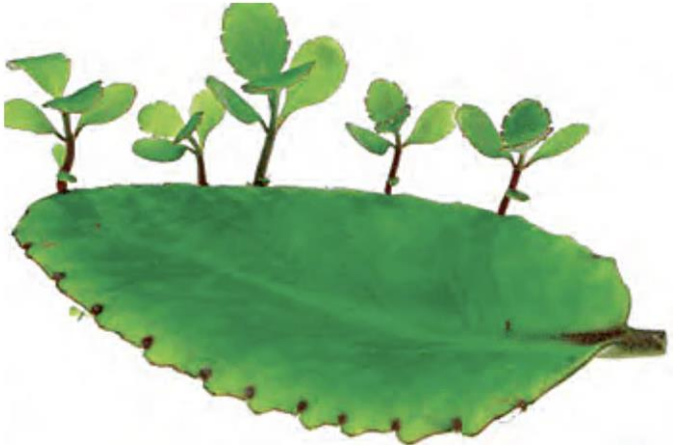
and so on.

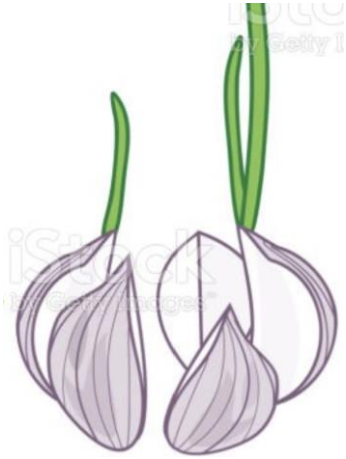


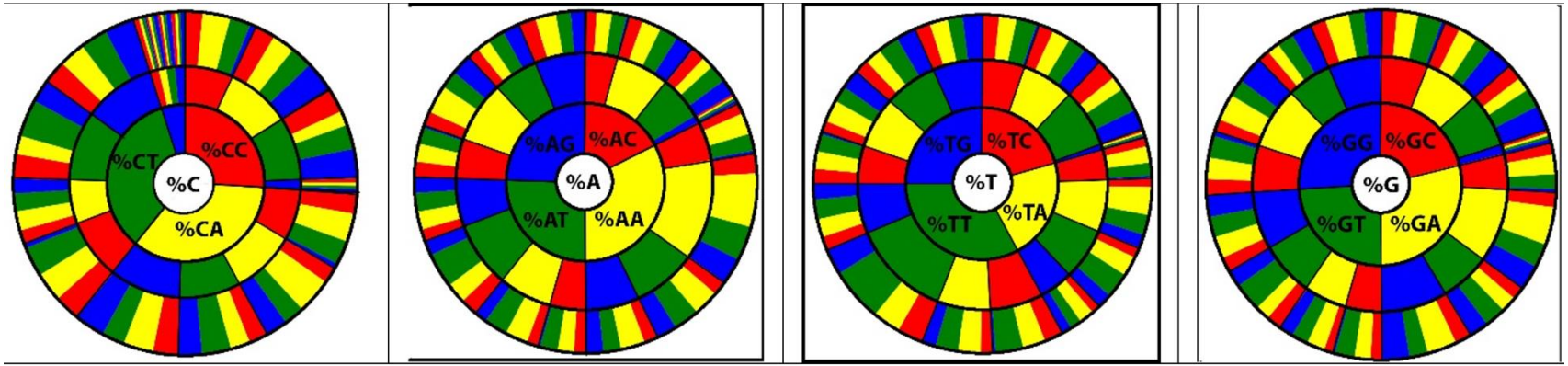
Due to this rule of tetra-groupings of n-plets, each of the cellules of the genomic mandalas can serve as a center of its own mandala. For example, each of the cellules on the first tier of the mandala, where %C, %A, %T, and %G are located, is connected with its own mandala of probabilities of n-plets. These new mandalas, shown below for human chromosome #1, obey the same rules of tetra-groupings n-plets, that is, **each separate cellule reproduces a new mandala obeyed the same rules. This is reminiscent of the reproduction of living bodies by seeds and grains**.



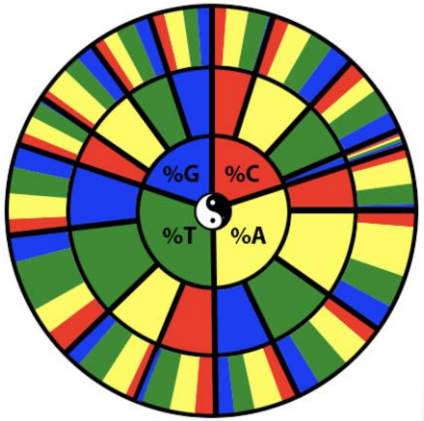
The reproduction of living bodies by seeds and grains

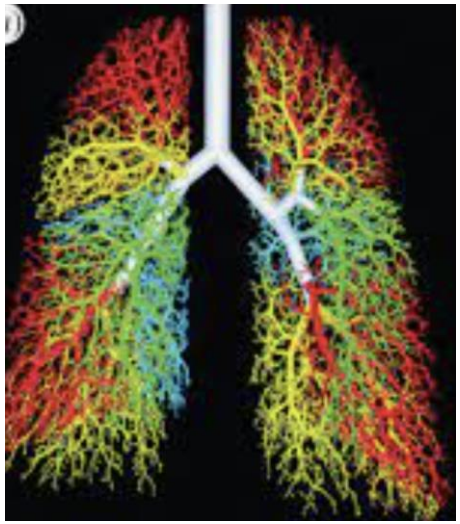




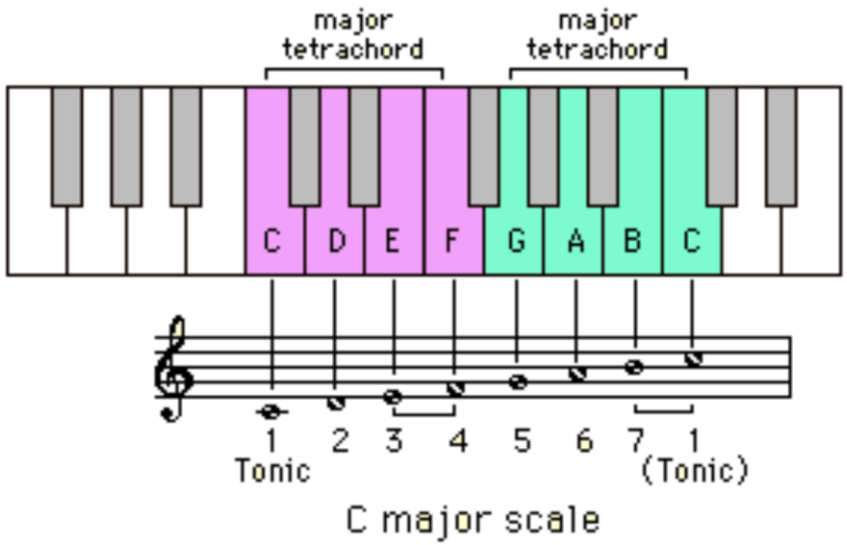


The features of genomic mandalas testify about fractal-like organization of genomic DNAs. They testify that already at the deepest level of biological organization - at the level of genomic DNAs associated with quantum informatics - fractal principles work, which totally permeate the overlying inherited biostructures and which are also connected to stochastic mechanisms of Gestalt biology.



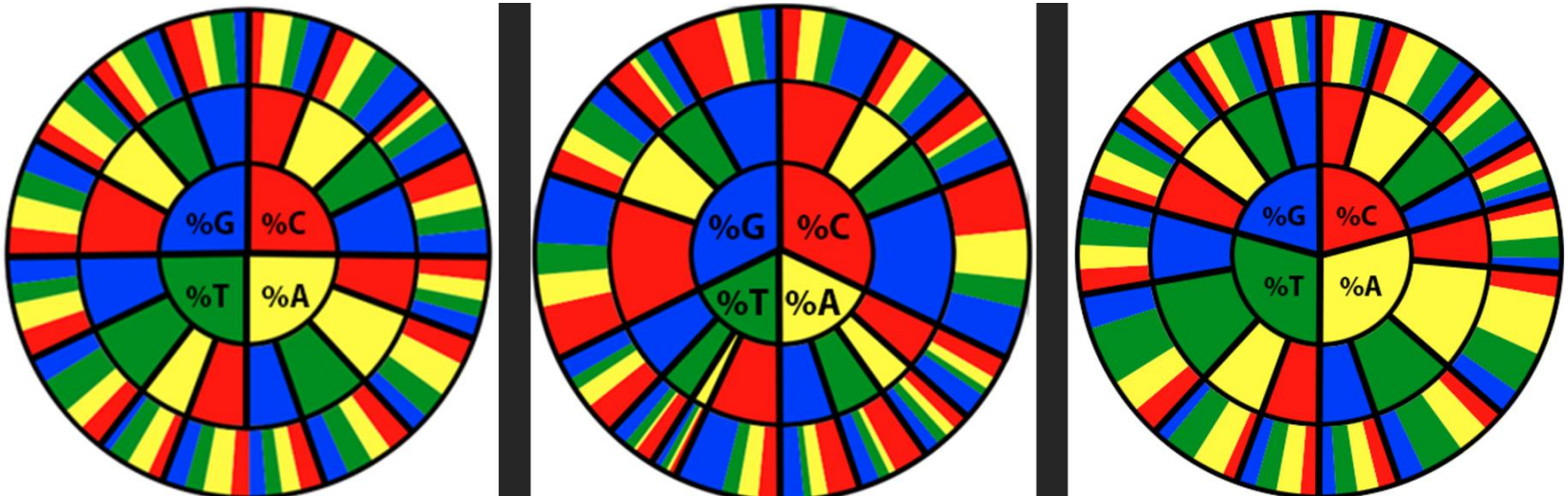


The theme of meditation on mandalas has been associated with musical meditation since ancient times. Not without reason, sets of bells exist in the ancient Buddhist monasteries. The principle of **tetra-grouping** in genome stochastics is associated with the important role of **tetrachords** in music, which has been known in musicology since Pythagorean times: **any classical musical mode is a set of two tetrachords** that combine 4 adjacent note scale steps.



(The shown Figures are taken from Internet).

In this regard, it seems that quantum-information genomic mandalas can be used for applied purposes to create on their basis - for each specific organism – stochastic-deterministic sequences of musical, laser and other physical influences that can affect the physiological activity of this organism. In particular, tetrachords of major or minor types can be used to produce corresponding genomic "music". This is a separate big applied topic for future research.



THE DOCTRINE OF ENERGY-INFORMATION EVOLUTION BASED ON BIO-ANTENNA ARRAYS

The speaker revealed that the described universal rules of stochastics of genomic DNAs can be expressed not only by tensor families of 2-qubits but also by algebraic expressions from the tensor-matrix theory of digital antenna arrays (called also as Smart Antennas). This theory, created by Ukrainian Prof. V.Slyusar, uses the Hadamard product of matrices (its symbol $\circ$) instead of the tensor product of matrices.

Thus, in the regular stochastics of genomic DNAs, quantum informatics and the theory of antenna arrays exist in parallel in some interrelation (see details in the published articles).

For example, in genomic DNAs, the (2*2)-matrix of 4 monoplets probabilities is interrelated with the (4*4)-matrix of 16 duplets probabilities by the equation, where the Hadamard product $\circ$ and additional (2*2)-matrices B_C, B_A, B_T, B_C exist:

$$\begin{bmatrix} \%C & \%A \\ \%T & \%C \end{bmatrix} \circ \begin{bmatrix} B_C & B_A \\ B_T & B_G \end{bmatrix} = \begin{bmatrix} \%CC & \%CA & \%AC & \%AA \\ \%CT & \%CG & \%AT & \%AG \\ \%TC & \%TA & \%GC & \%GA \\ \%TT & \%TG & \%GT & \%GG \end{bmatrix}$$

$$B_C = \begin{bmatrix} \%CC:\%C & \%CA:\%C \\ \%CT:\%C & \%CG:\%C \end{bmatrix}, \quad B_A = \begin{bmatrix} \%AC:\%A & \%AA:\%A \\ \%AT:\%A & \%AG:\%G \end{bmatrix}$$

$$B_T = \begin{bmatrix} \%TC:\%T & \%TA:\%T \\ \%TT:\%T & \%TG:\%T \end{bmatrix}, \quad B_G = \begin{bmatrix} \%GC:\%G & \%GA:\%G \\ \%GT:\%G & \%GG:\%G \end{bmatrix}$$

Similarly algebraic interrelation between the (4*4)-matrix of 16 duplets probabilities and the (8*8)-matrix of 64 triplets probabilities are expressed by the equation :

%CC	%CA	%AC	%AA
%CT	%CG	%AC	%AG
%TC	%TA	%GC	%GA
%TT	%TG	%GT	%GG

$\circ$

B_{CC}	B_{CA}	B_{AC}	B_{AA}
B_{CT}	B_{CG}	B_{AT}	B_{AG}
B_{TC}	B_{TA}	B_{GC}	B_{GA}
B_{TT}	B_{TG}	B_{GT}	B_{GG}

=

%CCC	%CCA	%CAC	%CAA	%ACC	%ACA	%AAC	%AAA
%CCT	%CCG	%CAT	%CAG	%ACT	%ACG	%AAT	%AAG
%CTC	%CTA	%CGC	%CGA	%ATC	%ATA	%AGC	%AGA
%CTT	%CTG	%CGT	%CGG	%ATT	%ATG	%AGT	%AGG
%TCC	%TCA	%TAC	%TAA	%GCC	%GCA	%GAC	%GAA
%TCT	%TCG	%TAT	%TAG	%GCT	%GCG	%GAT	%GAG
%TTC	%TTA	%TGC	%TGA	%GTC	%GTA	%GGC	%GGA
%TTT	%TTG	%TGT	%TGG	%GTT	%GTG	%GGT	%GGG

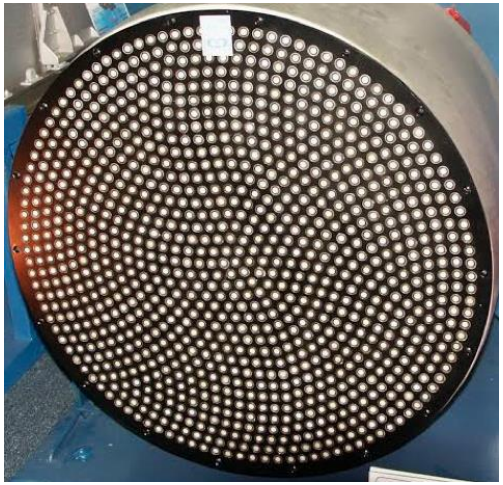
See preprint - https://www.preprints.org/manuscript/202203.0100/v1 (doi: 10.20944/preprints202203.0100.v1).

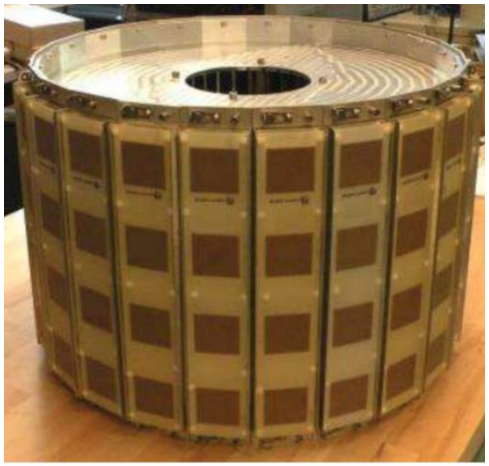
These matrix-tensor connections (or analogies) between the probability matrices of genomic DNAs and the tensor-matrix theory of digital antenna arrays stimulated the speaker to develop the doctrine of energy-information evolution based on bio-antenna arrays.

The doctrine studies a possible biological meaning of amazing emergent properties of antenna arrays, which have conquered modern technology, but have never been considered in science to comprehend the phenomenal properties of living bodies.

Antenna arrays have thousand applications: medical ultrasound scanning technology, sonar systems, radio relay stations, radio astronomic devices, avionics, and many others.

Modern science connects with antenna arrays future revolutionary changes in computers (biophotonics) and energetics (effective using solar energy) due to using nanoantenna arrays, which can include photonic crystalls, liquid crystals, etc.

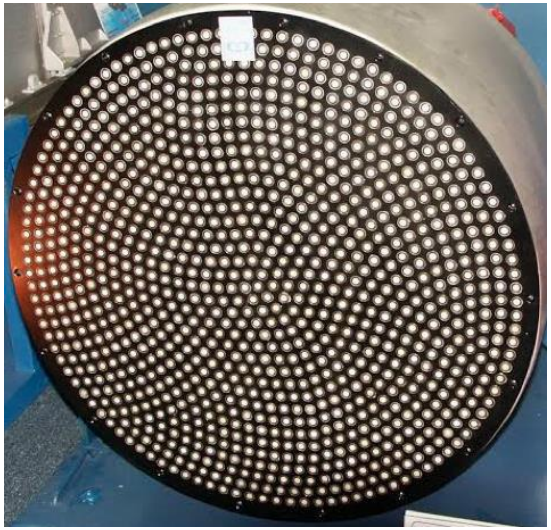


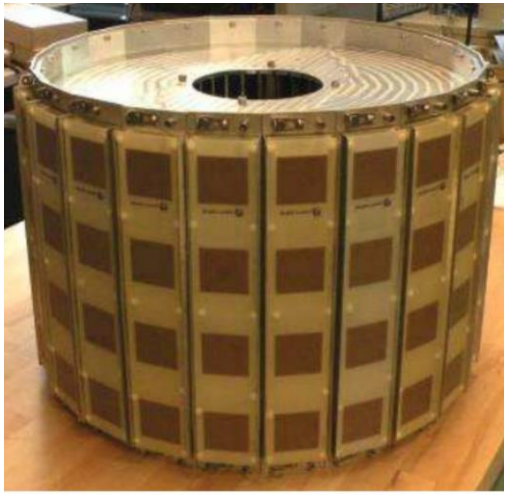


Пример ЦАР Alcatel-Lucent, 2011 год

(These images are taken from Internet free access sites)

Antenna arrays consist of many separate antennas, each of which can emit or absorb waves of a specific frequency range.





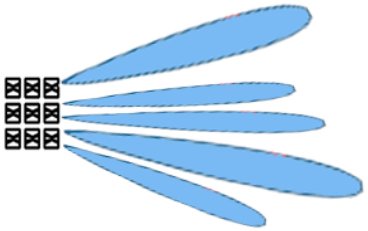
Пример ЦАР Alcatel-Lucent, 2011 год

(These images are taken from Internet free access sites)

Emergent properties of antenna arrays

Antenna arrays provide such kinds of radiation patterns (or beamforming), which are unable for a single antenna element. These emergent properties cause humanity to saturate and envelop the Earth with millions of antenna arrays. Let's list the main emergent properties of antenna arrays:

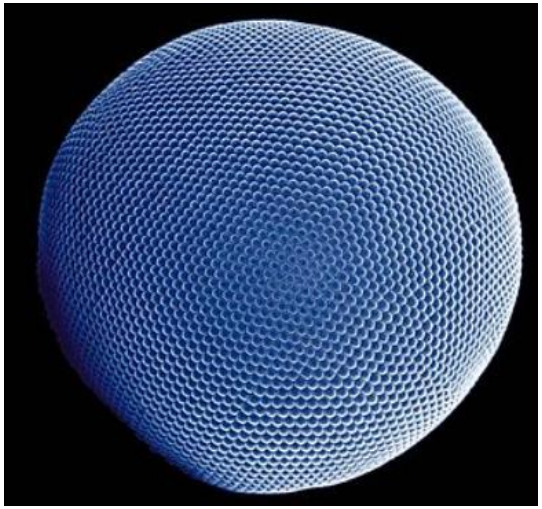
- 1) In a comparison with a single antenna, an array of N elements allows to increase approximately N times the directivity and the gain of the antenna, as well as allows to narrow beams;
- 2) Antenna arrays are a unique tool for providing communication noise-immunity and extracting a weak signal from a strong noise;
- 3) Phased antenna arrays capable of operating with multi-beam radiation patterns.

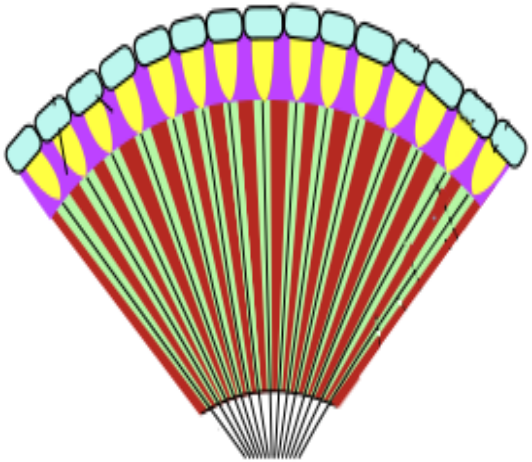


Given these unique emergent properties of antenna arrays, it can be expected that organisms are forced to use them in their life activity and evolution. The presented doctrine confirms this expectation on a set of examples of the structure and functioning of inherited physiological systems based on antenna arrays and their energy waves.

Let’s show some examples of such inherited systems. Considering these examples, one should remember that electrical and Vibro-mechanical oscillations in living bodies are closely connected because many tissues are piezo-electrical (nucleic acids, actin, dentin, tendons, bone, etc.).

Complex faceted eyes

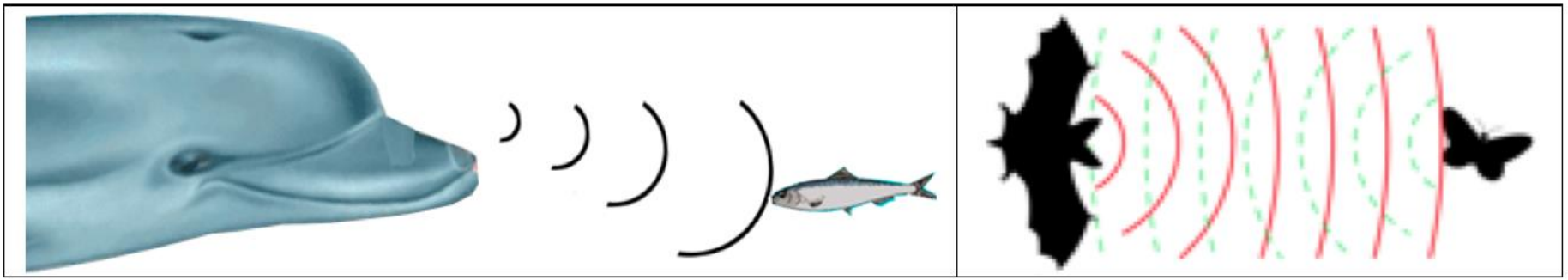




Insects and some other invertebrates receive visual information through complex faceted eyes, which serve as bio-antenna arrays for receiving electromagnetic waves.

(These images are taken from Internet free access sites).

Inherited phenomena of biological echolocation

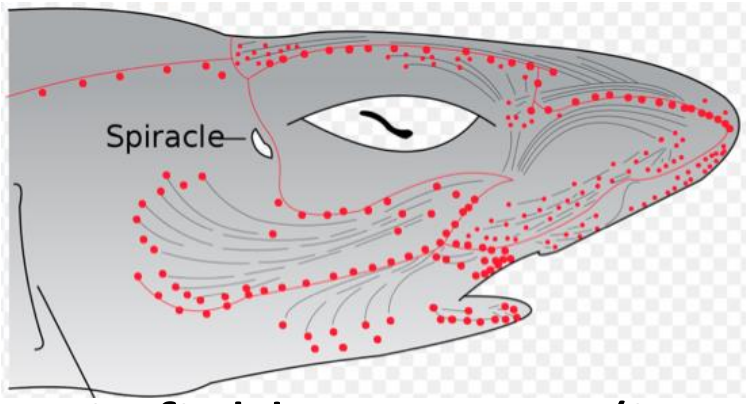


Many organisms have an innate ability to echolocation based on directed rays of a wave nature. Due to the mechanisms of echolocation, for example, dolphins and bats are able to recognize the distance, dimensions, and shape of the objects they track, by analogy with how active Smart Antennas make it possible in technology. A dolphin's body has many hydroacoustic receptors, which form a multi-element broadband hydroacoustic receiving antenna.

(These images are taken from Internet free access sites).

Inherited phenomena of biological electrolocation

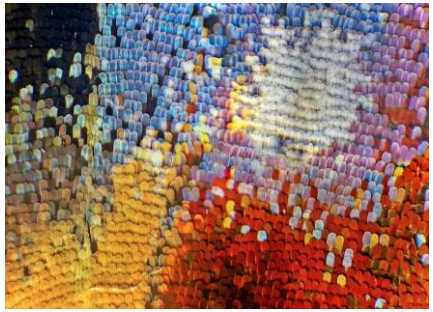
Electrolocation is also widespread with the generation and reception of electric fields for solving by organisms many vital tasks of a search, evaluation, and communication nature. In the active electrolocation, the animal senses its surrounding environment by generating electric fields and detecting distortions in these fields using electroreceptor organs. These organs are distributed throughout the body, forming bio-antenna arrays, the cumulative readings of which are processed by the body.



The arrangement of electromagnetic field receptors (in red) on the shark's head forms a receiving bio-antenna array (from Wikipedia).

Inherited sets of bio-photon crystals



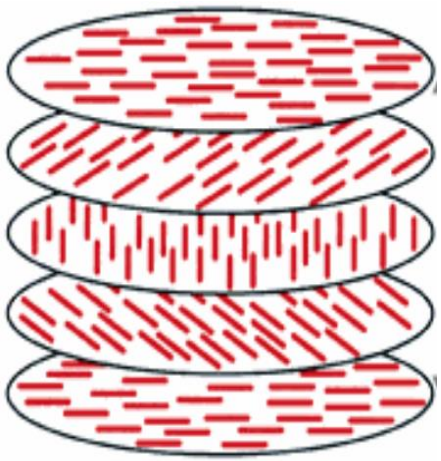



Figures: Photonic crystals form heritable species patterns on butterfly wings and peacock feathers (numerous wings scales are shown, which are photonic crystals).

Modern technologies actively use photonic crystals to control the spatial distribution of photon beams. A photonic crystal is a periodic optical nanostructure that affects the motion of photons. It is known that photonic crystals are related to the topic of nano-antenna arrays.

Inherited systems of liquid crystals

DNA and RNA, some proteins, membranes and cytoskeleton of cells are liquid crystals, which can also form nano-bio-antenna arrays. Of particular interest for biological research are liquid crystals called chiral phases or twisted nematics. For these crystals, the direction of the orientation of molecules in successive layers changes in a spiral.

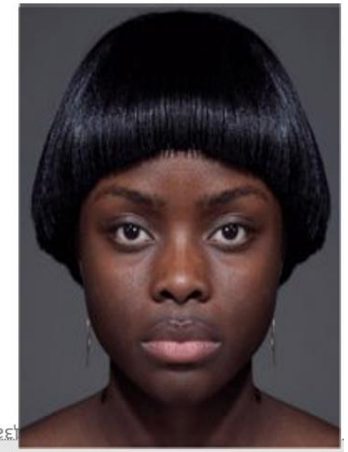


Our doctrine of evolution based on bio-antenna arrays states that **bio-antenna arrayses with their coordinated electro-magnetic waves «orchestrate life»**. This doctrine draws attention to important factors of electromagnetic waves:

- 1. Electromagnetic waves of bio-antenna arrays are involved in the operational transfer and redistribution of energy between the elements of the body;
- 2. For connections between parts of each bio-body, electromagnetic waves provide participations of magnetic and piezo-vibration components;
- 3. The types of polarization of electromagnetic waves are important for relationship between the elements of the bio-body since they are associated with the fundamental problem of biological dissymmetry and molecular chirality noted by L. Pasteur;

- 4) Memory and intellectual abilities are connected with bio-antenna arrays and their wave-coordinated activity;

- 5) The unique ability of antenna arrays to provide noise-resistant multi-channel operation with the extraction of weak signals against the background of strong noise allows us to rethink the phenomenal ability of organisms to work in many parallel channels with weak information signals against the background of strong noise with providing information noise-immunity.



Concerning the role of bio-antenna arrays in energy flows in bio-bodies one can add that the idea of the organizing role of coordinated energy flows inside the body exists since ancient times. It is associated with Ancient Chinese ideas about a certain energy “qi” (or “chi”), whose circulation defines human health and illnesses and which determines the existence of energy pathways called acupuncture meridians. By the impact of acupuncture needles on these meridians, these energy flows can be corrected. **It cannot be ruled out that this mysterious energy “qi” is connected with the energy of a multitude of coordinated electromagnetic and other wave rays from bio-antenna arrays.**

The genetic code and bio-antenna arrays

The described tensor-matrix analogies between structures of stochastic organization of genomes and Smart Antennas allow believing that the genetic code itself is one of the offsprings of wave activity and self-organization of bio-antenna arrays, and this code is connected with other inherited physiological offsprings of bio-antenna arrays.

The secret of the structural organization and origin of the genetic code, as well as the origin of organisms, must be sought not in the random combination of the molecular elements of the genetic code, but in the emergent properties of self-organizing systems of bio-antenna arrays with their wave energy activity. Accordingly, it is not genes that are the dictators of all life activity, since they themselves are built into the energy-information coherences of bio-antenna arrays and are produced by them.

BIOLOGICAL CODES AND ELECTROMAGNETIC WAVE CODES

Everyone knows that the car door can be opened remotely by electronic key whose antenna sends electromagnetic waves carrying the desired code. Different cars need different wave codes. Mechanisms of such codes are based on resonance interrelations. Antennas are resonance devices. **The speaker thinks that many biological codes use similar resonance principles of wave codes**.

Resonance mechanisms use the fundamental physical principle of an energy minimization because – in resonant combining of parts into a single unit – each of members of the ensemble requires less energy for performing own work than when working individually.

CONCLUSIONS

- 1) In connection with the tasks of code biology, universal rules for the stochastic organization of genomic DNAs have been discovered, which are associated with the general biological dualism "stochastics-determinism“;

- 2) These universal rules turn out to be related to quantum information formalisms and the tensor-matrix theory of antenna arrays;

- 3) The doctrine of energy-informational evolution is being developed on the basis of the amazing emergent properties of antenna arrays that have conquered modern technology, but have never been used in theoretical biology before. This doctrine allows us to consider a multitude of inherited biological phenomena of different levels from a single content point of view.

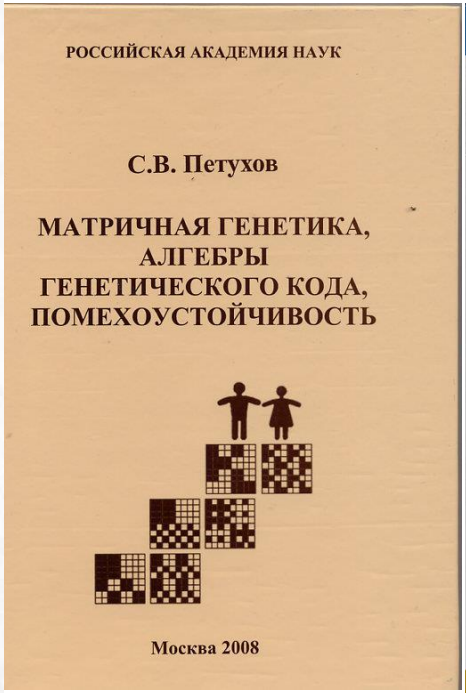
Many details of the talk are in Petoukhov's publications:

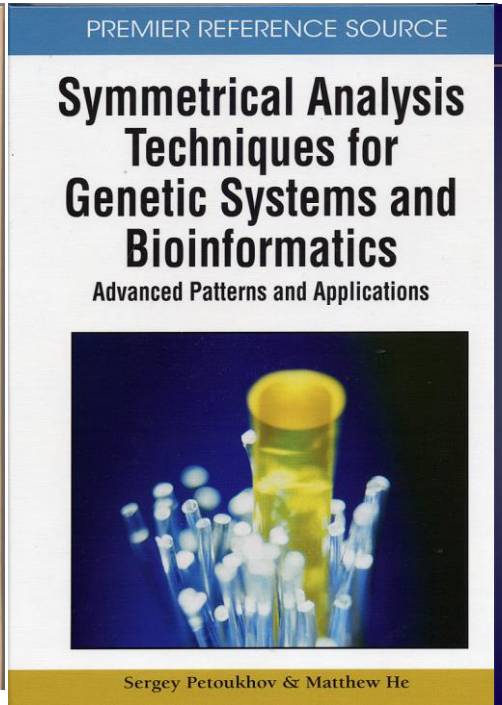
1) Biosystems, 2022, 104712;

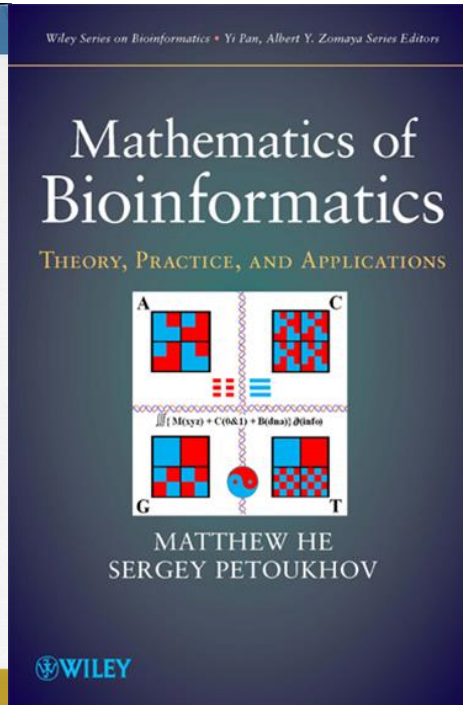
2) https://www.preprints.org/manuscript/202203.0100/v2

Many author's articles and books on algebraic and code biology are freely available on the website http://petoukhov.com/ .

Thank you very much for your attention!







BIOLOGICAL CODES AND E.-M. WAVE CODES

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