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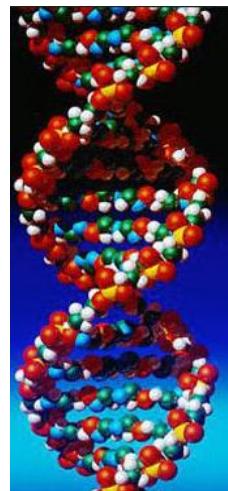
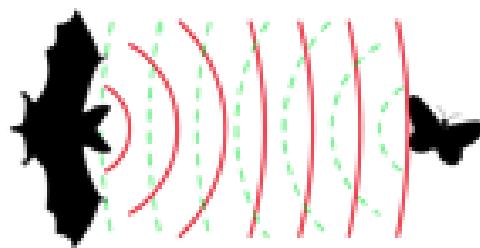
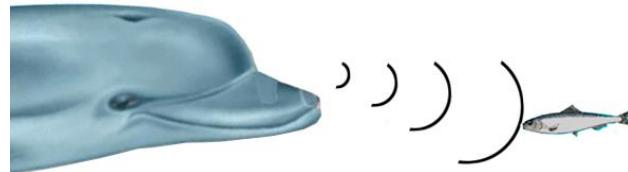
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# THE STOCHASTIC ORGANIZATION OF GENOMES AND THE DOCTRINE OF ENERGY- INFORMATION EVOLUTION BASED ON BIO-ANTENNA ARRAYS

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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 of 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.



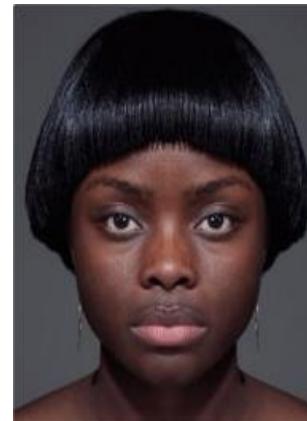
Gr.

Mendel

(1822-1884)

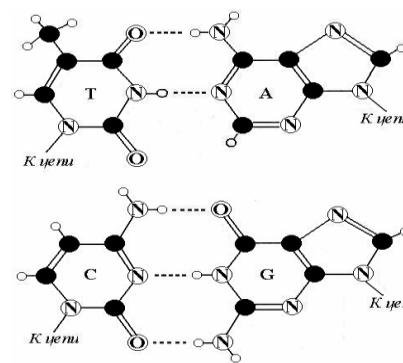
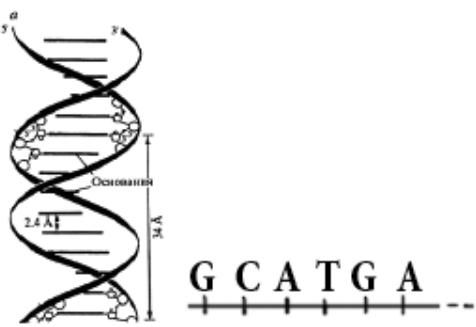
The stochastic nature of genetic processes in the "small" does not interfere with the inheritance of the traits determined in the "big" (so-called Gestalt phenomena). For example, fingerprints are different for all people, although fingers the "big" have a typical shape and composition (3 phalanges, 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 inherited gestalt phenomena of physiology 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 a sequence of four nucleotides (molecular letters): 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  $[C, A; T, G]^{(n)}$ :

	<b>1</b>	<b>0</b>	
<b>1</b>	C	A	
<b>0</b>	T	G	

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

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

We use these matrices in 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	0.2085	0.2910
%T	%G	0.2918	0.2087

0.05409	0.07274	0.05033	0.09504
0.07134	0.01031	0.07429	0.07137
0.06008	0.06312	0.04402	0.06008
0.09568	0.07286	0.05046	0.05419

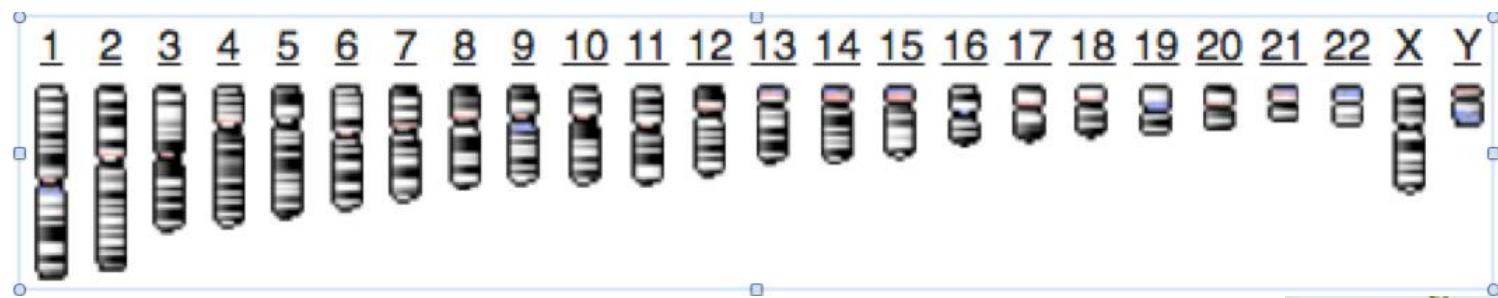
0.01385	0.01878	0.01524	0.01861	0.01183	0.01977	0.01447	0.03693
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0.01758	0.01275	0.00251	0.00227	0.01317	0.01942	0.01441	0.02237
0.02009	0.02088	0.00259	0.00291	0.02388	0.01781	0.01614	0.01848
0.01588	0.01964	0.01103	0.01986	0.01255	0.01456	0.00962	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

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 details in the published Petoukhov's articles)

# GENOMES OF EUKARYOTS AND PROKARYOTS

The same 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 speaker revealed that the described matrices of probabilities of n-plets from n-texts of any considered genomic DNA are interrelated by special matrix-tensor equations (using the Hadamard product of matrices  $\circ$  ).

For example, in genomic DNAs, the (2\*2)-matrix of monoplet probabilities is interrelated with the (4\*4)-matrix of duplet probabilities by the equation with additional (2\*2)-matrices  $B_C$ ,  $B_A$ ,  $B_T$ ,  $B_G$ :

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

where additional matrices are:

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

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

Similarly algebraic interrelation between the (4\*4)-matrix of duplet probabilities and the (8\*8)-matrix of triplet probabilities are expressed by the equation :

$$\begin{array}{|c|c|c|c|} \hline
 \%CC & \%CA & \%AC & \%AA \\ \hline
 \%CT & \%CG & \%AC & \%AG \\ \hline
 \%TC & \%TA & \%GC & \%GA \\ \hline
 \%TT & \%TG & \%GT & \%GG \\ \hline
 \end{array} \bullet \begin{array}{|c|c|c|c|} \hline
 B_{CC} & B_{CA} & B_{AC} & B_{AA} \\ \hline
 B_{CT} & B_{CG} & B_{AT} & B_{AG} \\ \hline
 B_{TC} & B_{TA} & B_{GC} & B_{GA} \\ \hline
 B_{TT} & B_{TG} & B_{GT} & B_{GG} \\ \hline
 \end{array} =$$

%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

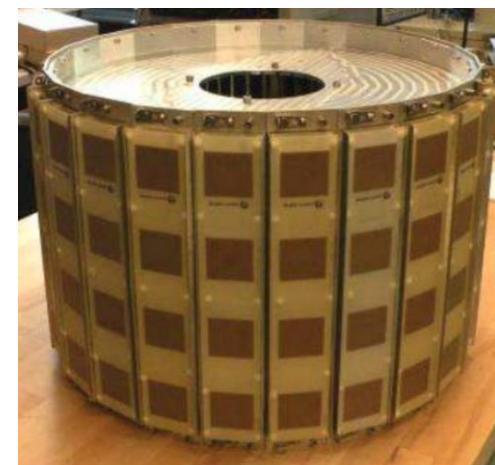
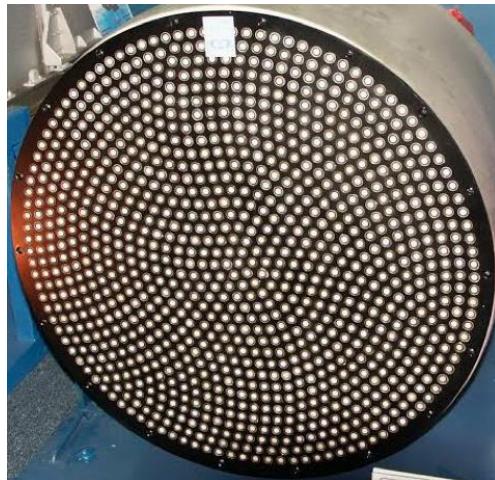
## **Analogies with tensor-matrix theory of digital antenna arrays.**

The described matrix-tensor connections between the probability matrices of genomic DNAs are analogical to **formalisms of the well-known tensor-matrix theory of digital antenna arrays**. This theory using the Hadamard product was developed by Ukrainian Prof. V.Slyusar [[https://en.wikipedia.org/wiki/Vadym\\_Slyusar](https://en.wikipedia.org/wiki/Vadym_Slyusar)]. It gives very advantageous possibilities in the field of many-component digital antenna arrays also called Smart Antennas.

**It was this analogy initially led the speaker to the doctrine of energy-information evolution based on bio-antenna arrays.**

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

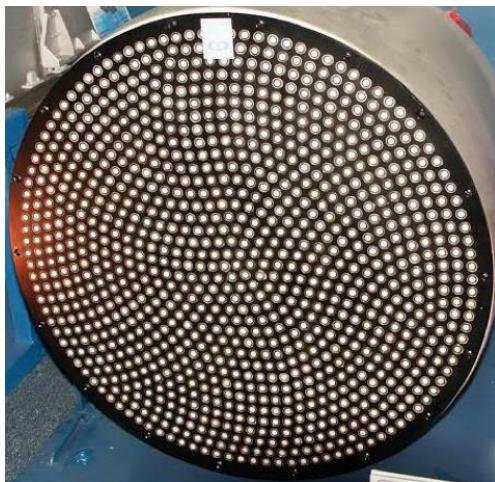
Modern science connects with antenna arrays future revolutionary changes in computers (biophotonics) and energetics (effective using solar energy) due to using nanoantenna arrays, which can include photonic crystals, liquid crystals, etc.



Пример ЦАР Alcatel-Lucent, 2011 год

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

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



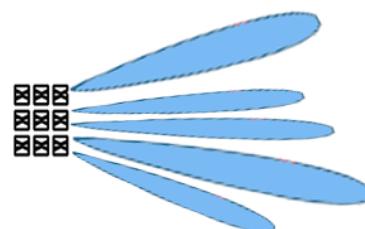
Пример ЦАР Alcatel-Lucent, 2011 год

(These images are taken from Internet in 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. Let's list main emergent properties of antenna arrays:

- 1) In compare 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.



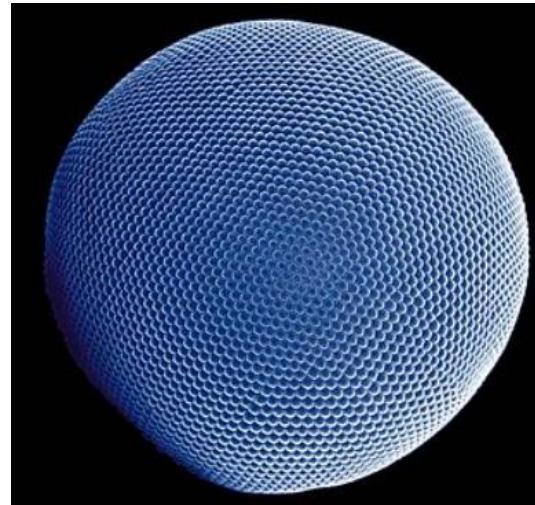
Given these unique emergent properties of antenna arrays, it can be expected that organisms are forced to use them in their life activity. The presented doctrine confirms this expectation on a set of examples of the structure and functioning of inherited physiological systems based on antenna arrays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

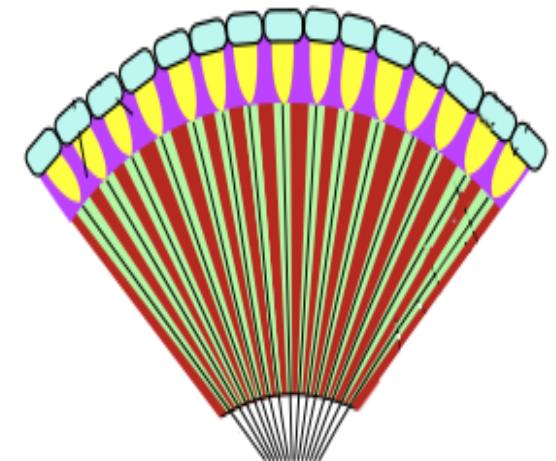
**Complex**



**faceted**



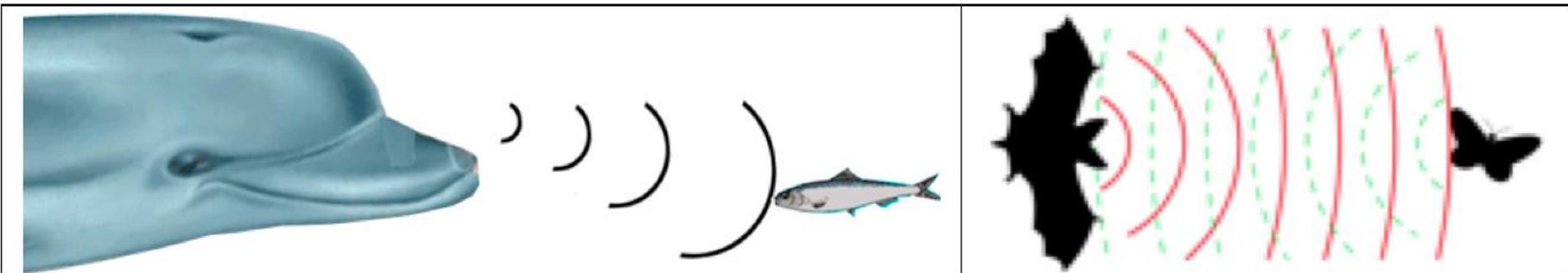
**eyes**



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 in free access sites).

# Inherited phenomena of biological echolocation

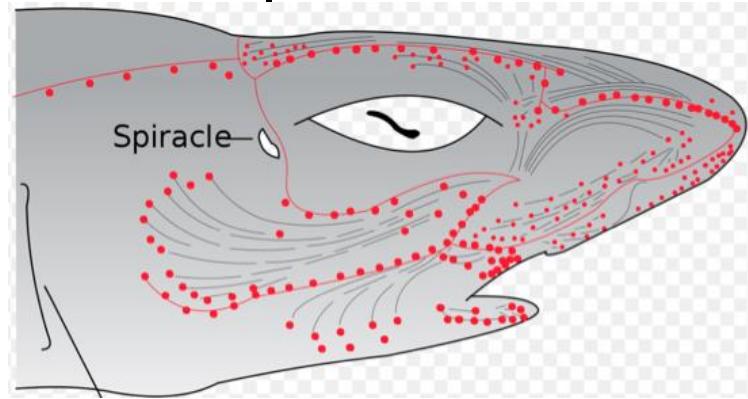


Many organisms have an innate ability to echolocation based on directed rays of a wave nature. Due to the mechanisms of echolocation, for example, dolphins and bats are able to recognize the distance, dimensions and shape of the objects they track, by analogy with how active Smart Antennas make it possible 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 in 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 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 arrangement of electromagnetic field receptors (in red) on the shark's head, which form a receiving bio-antenna array (from Wikipedia).

# Inherited sets of bio-photon crystals

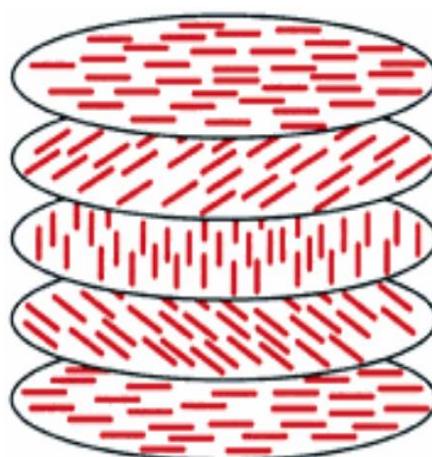


Figures: Photonic crystals form heritable species patterns on butterfly wings and peacock feathers.

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.

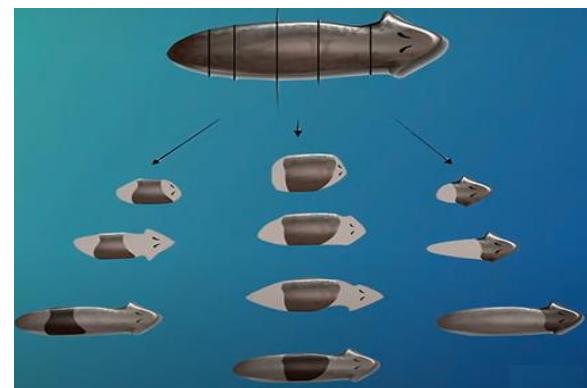
## Inherited systems of liquid crystals

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.



# Bio-antenna arrays and regeneration phenomena

It is natural to believe that the electromagnetic activity of bio-nanoantenna arrays is involved, in particular, in the distribution of rest potentials on cell membranes, which are liquid crystals. This factor of rest potentials are important for morphogenetic processes and the regeneration as it was shown in impressive experimental works by M. Levin and his colleagues at Tufts University, USA [<https://ase.tufts.edu/biology/labs/levin/>]. These works were carried out on flatworms - planarians, which have a head, a true brain, etc. Planarians are known champions in organ and tissue regeneration.



(Fig. from Levin's interview <https://www.youtube.com/watch?v=XheAMrS8Q1c> ).

The noted works studied regeneration of amputation parts of worm's body and showed that the determination of the correct position of the organ in the worm's body is controlled by the distribution of membrane potentials in not yet differentiated cells. Artificial changing by ionophores the typical distribution of the membrane potentials on an amputated fragment of the worm's body leads to the formation of **planarians with two heads** (one should note, that such artificial influence on liquid crystal membranes can significantly change cell systems of liquid crystal bio-antenna arrays participating in morphogenetic processes).



**Two-headed worm** (from Levin's interview <https://www.youtube.com/watch?v=XheAMrS8Q1c> ).

It is especially remarkable that if both heads are cut off from the resulting two-headed worm, then a two-headed worm is again regenerated from the remaining middle fragment. And this procedure can be repeated many times, each time receiving the regeneration of a two-headed worm.

According to Levin, this means that the memory of the correct structure of the body, which should be formed after regeneration, turns out to be radically changed, although the genome of this organism did not change and remained the same. **Therefore, the memory that tells the worm about how many heads it should have is contained not in the genome at all!**



**Two-headed worm** (from Levin's interview  
<https://www.youtube.com/watch?v=XheAMrS8Q1c>).

These experimental facts have led Levin to the important idea that emergent properties of an ensemble of cells are key participants of morphological and some other processes. **Multicellular ensembles are able to determine the type of morphological patterns formed, largely independently of the information in DNA.** This idea generated new experiments, in which Levin showed that the combination of cells from the skin of a frog into a single ensemble leads to the appearance of a tiny body of a completely new design. Such bodies, which are biological robots called “**xenobots**”, can move, navigate a labyrinth, explore the environment, feed and heal themselves, although they do not have a nervous system, do not have a brain, and they are simply collections of skin cells with unchanged DNAs (xenobots can live 10-14 days). These results allowed generating **Levin's concept that «the electrical blueprints orchestrate life»**

[<https://www.youtube.com/watch?v=XheAMrS8Q1c>].

Our doctrine of evolution based on bio-antenna arrays **proposes another basis point of view**. This doctrine states that just **bio-antenna arrays with their coordinated electromagnetic waves «orchestrate life»**. This doctrine draws attention to important factors of electromagnetic waves, which are absent in the concept of «the electrical blueprints»:

- 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 besides electrical potentials;
- 3. The types of polarization of electromagnetic waves are important for relationships 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 special 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 partially or completely precisely the energy of a multitude of coordinated electromagnetic and other wave rays from bio-antenna**



## **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 offspring of wave activity and self-organization of bio-antenna arrays, and this code is connected with other inherited physiological offspring of bio-antenna arrays in the organism.

**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.

People has long discussed the relationship between innate knowledge and knowledge acquired in the course of life. The extreme point of view is formulated in Plato's famous statement that to know means to remember, awakening, as it were, from sleep. Close to this is the widespread opinion that our body already carries in hidden forms the fullness of knowledge, whose parts come into our consciousness when they are insistently requested. But our body grows from a single fertilized cell. This original cell cannot contain all the named completeness of knowledge. Additional knowledge should come into our body from outside in the course of ontogeny. It is the ensembles of bio-antenna arrays that can serve as the system through which cosmic and planetary wave energy-information influences enter the body; these external influences are necessary for the adequate development and replenishment of the body's knowledge.

This talk presents only fragments of our works in algebraic biology. Many other materials are available free access on the speaker's website: <http://petoukhov.com/>.

Many details of the talk are in the preprint  
<https://www.preprints.org/manuscript/202203.0100/v1>  
(doi: 10.20944/preprints202203.0100.v1).

Thank you very much for your attention!

