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The Holographic Principle and Emergence Phenomenon

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1. Introduction

The present work was inspired by a serendipitous discovery of non-local effects in living organisms, which could not be explained by the known biological mechanisms. We have demonstrated on a large number of subjects (up to 13 000) that any small part of a human body, when exposed to pulsed electromagnetic fields, produces the interference patterns that carry diagnostically significant information; more precisely, we found that the shapes and textures of the most disorderly anatomic structures can be analyzed using minor superficial areas of the body as a source of information. This finding required a rational scientific explanation.

The studies conducted in the conditions of minimal perturbation made it possible to unveil some physical mechanisms underlying the non-local phenomena in complex systems of natural origin [Shaduri et al., 2002; 2008a]. The holographic principle offered by physicists as a solution to information-associated processes in certain (non-living) natural objects turned out to have more general scope of applicability. The real-time encoding and decoding of information have been detected in both - humans and animals [Shaduri, 2005].

Our experience makes us believe that without penetrating waves such as X-rays or ultrasound focused upon the areas of interest, it is not possible to observe internal structures of intact living body. It came as a big surprise that diverse parts of living systems may communicate not only through exchange of molecular and nervous signals, but also „wirelessly“. The wireless communication had been unimaginable before Heinrich Hertz proved it experimentally in 1888. Our clinical and experimental data that suggested the existence of some previously unknown mechanisms of information transfer in biological systems were met with ferocious resistance and misunderstanding as well: the physicists, who we addressed for help, could not believe that high-resolution images of internal organs and tissues could reach the outer surface of the human body. So, a small team of biologists, medical doctors and engineers was left to investigate the phenomenon further.

We have started from the very beginning by seeking rational answers to the naïve questions about the most general principles of the genesis, organization and functioning of simple systems. Based upon the existing knowledge the answers had to be inferred to such critical questions, as: what kind of interactions might result in interconnectedness of all constituents in the space occupied by the system? What are the simplest self-organizing systems like?

Why is nature constantly in the process of creation of the new order in the universe, where as, according to the second law of thermodynamics, the complexity of isolated systems must successively decrease in time? What fundamental interactions set all the machinery of nature to the creative work? The non-local phenomenon discovered in biological systems might just be the missing piece of the puzzle.

Today we can argue that real-time holographic mechanisms are crucial for integration and self-organization of any dynamical entity defined as an emerging/developing system. A conceptually new scenario of the genesis, adaptation, integral functioning and development of natural systems is being discussed below. The presented phenomenological model is a result of 10-year-long experimental and theoretical work in the field of interdisciplinary science of *Bioholography*.

Some critics might consider our model irreverent because of the intentional simplification of certain physical interactions. However, according to the observation of Albert Einstein "A theory is the more impressive the greater is the simplicity of its premises, the more different are the kinds of things it relates and the more extended the range of its applicability."

Certain aspects of physical reality are discussed within the unifying theoretical framework. The comparative analysis and generalization of empiric data enabled us to conjoin such seemingly non-related phenomena, as inevitable aging and decentralized memory of complex systems, embryogenesis and cancer-genesis and many other manifestations of the system functioning considered so far as independent concepts.

While discussing the most important elements of our theory, we draw parallels between the manifestation of holographic principle in non-living and living systems focusing on the holographic storage of information as the factor critical for the development and evolution of any natural system. We also emphasize the universality of the emergence phenomena in observable reality; differentiate the background order of a system phase-space and the foreground events; the subject of nature-genesis is touched as well, since the peculiarities of natural systems had to be traced back to their origin in order to reveal the factors basic for the integration of separate parts into a united entity.

Our theory already helped us to implement the holography-based approach to the system-study into medical practice and also, to predict many results of our experiments with living systems. Finally, this phenomenological model, that is more evidence-based reasoning than math-based hypothesis, contradicts neither physical or life sciences, nor elementary logic.

2. Systems, information, memory

The study of complex systems is partially hampered by the lack of generally accepted definitions. Strict definitions of basic concepts are fundamental to every scientific discipline; however, the essence of many terms, such as *system*, *information* or *complexity* remains vague and ambiguous. Below some commonly used definitions and descriptions of these terms are considered.

System. Many common definitions of a *system* suggest an organized assembly of resources and processes united and regulated by interactions to accomplish a set of specific functions [Bertalanffy, 1968]. Less strict interpretation of a *physical system* usually means that certain sets of entities are understood to serve a common objective comprising a whole, in which each constituent interacts with or is related to at least one other part of the whole. Simply put, a dynamical system of natural origin encompasses numerous interdependent units/agents organized in a non-trivial way in order to compile integral whole. Certain new

qualities of systems emerge at each level of complexity. This *emergence phenomenon* is receiving renewed attention lately.

Complex dynamical systems are systems in which many factors interact creating ceaseless changes. Complex adaptive systems (CAS), such as biological ones, represent special cases of complex systems that have the capacity to learn from their experience. All such natural entities temporarily occupy a region of available space (*phase space*) where laws of nonlinear dynamics govern and new properties arise from interactions of "non-summative" agents of systems. The definitions and descriptions of systems offered in scientific literature explain neither the principles of interaction of systems' parts nor mechanisms underlying the emergence phenomena and factors that drive the entity towards a common objective.

Some characteristics and peculiarities of complex adaptive systems are widely accepted:

- Multi-level hierarchical organization and nonlinear medium; CAS comprises subsystems which, in their turn, might be regarded as individual systems;
- Self-organization - a process in which the internal organization of a system either increases its complexity (emergence phenomenon) or restores previous order after temporal perturbations (resilience); all complex adaptive systems are able to function in a non-equilibrium state maintaining the basic homeostasis;
- Adaptive behavior - the capacity of some complex systems to react to variable environmental conditions adequately.

We believe that *the concept of system memory* has to be included in the definition of adaptive systems, since two phenomena specific for CAS – permanent emergence of new order and adaptation – are unimaginable if a system is not able to keep information on its previous states either in the form of structural alterations or as some functional relationships between its modules. No process of “learning” is possible without data storage: ambient information has to be perceived, processed and stored in a retrievable form. Hence, a kind of associative memory must be an embedded feature of adaptive systems.

Information. It was shown that an amoeboid organism *Physarum polycephalum* is able to navigate mazes and solve simple puzzles [Nakagaki et al., 2000]. Besides, this slime mold consisting of protoplasmic veins and nuclei can remember former events anticipating the unfavorable conditions in the test environment. So, information about experienced states may be memorized in a decentralized/diffuse form and no specialized “storehouses” of information are necessary for adaptive behavior of primitive living systems. It seems likely, that adaptive systems function akin to communication units incorporated into a larger system of interdependencies and feedbacks; however, the term *information* (in its physical sense) is even more ambiguous than the term *system*, hence a more precise definition is needed.

Some consider the universe as being primarily comprised of information that John Wheeler summarized in the slogan “it from bit” [Wheeler, 1990]. Obviously, information cannot act by itself and it cannot fill the space-time domain. An elementary information-related act requires at least two agents: a sender and a receiver of messages. Over the past decades, it has become common to adopt a general definition of *information* in terms of “data + meaning” [Floridi, 2005]. No doubt that a signal must affect some internal mechanisms of a receiver in order to be “understood”.

Shannon's model of information-exchange includes six critical elements: a source, an encoder, a message, a channel, a decoder, and a receiver [Shannon, 1948]. Any adaptive system must be able to differentiate the signals of variable environment when choosing appropriate tactics; consequently, a complex system needs some embedded mechanisms

that would encode, evaluate, decode ambient information and also keep it for future use. For adaptive systems developing in a noisy environment, any alteration of ambient noise, including its cessation, would be informative. Hence, not the signal itself but the alteration of habitual situation matters, this difference between the former and the new state being causal determinant for the behavior of any adaptive system.

3. A serendipitous discovery

There are certain issues to be clarified while studying complex systems of natural origin:

- It is recognized that not just the constituent agents of systems matter, but their relationships. Agents of CAS are mutually interdependent, but which type of physical interactions can result in such interconnectedness?
- How can systems perceive weak, e.g., non-thermal signals (aka information)?
- Any CAS has the ability to return to ordered state and also build more complex structures: where and how do the simplest systems store information on previous states?
- Multi-level systems, e.g., biological ones, are capable of division, multiplication and production of similar entities: was this ability characteristic of the simple progenitors of systems as well?

Is it possible to answer all of these questions if we assume that not only the local (e.g., molecular) events, but also the nonlinearly organized action of a relatively uniform background medium play an active role in integration and orchestrated functioning of system parts? This assumption has been made because non-local effects discovered in living systems could not be explained on the basis of local interactions and linear physical processes. We definitely needed to find the system-unifying factor(s) first.

Compromised field of research. When the air around an object is ionized by pulsed electromagnetic field, the dielectric breakdown of the gas is affected by weak fluxes and emitted charges of exposed objects so that a complex picture of brightness-variable patterns appear around the contact surfaces. The devices used for recording of resulting images are referred to as gas-discharge visualization cameras (*GDV-technology*). Application of GDV-technology (also known as *Kirlian-photography*) to the study of biological objects is considered to be non-scientific and useless - the majority of commercially available devices provide non-reproducible, non-informative and extremely variable imagery. Entire field of the bio-electro-photography was compromised, especially when certain GDV-technique users started to interpret the stimulated radiation of biological objects, e.g., the radiation of human fingertips, as a manifestation of mystic energy or "live fields" of non-physical nature.

Our own experiments with GDV-Camera produced in Russia [Korotkov, 2002] were disappointing. We found that:

- Stimulated emission of human fingertips cannot be used for diagnostic purposes if one follows the operational protocol offered by the author of the device: results of patient examination depend upon the age of subjects, duration of object exposure, the perspiration of a body and ambient humidity, as well as many other poorly controllable factors such as subject's emotional state;
- Recordings of the same finger often differ from one another considerably, even when captured within 2-3 sec interval;

- Essential components of fingertips' emission are lost: the most intense shots leave dark gaps instead of bright streamers that are either scattered upwards or shifted out of the focal plane down to the periphery of polished surface of the screen (fig. 1, A & B).

The technological process had to be changed in order to mitigate poor reproducibility of recordings; we needed to obtain more informative image of improved quality around objects of study (fig. 1, C).

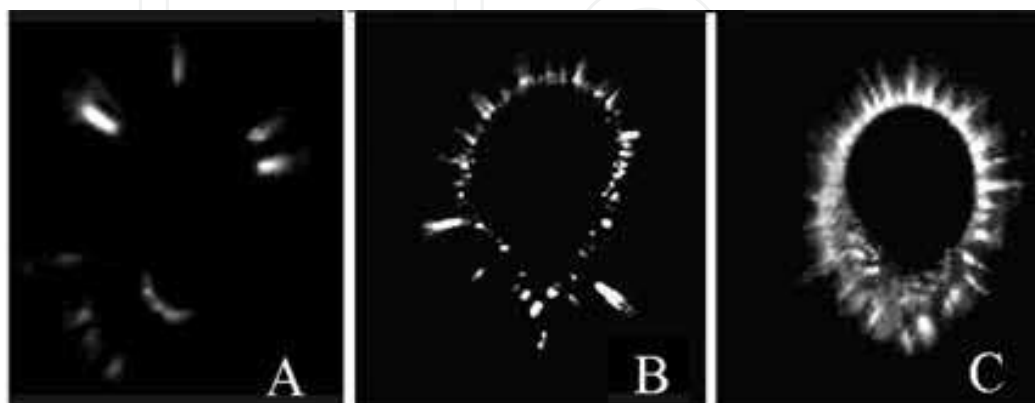


Fig. 1. Comparison of recordings obtained with Korotkov's GDV-Camera and our modality (BHT-scanner). A- a finger of a child (8y) recorded with GDV-camera; B, C - a finger of an adult (45 y) recorded using the GDV-Camera (B) and the new scanner (C).

BHT-system vs. pre-existing versions of gas-discharge devices. The improved technology and altered procedure of data acquisition enabled us to get stable, repetitive and informative imagery. New technology intended for a study of living systems' emission was named *Bioholotomography* (BHT). The methodology is patented and used for medical diagnostics. The capturing module of the device (fig. 2) comprises: the generator of the pulsed electromagnetic field; two elastic membranes (necessary for recombination of emitted charges and the preservation of the most informative components of scattering elements in the focal plane); a transparent electrode with the rigid surface; image capture unit; fiber-optic cables to transfer the imagery to the computer, where recordings are being stored and analyzed.

Electromagnetic fields of gradually increasing frequencies (1000-5000 Hz, voltage - 17 KV) induce short-term ionization of the air around the contact area; exposed objects having oval/rounded configuration (e.g., human fingertips) produce specific patterns (coronas) that are captured and analyzed. Proprietary software controls the process of capture and enables processing of recorded data. We use various modes of recording in studies of stimulated radiation of biological objects. Continuous operational mode (30 fps) of the device is intended for experimental work that is aimed at detection of body's short-term reaction to various influences. Discrete recording of frames is used for both - experimental and clinical purposes.

The routine BHT-examination is as follows: all 10 fingers of a patient - one after another - are positioned on the insulated screen of the device and are exposed to electromagnetic fields of gradually increasing frequency; flexible membranes between a fingertip and the glass surface of the screen make it possible to retain (and recombine) scattered charges within the focal plane. Entire process of recording of all fingertips takes no longer than 3-5 minutes. Subsequent analysis of the saved data implies either "spectral" evaluation of fingertip stimulated radiation (automated) or visual interpretation of recorded imagery (performed by trained medical professionals).

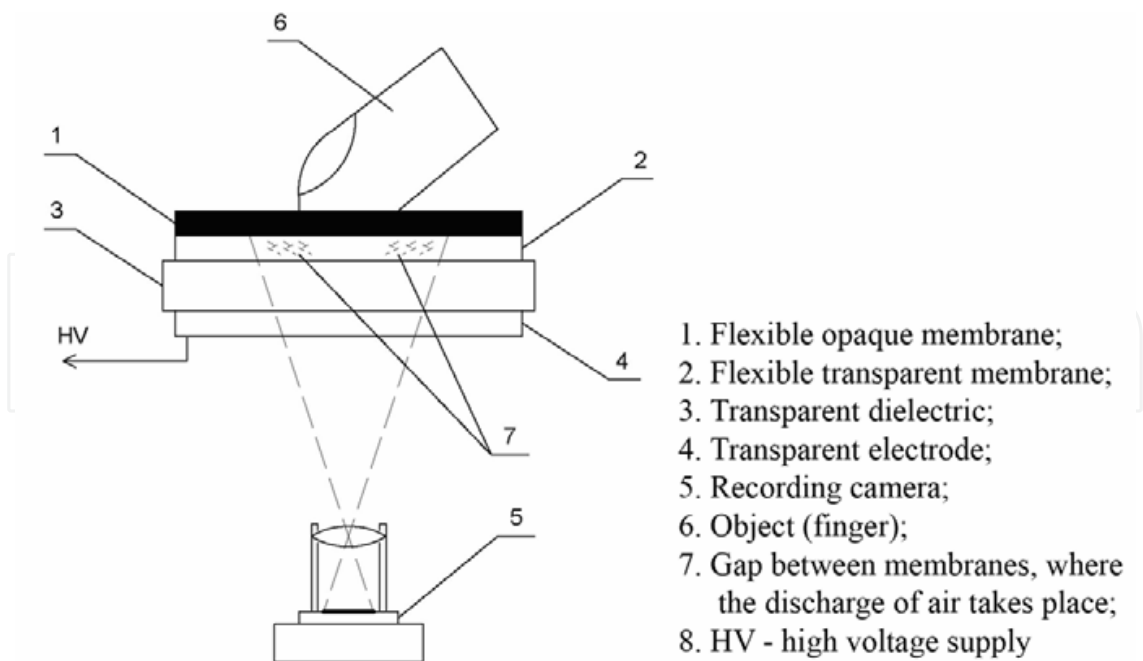


Fig. 2. Schema of the BHT-capturing module

As mentioned earlier, the modification of the technological process resulted in improved stability of recorded imagery thus facilitating the search of correspondence between the actual pathology and stimulated emission of certain body parts. The enhancement of data reliability yielded an unexpected result: we discovered that disordered areas of fingertip BHT-grams display some unusually shaped patterns that often repeat the characteristic contours of real anatomic structures. Moreover, we found that beside recognizable shapes of organs the fingertip *coronas* contain information on the texture and densities of the most malfunctioning organs and tissues, while properly functioning anatomic structures do not provide their signatures (fig. 3, 4).

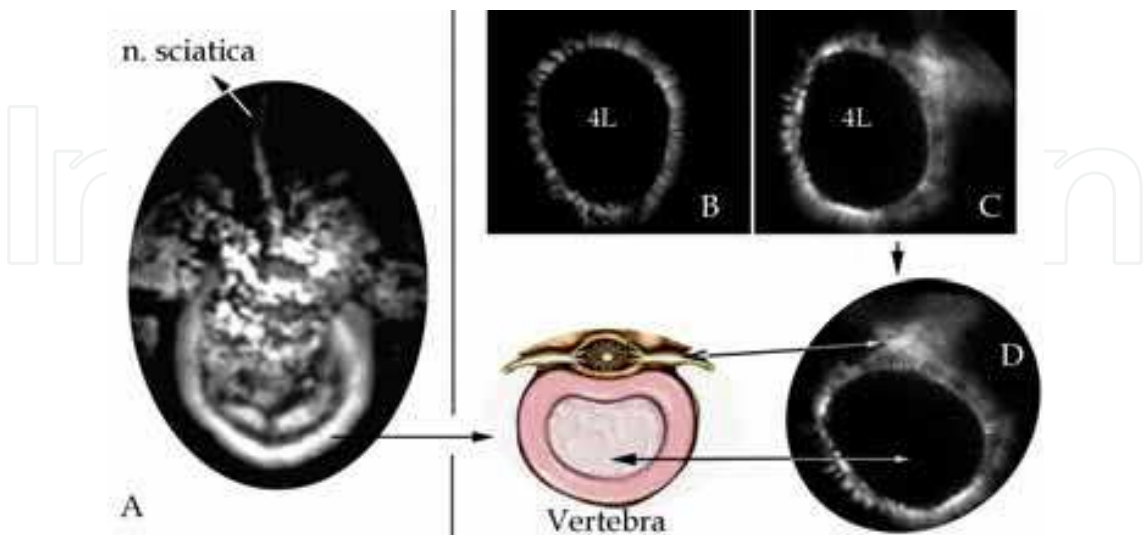


Fig. 3. Replicas of dense and soft tissues. A - a case of sciatic neuritis, a hologram; B - BHT-gram of a healthy person's finger; C - BHT-gram of the same finger on the second day of minor trauma (upper spine); D - the image is rotated to match the drawing's orientation.

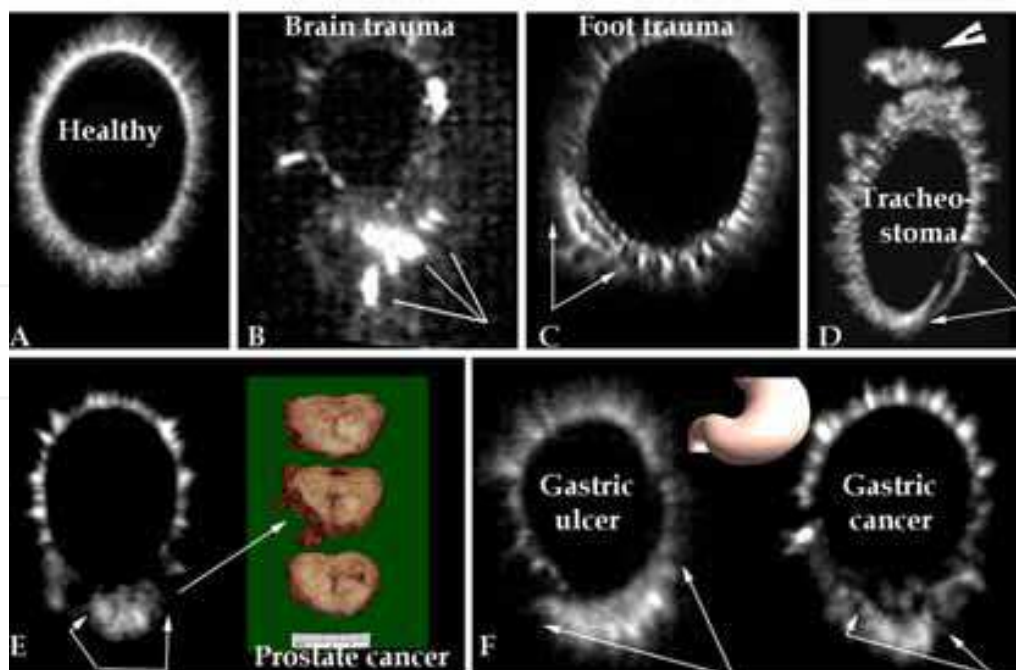


Fig. 4. Stimulated emission of fingertips: shapes and texture characteristic of the most affected organs/tissues. A – BHT-gram of a healthy person; B – recent head trauma; C – stretched ligaments of the left ankle; D – esophageal cancer, tracheostoma (arrowhead); E – prostate cancer – initial stage; F – two cases of stomach pathology: left – ulcer; right – advanced cancer.

Previously unknown peculiarity of living systems has been studied in a group of 3000 patients and also in some animals before we dared to announce our findings. Physicists gave the name to the discovered effect – *holographic diffraction*, since experimental study of this phenomenon revealed the effects that could be explained only in terms of the holographic principle.

On the holography and holographic principle. A *hologram* is encoded information about a real scene that can be decoded as a "virtual" 3-D image. Any type of waves may fix 3D information in a 2D form. Not only the amplitude, as in usual optical imaging, but also the phase of waves should be recorded in order to encode a complete spatial picture. This idea has been realized by D. Gabor, the inventor of holographic technique [Gabor, 1946] who proved that complete "structural" information about a scene/object under observation may be obtained through recording the phase-differences of interacting waves. It is known, that a periodic grating built in a nonlinear medium may generate real-time diffraction patterns [Denisyuk et al., 2000].

A rapidly developing field of the real-time holography deals with nonlinear *holographic gratings*, where the read-write processes proceed simultaneously. Holographic gratings are the diffraction gratings with a sinusoidal groove profiles. Diffracted energy and spectral performance of such holograms can be modified by changing the ratio of groove spacing and groove depth.

The holographic principle of information encoding and decoding is a natural phenomenon that should not be mixed up with the technical process of hologram-creation. The *holographic principle* states that all information lies at the boundary of a region of space [Susskind, 2008]. This principle for ordinary matter-systems and black holes has been affirmed while

studying the relationship between entropy, energy and gravitation. Some physicists argue that the holographic concept will become a part of the foundations of new physics, from which the quantum theory and relativity may be deduced as special cases [Bousso, 2002]. The processing of information takes place on various scales of physical reality. The underlying concept in holographic principle is the same as in the technical holography: in both cases a shift from one dimension to another takes place with the help of wave interactions and without significant losses of information.

All minor parts of a holographic recording contain information on the whole recorded object, although images reconstructed from the recording's different parts show entire scene from various viewing angles. We realized that interdependence of the "whole" and its parts holds in living systems as well: fingertips of a person often emit very complex patterns, which are being repeated multiple times, on various scales and from various perspectives in many areas of fingertip coronas (fig. 5a). This effect cannot be produced by molecular mechanisms. It is noteworthy, that the background noise (fig. 5b) and the fluctuations of coronas have been found to be diagnostically informative, yet for visual observation and demonstration of holographic imagery we usually increase contrast ratio of the captured stills thus reducing the noise.

Fluctuations and the *noise* in multi-scale stochastic systems are lately regarded as factors that contribute to the control, regulation and integration of intrinsic processes in dynamical systems. Moreover, the noise is recognized as one of the fundamental factors in the process of adaptation and aging phenomena, since it is closely related to stability and robustness of a system [Kirkwood, 2008]. We found that amplitudes, characteristic frequencies of the boundary emission and intensity of background noise depend upon the homeostasis of a body: in a quiet state of a healthy person and in conditions of normal exchange with environmental fields, the amplitudes of emission fluctuations are minimal (quasi-equilibrium of two nonlinear systems).

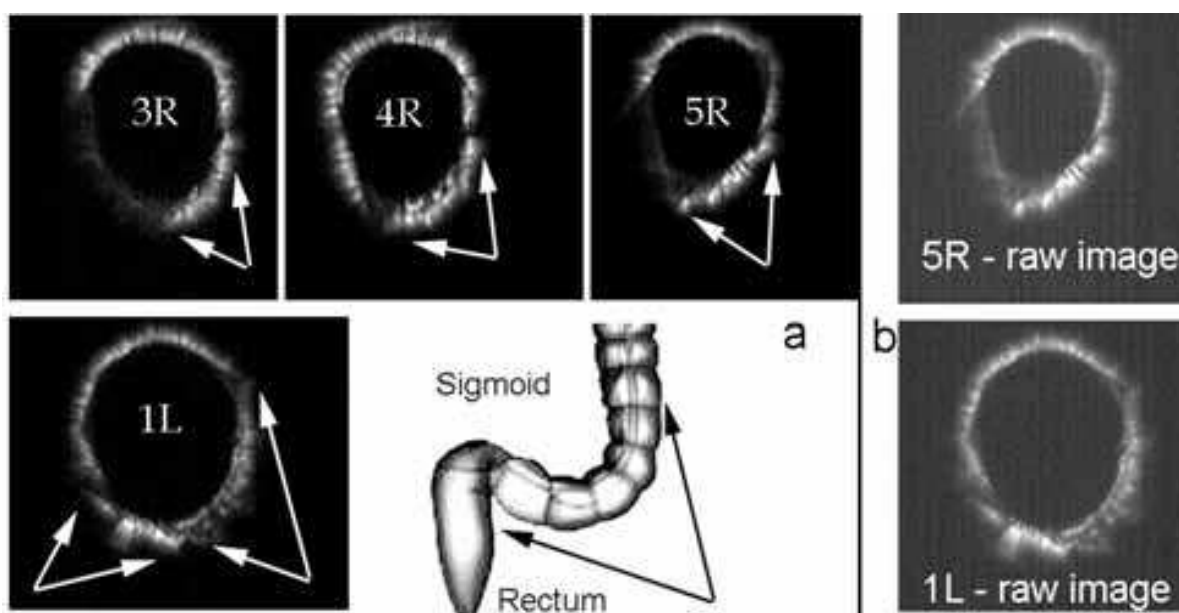


Fig. 5. Multiple replicas of large intestine: a case of colorectal cancer. a – several fingertip-coronas of the right hand (upper row) display patterns that do not differ much from one another; the corona of the left thumb shows two views of the affected area; b – the raw BHT-grams contain "noisy" components of the emission.

The real-time holography - the encoding of 3D information onto 2D surfaces (through a diffraction pattern) and its subsequent readout - seems to be the only concept explaining the appearance of signatures of malfunctioning organs/tissues on outer surfaces of a system. One can hardly imagine that in a mature organism the interference patterns can propagate reaching the surface of a body like a movie projected onto the screen. Yet, any physical phenomenon has its reasons, so we continued experiments hoping that more studies of these findings will lead us towards some rational hypotheses.

4. Holographic mechanisms in living systems - clinical study

The BHT-examination is a painless short-term procedure affecting only the periphery of a body. We believe that non-perturbing examination is extremely important in studies of system's integral functioning. It is evident, that since complex patterns of interference generated within nonlinear phase-space of the body do correspond to actual states of organs and tissues, the twists and turns of interdependent wave-forms should not be perturbed while observing the tiny patterns of interfering waves - interference patterns vanish whenever observers try to probe them. Fortunately, the optical block of the device allowed for examination of only small surfaces (e.g., human fingertips), so we avoided destructive intrusion into the main phase-space of the body affecting only its minor distal areas. In physics, the term observer effect refers to changes that the act of observation makes on the phenomenon being observed. The perturbing effects produced by observers explain the long-standing ignorance of the non-local phenomena in CAS; otherwise the physical effect of *holographic diffraction* in living systems might have been detected long ago.

As outlined above, modified gas-discharge-technology enabled us to record the patterns of malfunctioning anatomic structures by means of the harmless and easy-to-perform procedure of human fingertip examination. Since we could recognize only the signatures of misbalanced areas on fingertip BHT-grams, it was interesting to see if it is possible to perturb some parts of the body in such a way as to generate the holograms of organs and tissues deliberately. Indeed, one could try to acquire replicas of some anatomic structures either through mechanical/functional stimulation of targets or through application of perturbing signals to corresponding zones on a body surface. The most valuable for any hypothesis is its ability to predict experimental results. Our reasoning was simple: if information in living systems is really transmitted by permanently interfering and diffracting wave-fronts, then a body would emit large-scale replicas of those structures that lie in vicinity of deliberately perturbed zones. Such a selective or *Targeted BHT* is nowadays being used in the cases where certain anatomic structures have to be examined in more detail or where another problem dominates over particular areas of interest (fig. 6, 7). Hence, the Targeted BHT is based on the highly predictable reaction of the body.

Recently we developed the BHT-system which is intended for automated detection of malignant process in any part of a body. Cancer problem has been addressed because our experimental and clinical data were indicative of the dominant role of high-frequency processes in the holographic imaging. The malignant pathology is associated with the rapid proliferation of cells (processes of increased frequencies): we found that BHT-grams of the patients with malignant tumors have specific appearance. Medical doctors from Russia, Germany, France, Switzerland, New Zealand and some other countries contributed to our work sending the BHT-recordings of their patients' fingertips (as e-mail attachments) to the Center of Bioholography for expert analysis. A small-scale blinded testing in Moscow

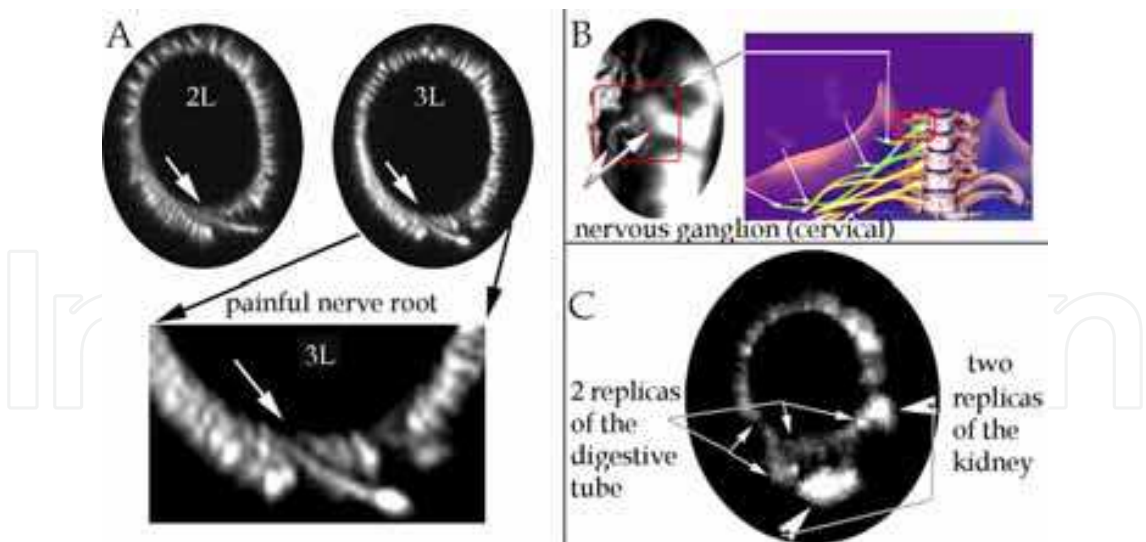


Fig. 6. Some examples of targeted BHT: A – BHT-signatures of mildly irritated nerve-roots obtained through the application of flexible magnets (10 Gauss) to lumbar spine; B – targeted BHT of cervical spine; C – simultaneous holo-imaging of two different organs in 15 min after impacts: the magnet was applied to the projection of the right kidney for 2 minutes while the person was drinking some tea (irritation of esophagus).

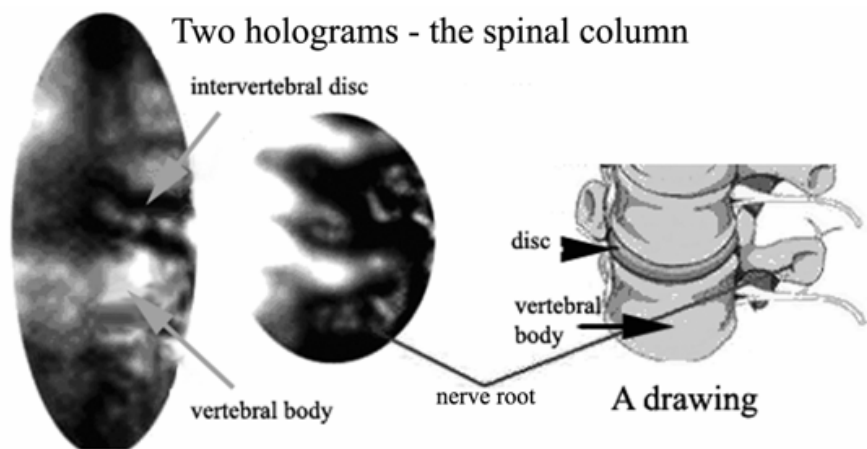


Fig. 7. Targeted imaging of vertebrae, intervertebral discs and nerve roots. BHT examination was conducted in 15 min after the 2 min-long application of EMF (3,5 mA; 0,3 Hz) to the lumbar spine of the patient with radiculopathy.

Hertzen Institute of Oncology confirmed high sensitivity of the novel *holo-imaging diagnostics* in terms of cancer detection through analysis of human fingertips' stimulated emission [Shaduri et al., 2008b]. Two cases of the early-stage cancer initially included into the control group were correctly diagnosed using BHT-technology - results of biopsy confirmed the BHT-data. Thus, it had been demonstrated that *biological holograms* are informative regarding both – the non-perturbing observation of living systems' states and the detection of malignant processes in any organ/tissue. Medical professionals have an opportunity to observe entire body and its problematic areas simultaneously and harmlessly that helps them in general diagnostics and also in evaluating the efficiency of therapy (fig.8). The arrows on fig.8 point to replicas of metastases in lymph-nodes that are prominent before chemotherapy but fairly visible after the course of therapy.

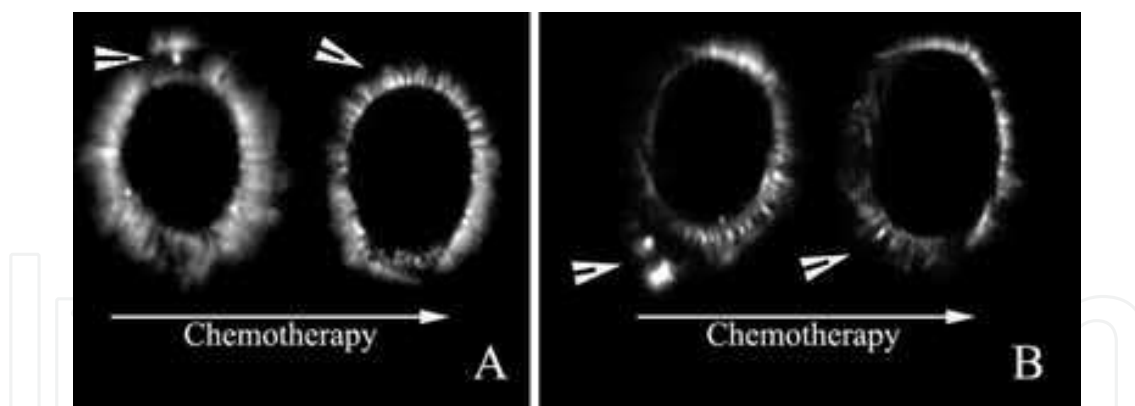


Fig. 8. The effect of chemotherapy on the fingertip BHT-grams: A – the case of advanced stage cervical cancer; B – gastric cancer.

5. Holographic Informational System (HIS) – some experimental results

It was understood that the phenomenon of non-local imaging presents a manifestation of the real-time holographic activity in CAS. We named entire set of the “wireless” mechanisms the *Holographic informational system (HIS)*, since these integrating processes ensure the propagation of 3D imagery throughout the whole body. The role of the HIS suggests the detection and correction of any problem that affects the normal modes of vibrations within the phase-space of a consolidated system.

Certain series of experiments have been conducted in order to study the time-dependent alteration of fingertip emission in response to physiological stimulation of various functional subsystems of the body. The sensitivity of HIS has been probed while comparing the emission of non-perturbed body (first 10 seconds of the video-recording) with the changes taking place during and after various impacts (subsequent 20 seconds). Some other experiments have been aimed at relatively long-term monitoring of the HIS-activity: emission of all fingertips was examined every 10-15 minutes (for several hours) before and after consuming food or beverages, after urination, intensive breathing, etc.

Analysis of BHT-data acquired during physiological stimulation of certain organs resulted in the following conclusions:

- When a person consumes some liquids or food thus irritating (successively) the oral cavity, digestive tube and stomach, the fingertip-coronas usually display signatures of these organs in the same order. An example of the holographic imaging of digestive tube is shown on figure 9: the tube-like patterns with an opening relevant to the upper part of digestive tube are manifested on the BHT-grams within seconds after drinking some water;
- The area of radiation around contact surfaces of fingers gradually decreases in response to inflows of new substances into a system (fig. 10);
- The recognizable replicas of the stomach and duodenum usually appear on coronas in 15-20 min after the meal (fig. 11). However, this time-span depends upon the initial state of the body, as well as upon the degree of functional/structural misbalance in targeted organs;
- Replicas of certain other organs and tissues of the digestive tract (e.g., pancreas, liver and gall-bladder) can be obtained through the application of magnetic, electromagnetic or electric fields to the skin in the projections of these organs;

- Intensive breathing usually results in formation of bronchi-like patterns on coronas (fig. 12). The replicas of other parts of lungs may also be obtained: these processes of holographic imaging depend upon homeostasis in both - entire body and the respiratory system.

We found that the initial state of a system plays an important role in these experiments, since the violated homeostasis temporarily distorts and “overrides” information on less active sources of perturbations. It became clear that all participants in BHT-experiments must be in a quasi-stationary state of balance, close to a state that is usually required for measurements of the basal metabolic rate.

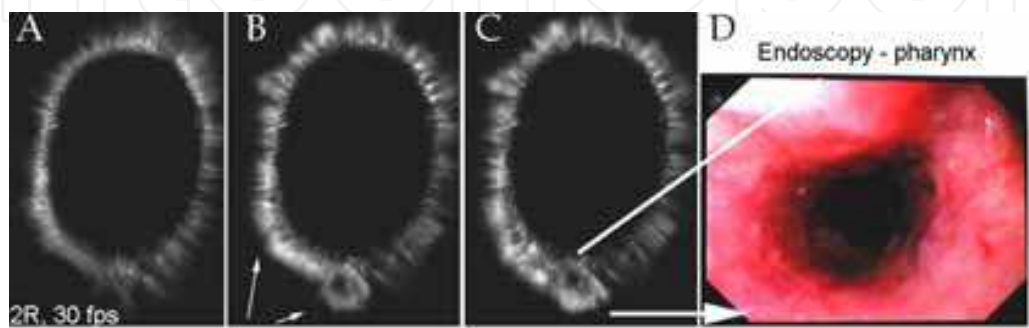


Fig. 9. Alteration of a fingertip corona in response to water consumption. Video-recording of the index finger-emission was conducted during 30 seconds (first 5 seconds - before drinking) A - background radiation. B - an immediate effect of some water intake: arrows point to the replica of esophagus (displayed upside-down); C - BHT-gram recorded just after several gulps of water; D - endoscopy of the pharynx to compare with the corresponding hologram.

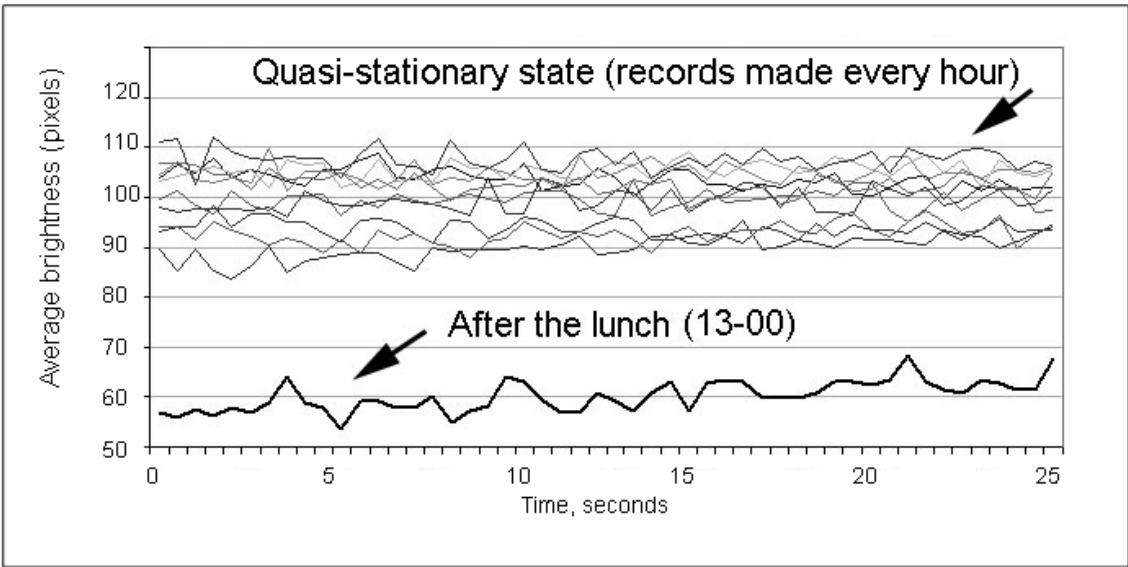


Fig. 10. Variation of a person’s emission during the day. Results of a finger video-BHT conducted each hour during a day (from 10 a.m. till 21 p.m.). In 30 min after the lunch the intensity of superficial emission decreases significantly, while as all other curves occupy a relatively narrow range of average brightness.

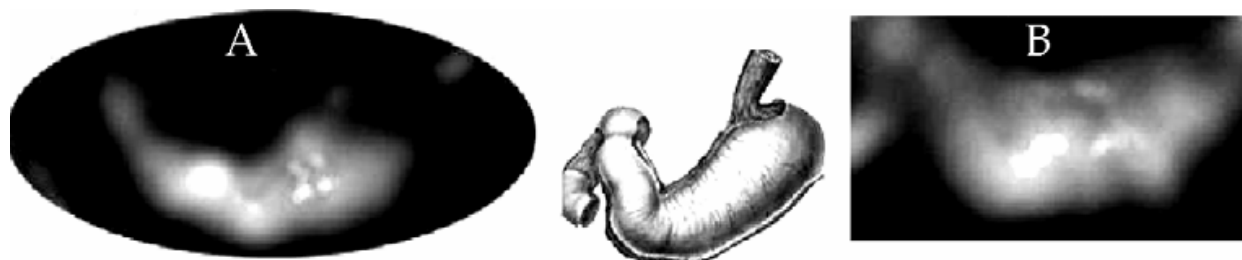


Fig. 11. Replicas of the stomach obtained using the Targeted BHT: A – a hologram of the healthy stomach is displayed on the 15-20-th min after the intake of some cereal (100 g); B – a case of gastritis: large-scale replicas of the stomach appeared earlier than in healthy subjects (on the 10-th min after the meal).

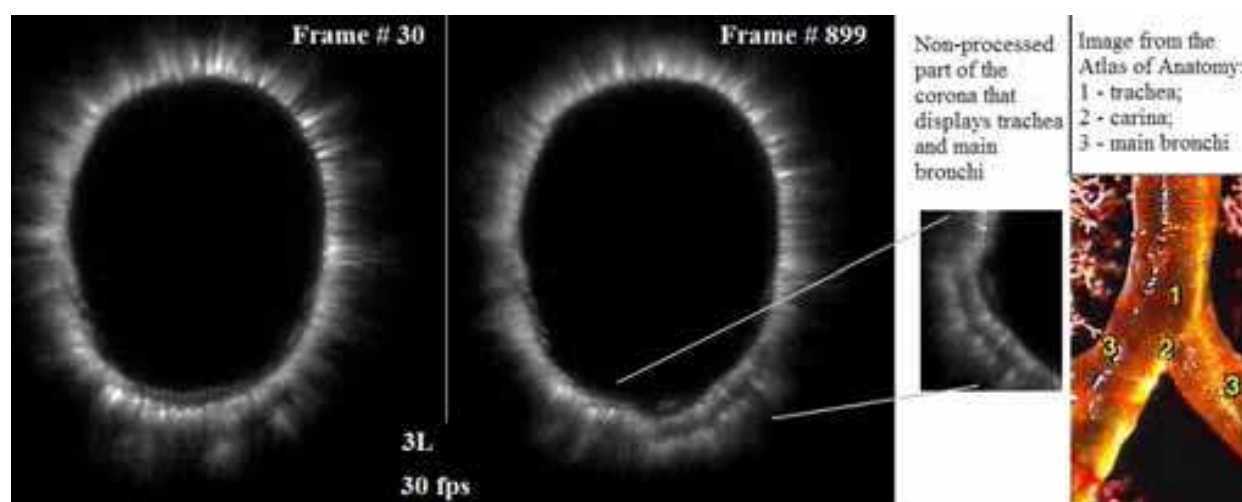


Fig. 12. Alteration of a finger corona in response to intensive breathing (started on the 11-th second of video recording).

While conducting BHT-examination of patients, we realized that internal bleeding or discharge from the body greatly alters emission of fingertips. It was interesting to check whether the emission would react to a small lesion of the skin. The figure 13 presents results of such an experiment: scarification of previously massaged ring finger of the left hand was conducted on the 11-th second of BHT video-recording. One can see bright shots (indicated by arrows) that appear almost instantly on the middle fingertip-corona of the right hand in response to the skin puncture.

Thus, we studied some non-local effects of substantial impacts upon a system, though an important question remained unanswered: can the HIS mechanisms differentiate signals of various types and strength? It is known that some biological effects are associated with ambient fields so weak that their intensities are below the "thermal threshold" [Comare, 2006]. Stating that there are no known biological mechanisms that might perceive such weak signals, mainstream science does not offer any explanation of the sensitivity of organisms towards the fields of non-thermal intensity. Is it possible to study the perception of feeble ambient fields by means of BHT-technology?

Figure 14 shows how a weak magnetic field and the inputs of chemical substances (water) into a body alter the total area of fingertips' emission. One can see that the areas of fingertip-coronas decrease slightly when video-BHT is being conducted without any impact upon a

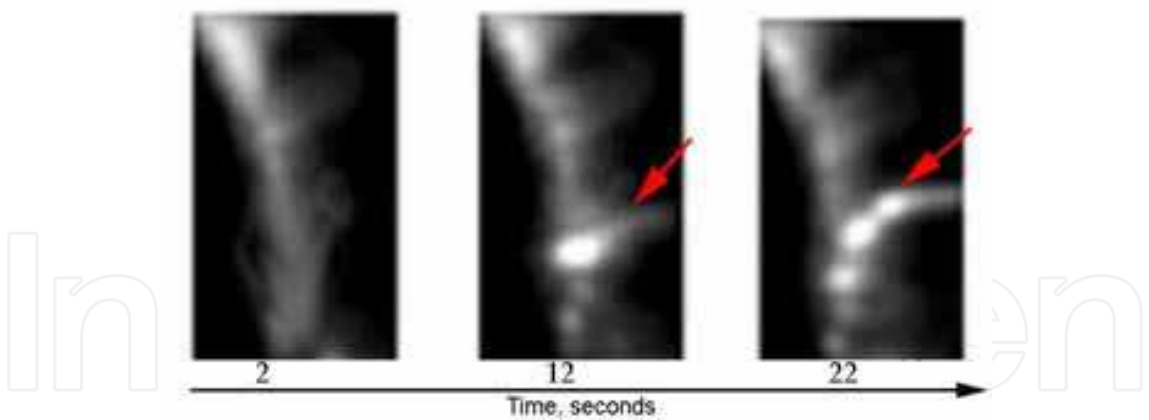


Fig. 13. HIS reaction to the skin damage. The puncture of the left hand finger alters the emission of the right-hand middle finger. See the text for more details.

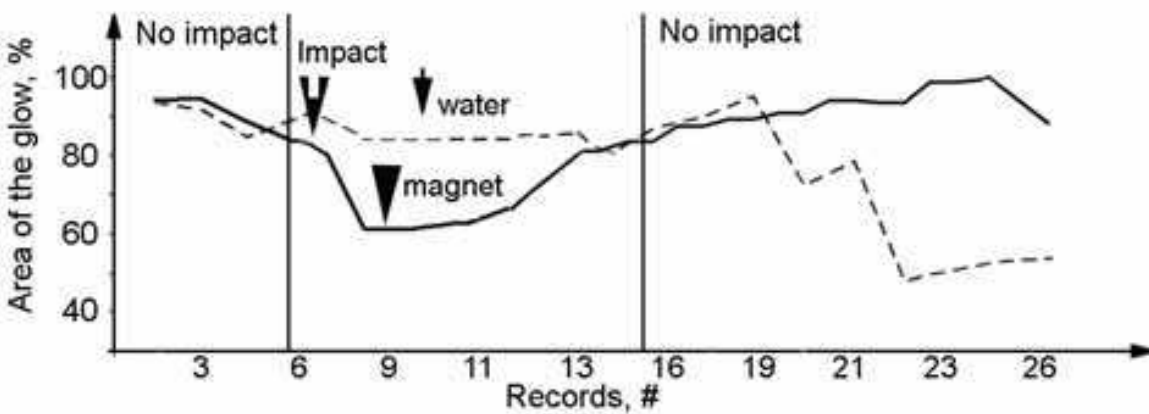


Fig. 14. Alteration of BHT-grams during the intake of some water (100 ml) and application of magnetic field (10 Gauss) to the left arm. Emission of the right-hand index fingertip is recorded with 3 sec-long intervals. Area of the emission is calculated as the % of the first 5 stills (no influence).

body; however, fluctuations are suppressed as soon as a person starts to consume some water (dotted line in the middle part of the chart). In several seconds after the first gulps of water the areas of coronas begin to shrink in a step-like manner while disturbances (information) propagate towards the lower levels of the system-hierarchy. Hence, not only the mean intensity of coronas decreases when new molecular substances enter a system, as shown on figure 10, but also their areas become smaller.

Application of a weak magnet (*Bioflex*, 10 Gauss, diameter 20 cm) to the arm of the opposite hand affects the emission in a distinct manner: the area of fingertip emission decreases much sooner than in the cases of substantial inputs, this effect being compensated in several seconds. The area of emission returns to initial values even earlier than the magnet is taken off (and earlier than the effect of water consumption becomes prominent). It is evident that there is a major difference between reactions of the HIS to magnetic fields and to substantial inputs. Dynamics of both processes is time-dependent and is indicative of a state which is far from equilibrium.

Several series of experiments have been conducted using coherent and non-coherent light, electric, electromagnetic and acoustic signals directed to various areas of the body surface.

Below we present results of the experiment, where beams of red laser (50 Hz) have been flashed to the palm of the right hand from the distance 0, 5 m (fig. 15). Immediate decrease of the left hand finger emission and subsequent modulation of fluctuations are indicative of the strong non-local reaction of HIS mechanisms towards the short-term superficial impacts of light. These effects might be much more spectacular, though our observations refer to time averages in non-ideal experimental conditions: for experimental work we use the certified device developed for clinical purposes.

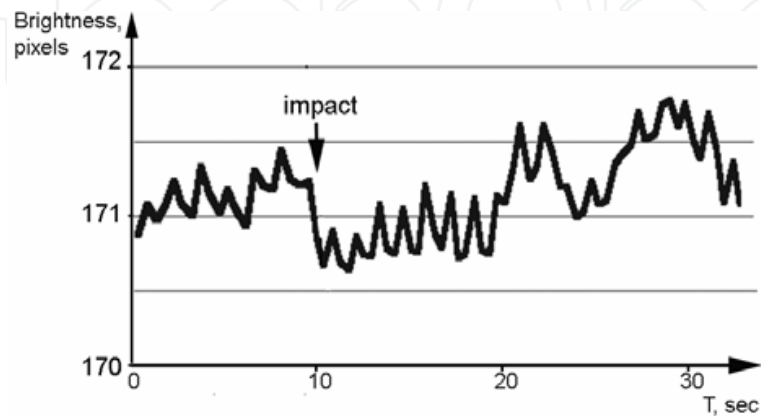


Fig. 15. The effect of laser beams on a finger emission (see the text).

While conducting the routine clinical work we realized that problems associated with significant misbalance in the region of high frequency fluctuations (as e.g., in the cases of viral infections or toxic states) are manifested as major gradients of emission intensity and the fragmentation of corona patterns. One can see (fig.16) that in the cases of cellular misbalance certain areas of BHT-grams present the chains of bright “grains”/speckles.

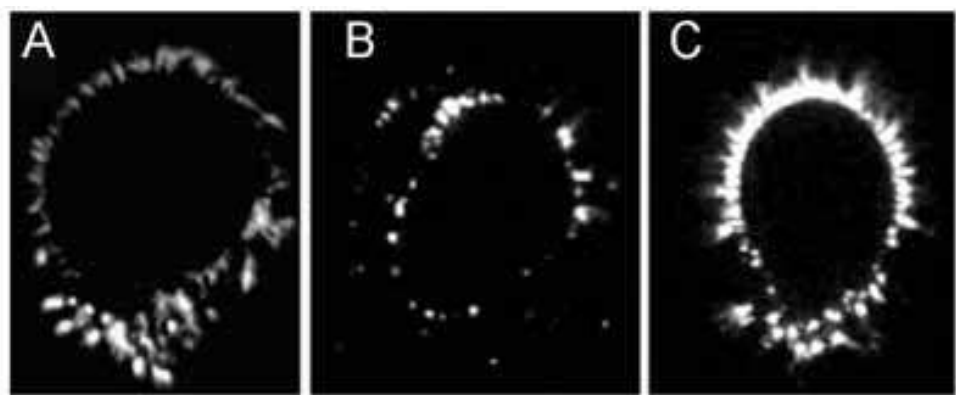


Fig. 16. Fractal appearance of coronas: 3 cases of cellular/metabolic disorder. A – malignant transformation of blood cells – the recording made several months prior to clinical manifestation of acute leucosis; B – a case of AIDS; C – reactivation of *Herpes Zoster*.

The fragmentation of fingertip coronas is nowadays used as an indication of increased activity on the cellular/intra-cellular levels of system-hierarchy. We found that fractal areas and bright speckles on BHT-grams appear in response to various weak impacts, e.g., alteration of ambient fields. The idea that geomagnetic and geo-electric fields are fundamental parts of information flow in the biosphere is not new [Cole & Graf, 1974]. Indeed, alteration of the earth fields results in a wide range of patterning defects and

abnormal reactions in plants and animals [Conley, 1970; Braun, 1973]. Our own experiments have demonstrated that even partial isolation of a body from natural geomagnetic fields causes the distortion and gradual fragmentation of BHT-grams. These results have been interpreted as the transmission of ambient information down to the cellular level of the system-hierarchy. BHT-examination has been conducted in the normal ambience and every 10-15 min after entering the room where magnetic fields comprised only 30 - 45% of natural values. Major gradients of brightness and abnormal shaping of BHT-grams, as well as their increasing fragmentation during first 30 - 45 min of experiments have been determined in all replicate studies (25 participants). We found that the coronas always restore normal appearance after the first stage of chaos-augmentation, albeit the second stage of the relaxation requires longer time (80 - 110 min) than the first one.

It has been interesting to check the reaction of HIS to the changes of boundary temperature as well. Figure 17 presents results of the experiment, where the emission of the left hand fingertip-corona has been recorded while another hand was affected by heated water. This experiment yielded the counter-intuitive results, since water of comfortable temperature caused the large-scale periodic fluctuations of emission much earlier than the cold or very hot water. It is likely that afferent nervous impulses, which represent linearly propagating signals, temporarily suppress the activity of nonlinear mechanisms of the HIS disrupting the phase-conjugated vibrations.

One can infer from the presented data that the wireless mechanisms of signal transfer react more efficiently and rapidly to weak signals, than to more powerful ones: the HIS uses only nonlinear mechanisms of weak interactions, while the nervous system operates through the fixed and linear guides of impulses, so intensive firing of linear signals seems to arrest the fluctuations for a while.

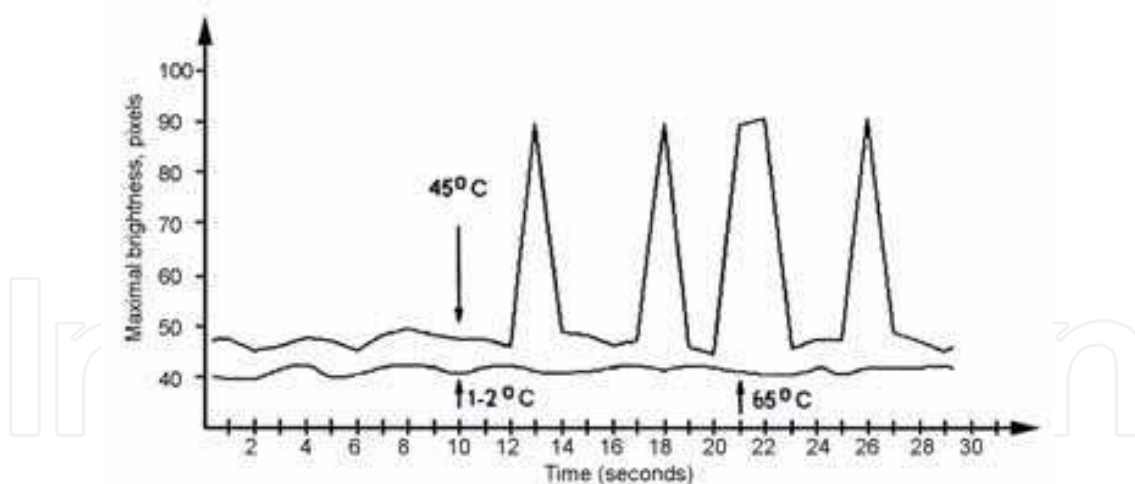


Fig. 17. The alteration of a body emission in response to distant thermal signals. See the text for explanations.

6. Dynamical systems in nature: our model and its discussion

The need to unveil the physical basis of our accidental finding pushed us towards various trends of modern sciences. Numerous inconsistencies, ambiguities and over-complicated explanations slowed down our research. We have been faced with the fact that open questions dominate over comprehensible answers when it comes to the most fundamental

physical issues. As an example of poor reliability of some widely accepted physical constants and ideas, one might name the recent data of Randolph Pohl of the Max Planck Institute in Germany, who reported that a primary building block of the visible universe, the proton, is smaller than previously thought [Pohl et al., 2010]. The value of gravitational force is also being challenged by two different methods as announced in the journal Nature [2010], etc. Hence, we had to seek out the “pearls” hidden in the oceans of excessive information in order to find, understand and reevaluate (with the new discovery in mind) all the facts and hypotheses that could integrate various notions and observations into a united, viable and verifiable system of knowledge. Drawing on our experimental data and on the knowledge accumulated in various trends of science we came to a conclusion that all dynamical systems of natural origin pass through similar stages while emerging and developing. Generic scenario of system’s “life-cycling” is discussed below. The offered model is based on the assumption that the space occupied by an integral entity (more exactly, the nonlinear phase-space of all dynamic systems, the universe being one of them) plays an active role in all emergence phenomena.

The structure and functional role of the space is being actively debated lately [Verlinde, 2010; Makela, 2010]. The hypothesis on background independence where geometry and gravity are regarded as emergent concepts is being studied in quantum theories of gravity [Marpoulou, 2007]. It is thought that the nonlinearity of space may explain many enigmas in modern physics. According to our model, the background phase-space is an active and self-organizing domain of physical reality – it acts as a “self-healing network” that controls and regulates all local perturbations by imposing physical forces and constraints on passive matter (on particles and their composites). The same phase-space acts also as a 3D medium for real-time holographic processes within the entire system.

The principle of holography with the new discovery in mind. The holographic principle, which is rooted in the “holomovement” hypothesis of David Bohm [1983], has been reevaluated and further developed by Gerard 't Hooft [1993] and Leonard Susskind [2008]; physicists ascertain that total information about the (D+1)-dimensional space may be found on its boundary/surface (the D-dimensional space). Jacob Bekenstein was the first to recognize that a universal relation exists between geometry and information [Beckenstein, 1972]. Later Bousso [2002] offered the general concept of covariant entropy bound showing its close relation to the holographic principle.

Essential arguments contributing to the support of the holographic hypothesis are:

- The theorem of Bell [1964], who showed that entanglement in a quantum system (EPR phenomenon) may persist over long distances;
- Data of Aspect [1982], Gisin [1999] and some other physicists who demonstrated the existence of quantum non-locality experimentally; many scientists plan to use entangled states for quantum cryptography [Ekert, 1991], entanglement-assisted communication [Bennet et al., 1997], fast quantum computations [Shor, 1997], etc.;
- The entropy bound: an upper limit on the entropy or information that can be contained within a given finite region of space-time [Beckenstein, 1981; Busso, 2002];
- The “Maldacena duality”: a conformal field theory defined on the boundary of a maximally symmetric manifold with constant negative curvature [Maldacena, 1998];
- Fractal distribution of galaxies: Mureika (2007) did show that such a distribution is a signature of holography (*fractal holography*);
- Wide-angle power correlation suppression in the cosmic microwave radiation that has been found to be compatible with the idea of holography (Huang et al. 2006);

- The holonomic model of Karl Pribram [Pribram, 1991]. The author argues that memories may be enfolded within every region of the brain rather than being localized;
- The *holo-diffraction* phenomenon: the first experimental evidence of the non-local effects manifested in living systems [Shaduri, 2005].

We have demonstrated that information about any significant disorder in a body may be detected through the analysis of minor „terminals“ of a system such as human fingertips. The *non-local imaging* of internal anatomic structures may be explained only if information is transmitted throughout entire body using the mechanisms of wave interactions: all agents and functional units of complex systems have to be permanently covered by a high-bandwidth holographic network.

In modern communication systems the most promising developments are envisioned in the area of the self-healing, self-configuring and scalable wireless networks that are capable to control and repair many deviations from normal modes of the network functioning. Highly resilient systems that use interconnected meshes of self-healing rings are being studied worldwide. Hence, humans re-invented a technology that actually presents the oldest and the most general mechanism of permanent communication between all constituents of natural systems.

We believe that the holographic grating of a system preserves the memories on the former and present states during whole lifecycle of an individual system. Thanks to the holographic principle of system functioning it is possible to readout the life story of a CAS, since its experience is being remembered in the form of updatable interference patterns. For instance, the BHT-grams of humans sometimes display holograms of former structural lesions such as bones fractured in early childhood. We suggest that the orchestrated phase-space acts as a master reference for local disturbances opposing all new formations and restoring the harmonic order whenever possible. Such a permanent feedback between the *reference* domain and various *object-associated events* had to appear in early universe.

Some arguments in favor of our model.

Theoretical physics and cosmology. NASA's Wilkinson Microwave Anisotropy Probe (WMAP) has found the sound waves in the early universe, where there is a primary “note” and a series of harmonics, or overtones [NASA, 2008]. So, some resonances of compression waves in the fabric of the space-time were already present in the first trillionth of a second after the “birth” of our universe. The most important (for our model) is the discovery of primordial fluctuations as it supports the hypothesis on the organizing role of system phase-space vibrations. Recently Verlinde proposed a theory which is actively discussed in scientific literature: the author derived Newton's Second Law, Newtonian gravity and general relativity, all by considering various holographic “screens” in space and suggesting the gravity to be an emergent property of the deeper underlying structure of the universe [Verlinde, 2010].

Waves as particles. A nested hierarchy of vibrating “lattices” of the non-linear medium may be viewed as a system of standing waves. It is acknowledged that *standing waves* arise when counter-propagating flows interact within a bounded area. Each and every possible standing wave has its specific energy. The localized standing waves that retain their forms over a long period of time are named *solitary waves, or solitons*. Solitary waves are robust and exhibit particle-like behavior; they can pass through each other or bounce back from each other emerging asymptotically unaltered from the collision [R.Rajaraman, 1982]. Hence, solitons behave as *wavicles* (both - waves and particles). Cohen et al. described the so called *holographic solitons* that consist of two mutually coherent field components. According to the

authors, the two components of the holographic solitons interfere, induce a periodic change in the refractive index, and simultaneously Bragg-diffract from the grating [Cohen et al., 2002]. The wavicles (solitons) and composite particles are extremely important, since a holographic grating may store information and continue to build new orders with their help.

Why did not everything just stay in a wave-form within the early universe? Could the universe develop without particle-like structures? The answer is definitely negative: the “solid agents” are crucial for the evolution and growth/inflation of any natural system – they help to preserve structural information on former states of a macro-system. We suggest that the smallest solitons act as the building blocks for more complex composites and also as the scattering elements distributed across the space. This assumption helps to approach many theoretical problems from a new viewing angle: the emergence of mass (constellations of fundamental particles), the appearance of the diffraction grating in the universal medium, the arrow of time, the generic phenomenon of continuous evolution and some other “enigmas” can be reconsidered in terms of real-time holographic processes.

We also assumed that the lowermost boundary of the universe might be formed through the generation of higher-order harmonics - the only option to reduce free energy and create an order out of the ultimate chaos in a bounded region of space (see below – “Genesis of complex systems”). Just imagine that we took out all the mass possessing matter from the universal system. The vibrating particle-free medium left after this “thought-experiment” would never evolve/change: no displaced mass - no fringes within the phase-space grating; no fringes/memories - no new order and no emergence phenomena; no changes of a system-state - no time arrow, etc.

Emergence of the holographic grating. Our scenario suggests that the lowest threshold of the observable reality is distributed within the space as a kind of „pinch harmonics“. This idea is not original: Misner, Thorne and Wheeler [1973] speculated that gravitational collapse at the Planck scale of distance is taking place everywhere and all the time in the geometry of the space-time; the space-time being made of Planck-size black holes has been assumed by some other physicists as well [Crane, 1993].

Indeed, the fragmentation/quantization of the dynamic background of our universe might result in emergence of the ground-state order where the Planck-scale solitons stabilize and solidify the *lowermost boundary of entire space*. Such a uniform medium with finite-value frequencies and permanent interaction between the incident and back-reflected wave-fronts can exhibit the properties of a holographic grating. Any local instability or displacement of solid inclusions from their quasi-stationary positions would perturb the resonances of the “humming” medium: the effects produced by perturbed lattices of the phase-space would then be manifested as physical forces imposed on passive particles. It should be emphasized that the displacement of particles towards the lower-energy states (relative immobilization) is similar to recording of information in the form of new structural combination and new interference patterns in the background ranked by energy states; this process is exactly the same as used in data holographic storage.

The self-healing network of a system-medium can deal with chaotic processes using the mechanisms similar to those known in non-linear optics (e.g., the generation of complex conjugate waves propagating backwards through a distorting medium). We have postulated that the universal medium is organized, fine-tuned and ranked by energy states, so any new boundary and any linear displacement in such a medium would be opposed by the background activity. Just imagine a small partition of such a nonlinear phase-space enclosed

within a spherical volume. The isolated phase-space would be forced to reorganize its medium according to new conditions: excessive energy “trapped” within it would generate new sub-harmonics (sub-lattices) and, correspondingly, new band-gaps, so that the spectrum of a bounded area would be squeezed becoming narrower and also more coherent compared to the host system’s spectrum. Obviously, the boundary vibrations of a distinct phase-space have to match a normal mode of the host-system – otherwise it would be impossible to preserve the structural stability.

Physical forces and phase-space. Any excitement in the range of high frequencies greatly affects all vibrations of a living system (fig. 13; fig. 16): major gradients of the emission brightness and density are characteristic of cellular/intracellular disorders. We have also demonstrated that superficial signals propagate towards the lower levels of the hierarchy, where high frequency vibrations are able to displace some small molecules and atoms from their meta-stable positions. Besides, we found that a system relaxes only after the high frequency agents become involved in *signal-processing*. One can infer from these data that high frequency vibrations play crucial role in the self-organization of the “whole”. Both - upstream and downstream propagation of perturbations through all the lattices (energy states) of medium-grating are necessary for normal functioning of multi-level systems; however, micro-scale events are associated with strong coupling of high-frequency processes (minimal degrees of freedom), whereas events on upper levels of system-hierarchy are driven by medium lattices of lower frequencies (weak forces, higher degrees of freedom).

Weak interactions are considered a separate type of the four fundamental interactions. Yet our scenario that is consonant with some of the new theories suggests that all types of physical interactions present the manifestation of the *geometry-dependent* interplay between the active phase-space and the complementary but passively driven agents of a system. By turning the logic around and postulating the existence of local equilibrium conditions, Jacobson [1995] came to a conclusion that the space-time might be comprised of waves propagating as adiabatic compression waves (analogous to sound in a liquid). As mentioned earlier, the Newton’s universal law of gravitation arises naturally and unavoidably in a theory in which space is emergent through a holographic scenario [Verlinde, 2010; Makela, 2010]. These and similar theories suggest that gravitation is emergent property of more general description of observable reality.

A subject that to our knowledge was never discussed in scientific literature concerns the concept of nature. The universe and nature are not synonyms: we believe that nonlinear phase-space with its self-healing grating must be distinguished from the “foreground” processes (local/linear events); nature is an emergent realm encompassing all the diverse products yielded by permanent interaction of the reference and “object” domains. Hence, according to our model, nature presents a by-product of perturbations within the ordered medium; its masterpieces would never emerge without the feedback between the holographic grating of the self-organizing phase-space and particle-associated events.

7. Emergence and evolution of complex systems

Genesis of a new system through the “lasing” of an old system’s part. An isolated partition of a relatively complex system behaves in the same way as bounded partitions of other phase-spaces – it utilizes excessive kinetic energy by creating new boundaries and resonances through successive fractalization (an example is the binary cleavage of a

fertilized ovum in mammals). The lesser the diameter of a sphere, the greater surface area it has relative to its volume, so the generation of smaller compartments enlarges the total surface area reducing the entropy of the whole (important in terms of thermodynamics and information theory).

The fragmentation of an isolated phase-space of a larger system and the narrowing of spectra may result in appearance of a new entity with its individual holographic grating: high frequency vibrations within a bounded fraction of medium can destroy all the complex substances of parental system driving the area towards the ground-state order – normal modes of the medium vibrations; as soon as all the constituents within the isolated area reach a state of ultimate excitement, the “random lasing” can take place [Polson & Vardeny, 2004]. The term *random lasing* defines amplification of vibration intensity in a randomly scattering medium that eventually leads to a coherent or quasi-coherent state. A team of researchers [Song; Xiao et al., 2010] have shown that dense tissues of bones present an ideal biological material for random lasing. A perfect order and coherent spectra may be obtained out of ultimate disorder if energy is trapped within (or pumped into) a minute area of the biological tissue. Hence, in order to become an individual system, a minuscule partition of the nonlinear phase-space of a host-system has to be isolated and transformed into an ordered medium through the effect of lasing. This process is opposite to emergence and development. The “antidevelopment” through lasing effects is necessary - any new system should empty its holographic “diary” before it starts to record personal history.

We argue that the lasing is crucial for emergence of any new system within the phase-space of a complex host-system. When the low-frequency vibrations of the parental phase-space are cut out by a boundary (closed for particles), the generation of new lattices-harmonics and corresponding band-gaps squeezes the spectrum of bounded area creating conditions favorable for emergence of a new holographic grating. The lasing of medium takes place during the transformation of normal biological tissues into a *neoplastic system (malignantly growing system)* as well.

Once created, an individual system may divide, shrink or degrade but it would never conquer additional space without regular exchange of particles with the host-system. The growth takes place in those multi-level systems that are unable to match ambient vibrations without enlargement of their surface area: they continue to grow up to the moment when near-zero effective force is achieved on the boundary between the outer and internal phase-spaces. As the number of oscillating particles increases within a new entity, its free energy decreases gradually being spent on formation of new resonances and new molecular structures. The time a maturing system takes to transfer energy/excitation from the upper level lattices of low frequencies to the bottom lattices of high-frequency grows in parallel with the number of resonances and mass. We already mentioned that minimum 30 min is required for weak ambient signals to reach the cellular level of the system-hierarchy in adults. We also found that BHT-grams of children and pregnant women, as well as fingertip coronas of the patients with cancer, are more disordered and variable than BHT-grams of other groups of examinees.

Evolution of systems. The evolution of natural systems reached a point of bifurcation at some moment: a multi-level hierarchy could be built only through the exchange of particles with the environment. The separate “units” of simple structure such as elementary particles could interact with one another but they were unable to generate new resonances within their phase-spaces. Certain interactions between elementary particles and their composites resulted in the appearance of complex flexible molecules that matched some profiles of

medium lattices. A tuned entity of flexible molecules and medium grating became able to withstand intrusion of small portions of chemical substances into the bounded area – new particles started to play the stabilizing role and also contributed to the holographic storage of data.

Some flexible chains of molecules and atoms that matched the sinusoidal profiles and grooves of medium (vibrating in synchrony with corresponding lattices) survived the degradation of the “whole”: they started to act independently of their host-systems either through transition into other systems or by building their own phase-spaces in appropriate medium. In this way certain macromolecular structures (e.g., chains of nucleotides) made it possible to exchange and/or spread information on fundamental modes of original phase-spaces. It is known that the main blueprint of genetic instructions – DNA – is structurally flexible polymer: it exists in many possible conformations; the carbonyl centers of its esters may give rise to 120° angles and DNA also contains grooves/spaces between the twin helical strands of complementary base pairs. Besides, DNA may carry out low-frequency collective motion [Urabe et al., 1983]. Hence, these molecules are able to provide information on the profiles of those vibrating lattices of medium that a new system can use while organizing its individual phase-space.

The encoding of system-memory about individual phase-space-modes through its transformation into the genetic (solid) form has started a new era in the history of CAS. The further cooperation of distributed mechanisms of HIS with some linear conductors of signal transmission (nerves) greatly improved the control and regulation of internal processes, and also facilitated exchange of information with system ambience. The unity of linear and nonlinear information-managing mechanisms created a new platform for accelerated development.

Associative memory of complex systems. We believe that genetic memory is used as a code for new phase-space grating; however, it cannot contribute to the adaptive behavior of systems: any CAS should create its own archive/database in order to behave adaptively. The “fringes” of memory (immobilized particles) in the holographic grating of a system medium can appear in response to any significant perturbation of a system state. The medium resonances and scattering/diffracting particles comprise a kind of system-archive where information about personal experience of a system is retained in a readily updatable form. An update of saved information might be compared to search-engines that browse within the memory of a computer using keywords as guides. 3D-holograms are sensitive to selected wavelengths/frequencies, so perceived packets of signals may find targets due to this sensitivity. Interaction of detuned or linear wave-fronts with the holographic grating and simultaneous diffraction makes it possible to read out the phase-conjugated waves.

The higher the coincidence between previously experienced and new states of the body and the higher the dominant frequency of new signals, the better and faster is the process of “data-recollection” (aka the reconstruction of saved holograms). With this conjecture in mind one can explain certain poorly understood peculiarities of adaptive systems. For instance, it is occasionally claimed that a complex adaptive system has individual strategy based on particular goals and predictions of the future. A goal to which all agents of CAS thrive is nothing but the desired equilibrium (albeit, animals and humans may act voluntarily). Some scholars refer to goal-directed units as basic agents of CAS. This opinion contradicts a widely accepted point of view that behavior of a system is not predicted by the behavior of its parts. Obviously, neither a system nor its parts would have any particular “goals” while the archive of personal memory is empty; however, any adaptive system has a

kind of a *free will* in the sense that even the most primitive organisms are able to choose particular scenario(s) drawing on their former experience: since a sequence of numerous successive holographic recordings can be updated almost instantly, an adaptive system may have some time to change its behavior faster than undesirable events cross the brink of unavoidability. Such a capability of CAS to foresee the final results of particular states (*premonition*) has nothing to do with paranormal phenomena.

According to the described model, any adaptive system conducts the real-time holography permanently, during the whole life-cycle. CAS may differentiate signals operating across multiple wave-bands; however, not all the signals and states of a system are being “remembered”: the *self-healing network* may restore all resonances after some non-essential or already experienced (weak) impacts; so only relatively powerful, significant and previously non-experienced states are being recorded and archived. The described type of the non-local memory cannot be fully erased until the energy is sufficient to avoid irreversible collapse of near-boundary lattices; each new input into the holographic database of a system brings closer the moment, when the HIS becomes less sensitive to new inputs due to the growing number of immobilized particles. Hence, data storage yields not only beneficial (e.g., experience) but also unwanted effects such as aging and inevitable collapse/death. The life-cycle of a system ends naturally when the outer lattice of the HIS ceases its tuned vibrations. This “gravitational” collapse takes place if free energy falls below the threshold due to critical number of fringes (manifested also as wrinkles on a body surface) and the deterioration of exchange via the shrunken boundary. Thus, the life-cycling and the decentralized memory of complex systems are mutually interdependent concepts.

Cancer: undesired system-genesis. Oncogenesis suggests the process of malignant transformation when a subset of the cells, called cancer stem cells, rapidly replicates themselves [Cho & Clarke, 2008]. We argue that cancer is a new system that emerges within a host-body as a distinct phase-space, so there should be a kind of similarity between the first stages of oncogenesis, embryogenesis and nature-genesis. Consider a region in a body that contains or accumulates excessive energy but has a restricted access to ambient substances (poorly permeable boundary). Energy may be increased due to several factors: viral activity; the presence of certain molecules that either resonate with very high frequencies of ambient fields or affect polypeptides/nucleic acids in such a way that ground-state vibrations become altered; repeated mechanical irritation may also create conditions beneficial for cancer. Definitely, the boundary of an emerging system must be closed for substances at the first stage of oncogenesis. Such a situation might take place within the tissues of increased density or low excitability (e.g., fibroids, scars, etc.). In the case the energy is high enough to cause the random lasing of entire area, a new individual system – a neoplasm – might emerge. The smaller the area occupied by new phase-space and the narrower the range of its characteristic frequencies more chances appear for a neoplasm to start aggressive growth.

Not every area that accumulates energy would produce malignant tumors in biological systems. Some possible scenarios of the host phase-space-partitions are given below:

1. The exchange of substances becomes possible earlier than the cellular constellation reaches coherent state through the lasing: the cells grow non-aggressively yielding a benign tumor;
2. The gain medium accomplishes the lasing but boundaries remain closed for particles: entire area „melts down“ yielding a cyst(s);

3. Exchange of substances with the surroundings begins just after the coherent state is achieved through the lasing: the neoplasm builds its individual holographic grating and starts malignant growth.

BHT-data substantiate our model of cancer-emergence. The lasing of medium and quasi-coherent radiation may be suspected when BHT-grams contain extremely bright lines/inclusions within dark areas. The narrow focused „beams” and bright “bulbs” that often produce diffuse or branching *illumination* are characteristic for aggressively developing neoplasm in early stage cancer (fig. 18, A, B). The metastatic transformation of cells also provides bright inclusions within dark and poorly structured replicas of degrading tissues (fig. 18, C).

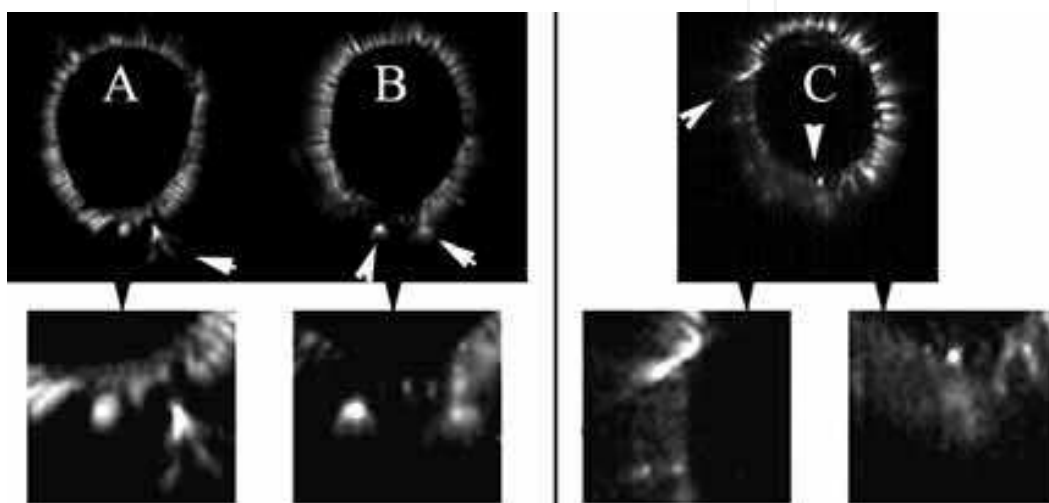


Fig. 18. BHT-signatures of lasing in biological tissues (white arrows). A, B – early stage of breast cancer (two recordings made within 3 months); C – metastases in gastric cancer.

The proposed model of the cancer-genesis is indirectly substantiated by a team of researchers, who have discovered that the malignant human tissue can be distinguished from nonmalignant samples through the assessment of their emission spectra [Polson & Vardeny, 2004]. A more detailed version of our theory of cancer-genesis will be published elsewhere. We hope that the generic model of cancer would help medical professionals in their struggle against this undesired manifestation of the universal phenomenon of system-emergence.

8. Concluding remarks

We have outlined our phenomenological model of system-emergence and development. The discovery of non-local effects in living systems has triggered the search for physical mechanisms that might make it possible to integrate the separate constituents of a system and their relationships into an orchestrated entity. We found that real-time holographic processes within nonlinear phase-spaces of natural systems could explain our experimental evidence. The principle of holography was already known to be manifested on other scales of observable reality that facilitated our theoretical research. Obviously, the holographic replicas of anatomic structures could not be formed in a mature organism: we recognized that emergence of the holography-based mechanisms is closely related to the very first

stages of natural system-formation. Hence, it became necessary to study the generic process of system-genesis, more precisely, the origin of natural systems in our universe.

To expand the understanding of the most general mechanisms of system-genesis and explain the phenomenon of emergence we addressed certain problems in theoretical physics. While tracing back the origin of self-organizing systems in our universe only the most reliable hypotheses, observations and experimental data were considered. Our quest encountered the problems of nature-genesis and wave-interactions at some point, and, eventually, we came to the conclusion that the only way to overcome these stumbling-blocks is to turn the common logic around postulating that the universal space presents the nonlinear reference-medium for local (particle-associated) disturbances and linear processes. The hidden activity of the phase-space - the rear side of a “coin” - turned out to be much more important than visible and measurable manifestations of the physical reality. Indeed, “the obscure connection is more powerful than the apparent one” as has been put by Heraclitus. Hence, the active role of periodically organized nonlinear space shared by all constituents of a system became a cornerstone in our model - it facilitated further search for reasonable explanations of system-peculiarities. Recently we found that some physicists regard the microstructure of the universal phase-space as an answer to the deepest questions in science [Smolin, 2010], namely why space, time and gravity exist at all. So our reasoning is not just a *vox clamantis in deserto*.

To summarize, we argue that the most fundamental aspect of physical reality is the interaction between the nonlinear phase-space of the universe and the local “foreground” events that allows the permanent creation of new order and emergence of complex structures through the holographic scenario. We believe that this interaction drives the evolution of the universal macro-system producing the “daughter-units” (new systems) of various types, aromas and flavors during its finite lifecycle.

9. Acknowledgements

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Holography has recently become a field of much interest because of the many new applications implemented by various holographic techniques. This book is a collection of 22 excellent chapters written by various experts, and it covers various aspects of holography. The chapters of the book are organized in six sections, starting with theory, continuing with materials, techniques, applications as well as digital algorithms, and finally ending with non-optical holograms. The book contains recent outputs from researches belonging to different research groups worldwide, providing a rich diversity of approaches to the topic of holography.

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