

# Structural Alterations among Water Molecules after Bioinfluence of Dimitar Risimanski

Ignat Ignatov<sup>1\*</sup> Oleg Mosin<sup>2</sup>

1. DSc, Professor, Scientific Research Center of Medical Biophysics (SRCMB),  
N. Kopernik Street, 32, Sofia 1111, Bulgaria

2. PhD (Chemistry), Biotechnology Department, Moscow State University of Applied Biotechnology,  
Talalikhina Street, 33, Moscow 109316, Russian Federation

## Abstract

This paper deals with the review of the results for influence on water for restructuring of water molecules. The aim is improvement the quality of water for positive biophysical effects in human body. There are appears structural fluctuations in water samples after bioinfluence of Risimanski. The deionized water after the bioinfluence of Risimanski has the energy at  $E = -0.1387$  eV; there is the local extremum with  $f(E)$  value measured at  $76.9 \pm 3.8$  eV<sup>-1</sup>. The mountain water after the bioinfluence of Risimanski has the energy at  $E = -0.1387$  eV; there was the local extremum with  $f(E)$  value measured at  $93.1 \pm 4.7$  eV<sup>-1</sup>. Additionally, by using IR, NES, and DNES methods were investigated various samples of water from Bulgarian water springs: the melt water from Glacier Rosenlauri, Swiss Alps, as well as the human blood serum of people with excellent health and cancer patients between 50 and 70 years old. The aim is describing of local extremums of water molecules, which are useful for human health. Other experiments were performed on deionized and mountain water with bioinfluence of Dimitar Risimanski. As an estimation factor in NES and DNES was measured the values of the average energy of hydrogen bonds ( $\Delta E_{H...O}$ ) among H<sub>2</sub>O molecules in water samples, as well as a local extremums in the NES and DNES-spectra of various samples of water and the human blood serum at  $E = -0.1387$  eV and  $\lambda = 8.95$  μm. For a group of people in critical condition of life and patients with malignant tumors the greatest values of local extremums in IR-, DNES-spectra were shifted to lower energies relative to the control healthy group. Further we applied this method for calculation of percent distribution of H<sub>2</sub>O molecules in all studied water samples according to energies of hydrogen bonds ranged from (-0.08 to -0.1387 eV). It was shown that mountain water is among the most important factors for human longevity and human health. The variety of ions (K<sup>+</sup>, Na<sup>+</sup>, Ca<sup>2+</sup>, Mg<sup>2+</sup>, Mn<sup>2+</sup>, Fe<sup>2+</sup>, Fe<sup>3+</sup>, Zn<sup>2+</sup>, SO<sub>4</sub><sup>2-</sup>, Cl<sup>-</sup>, HCO<sub>3</sub><sup>-</sup>, CO<sub>3</sub><sup>2-</sup>), the chemical-physical parameters (pH, electroconductivity) and the decreased content of deuterium in studied water samples renders beneficial effects of these types of water on human health. In frames of the research was carried out the computer calculation of elemental polyhedral water nanoclusters with a formula (H<sub>2</sub>O)<sub>n</sub>, where  $n = 3-20$ . Based on this data some important physical characteristics of water were obtained, e.g. the average energy of hydrogen bonding between H<sub>2</sub>O molecules in the process of cluster formation was measured by the DNES method compiles  $-0.1067 \pm 0.0011$  eV. The research is performed with Method of color coronal spectral analysis. There are studied water samples with deionized water before and after influence of Risimanski.

**Keywords:** longevity, mountain water, IR, NES, DNES, coronal discharge

## 1. Introduction

Water is the main substance of life. The human body of an adult person is composed from 50 to 55% of water. With aging, the percentage of water in the human body decreases. Hence, the factor of water quality and its amount in organism is an essential factor for the research (Pocock *et al.*, 1981; Howard & Hopps, 1986). Water is present in the composition of the physiological fluids in the body and plays an important role as an inner environment in which the vital biochemical processes involving enzymes and nutrients take place. Water also is the main factor for metabolic processes and aging (Ignatov, 2012). Earlier studies conducted by us have demonstrated the role of water, its structure, the isotopic composition and physical-chemical properties (pH, temperature) on the growth and proliferation of prokaryotes and eukaryotes in water with different isotopic content (Mosin & Ignatov, 2012; Ignatov & Mosin, 2013a; Ignatov & Mosin, 2013b). These factors, the structure and composition of water are of great importance in many biophysical studies. The peculiarities of the chemical structure of the H<sub>2</sub>O molecule and weak bonds caused by electrostatic forces and donor-acceptor interaction between hydrogen and oxygen atoms in H<sub>2</sub>O molecules create favorable conditions for formation of directed intermolecular hydrogen bonds (O-H...O) with neighboring H<sub>2</sub>O molecules, binding them into complex intermolecular associates which composition represented by general formula (H<sub>2</sub>O)<sub>n</sub>, where  $n$  can vary from 3 to 50 (Keutsch & Saykally, 2011). The hydrogen bond is a form of association between the electronegative O-atom and a H-atom, covalently bound to another electronegative O-atom, is of vital importance in the chemistry of intermolecular interactions, based on weak electrostatic forces and donor-acceptor interactions with charge-transfer (Pauling, 1960). It results from interaction between electron-deficient H-atom of one H<sub>2</sub>O molecule (hydrogen donor) and unshared electron pair of an electronegative O-atom (hydrogen acceptor) on the neighboring H<sub>2</sub>O molecule.

There are studied the various samples of water from Bulgarian water springs: the melt water from Glacier Rosenlauri, Swiss Alps, as well as human blood serum of people with excellent health and cancer patients between 50 and 70 years old. In frames of this research on the water quality were investigated 415 people living in the municipalities of Teteven, Yablanitza, Ugarchin, Lukovit, Lovech district; Dolni Dabnik, Pleven district, Kuklen, Plovdiv district (Bulgaria), where is lived the most of long lived people and their siblings, were studied.

The authors also performed the research of electrochemically activated Kangen Water<sup>®</sup> on the distribution of H<sub>2</sub>O molecules according to the energies of hydrogen bonds, as well as studies of the NES and DNES spectrum and the biophysical effect of this type of water on human body. Particularly there was obtained and studied the electrochemically activated Kangen alkaline water catholyte with pH = 8.5.

The research is including control water samples with deionized water and mountain water from mountain sources in Zlatishko-Tetevenska mountain, Teteven, Bulgaria. The results are connected with measurement of deionized water and mountain water after bioinfluence of Dimitar Risimanski. The bioinfluence is from Risimanski with biophysical (electromagnetically) fields.

## 2. Materials and Methods

### 2.1. Preparation of Water Samples with Varying Deuterium Content

For preparation of water samples with varying deuterium content we used D<sub>2</sub>O (99.9 atom%) received from the Russian Research Centre "Isotope" (St. Petersburg, Russian Federation). Inorganic salts were preliminary crystallized in D<sub>2</sub>O and dried in vacuum before using. D<sub>2</sub>O distilled over KMnO<sub>4</sub> with the subsequent control of deuterium content in water by <sup>1</sup>H-NMR-spectroscopy on Bruker WM-250 device ("Bruker", Germany) (working frequency – 70 MHz, internal standard – Me<sub>4</sub>Si) and on Bruker Vertex ("Bruker", Germany) IR spectrometer (a spectral range: average IR – 370–7800 cm<sup>-1</sup>; visible – 2500–8000 cm<sup>-1</sup>; the permission – 0,5 cm<sup>-1</sup>; accuracy of wave number – 0.1 cm<sup>-1</sup> on 2000 cm<sup>-1</sup>).

### 2.2. NES and DNES Spectral Analysis

The device for DNES spectral analysis was made by A. Antonov on an optical principle. For this was used a hermetic camera for evaporation of water drops under stable temperature (+22–24 °C) conditions. The water drops were placed on a water-proof transparent pad, which consists of thin maylar folio and a glass plate. The light was monochromatic with filter for yellow color with wavelength at  $\lambda = 580 \pm 7$  nm. The device measures the angle of evaporation of water drops from 72.3° to 0°. The DNES-spectrum was measured in the range of -0.08– -0.1387 eV or  $\lambda = 8.9$ –13.8  $\mu\text{m}$  using a specially designed computer program. The main estimation criterion in these studies was the average energy ( $\Delta E_{\text{H...O}}$ ) of hydrogen O...H-bonds between H<sub>2</sub>O molecules in water samples and human blood serum.

### 2.3. Studying of the Human Blood Serum

1% (v/v) solution of human blood serum was studied with the methods of IR-spectroscopy, non-equilibrium (NES) and differential non-equilibrium (DNES) spectral analysis. The specimens were provided by Kalinka Naneva (Municipal Hospital, Bulgaria). Two groups of people between the ages of 50 to 70 were tested. The first group (control group) consisted of people in good clinical health. The second group included people in critical health or suffering from malignant diseases.

### 2.4. IR-spectroscopy

IR-spectra were registered on Bruker Vertex ("Bruker", Germany) IR spectrometer (a spectral range: average IR – 370–7800 cm<sup>-1</sup>; visible – 2500–8000 cm<sup>-1</sup>; the permission – 0,5 cm<sup>-1</sup>; the accuracy of wave number – 0,1 cm<sup>-1</sup> on 2000 cm<sup>-1</sup>) and on Thermo Nicolet Avatar 360 Fourier-transform IR.

### 2.5. Statistical Processing of Experimental Data

Statistical processing of experimental data was performed using the statistical package STATISTISA 6.0 using the Student's *t*- criterion (at  $p < 0.05$ ).

### 2.6. Color coronal spectral analysis

Experiments were carried out by using selective high-frequency electric discharge (SHFED) on a device with the electrode made of polyethylene terephthalate (PET, hostafan) with an electric voltage on the electrode 15 kV, electric impulse duration 10  $\mu\text{s}$ , and electric current frequency 15 kHz. The electrode of the device was made of hostafan, and was filled up with electro-conductive fluid. The spectral range of the emission was in the range 380–495 nm and 570–750 $\pm$ 5 nm. The measurements were measured in electronvolts (eV). Detection of gas discharge glowing was conducted in a dark room equipped with a red filter. On the electrode put a photosensitive paper or color film. The object under study (human thumb) was placed on top of a sheet of photo paper or color film. Between the object and the electrode were generated impulses of the electric voltage 15 kV and electric current

frequency – 15–24 kHz; on the reverse side of the electrode was applied the transparent electrically conductive thin copper coating. Under these conditions in the thin contact gas space between the studied object and electrode was generated gas electric discharge in the form of characteristic glow around the object – a corona gas electric discharge in the range of 280–760 nm, illuminates a color photo or a photographic film on which was judged about the bioelectric properties of the studied object. Along with the visible range, for this method were obtained color spectra in UV and IR range. Evaluation of the characteristic parameters of snapshots was based on the analysis of images treated by standard software package. Statistical processing of the experimental data was performed using the statistical package STATISTISA 6 using Student's  $t$ -criterion (at  $p < 0.05$ ).

### 3. Results and Discussions

#### 3.1. Comparative analysis between longevity of long living people, centenarians and their siblings and the quality of water

In frames of the research on the water quality 121 long living people from Bulgaria over 90 years of age have been studied together with their 294 siblings. The average lifespan of long lived people and centenarians in mountain areas is 94.1 years. For the average lifespan of long lived people in plain areas the result is 90.6 years. The most adult person from mountain areas is 104 years old and for plain areas is 97 years old. For the brothers and sisters of long live people from mountain areas the average lifespan is 88.5 years. For the brothers and sisters of long live people from plain areas the average lifespan is 86.4 years. The difference in life expectancy of the two groups of people is reliable and it corresponds to the Student's  $t$ -criteria at  $p < 0.05$  with a confidence level of  $t = 2.36$ . There are distances of no more than 50–70 km between these places and the only difference is the mountain water and air.

There have been 21519 residents in Teteven and 142 of them were born before 1924. Figure 1 demonstrates the interrelation between the year of birth (1912–1924) of long living people (age) and their number (Teteven municipality, Bulgaria).

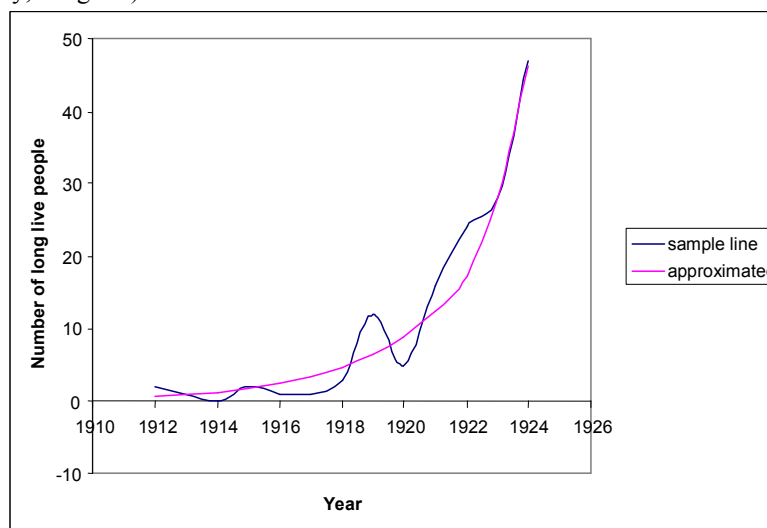


Figure 1: Interrelation between the year of birth of long living people (age) and their number in Teteven municipality, Bulgaria.

From the standpoint of genetics, the process of aging is associated with disruption of the genetic program of the organism and gradual accumulation of errors during the process of DNA replication. Aging may be associated with the accumulation of somatic mutations in the genome and be influenced by free radicals (mainly oxygen and primary products of oxidative metabolism) and ionizing radiation on DNA molecules as well (Woodhead, 1984; Adelman *et al.*, 1988). Such mutations can reduce the ability of cells to the normal growth and division and be a cause of a large number of various cell responses: inhibition of replication and transcription, impaired cell cycle division, transcriptional mutagenesis, cell aging that finally result in cell death. Cells taken from the elderly people show a reduction in transcription when transferring information from DNA to RNA.

From the standpoint of dynamics, aging is a non-linear biological process, which increases over time. Accordingly, the rate of aging increases with time. The accumulation of errors in the human genome increases exponentially with time and reaches a certain stationary maximum at the end of life. L. Orgel shows that, for this reason, the probability of cancer occurrence increases with age (Orgel, 1963). Figure 2 shows L. Orgel's results on the interrelation between age and the number of cancer cases. The accumulation of errors in synthesis of abnormal proteins increases exponentially over time with age. Cells taken from elderly people show the reduced levels of transcription or transmission of information from DNA to RNA. Therefore, the probability of cancer increases with age. The interrelation between the number of Bulgarian centenarians in the mountainous

municipality of Teteven and their age is close to exponential.

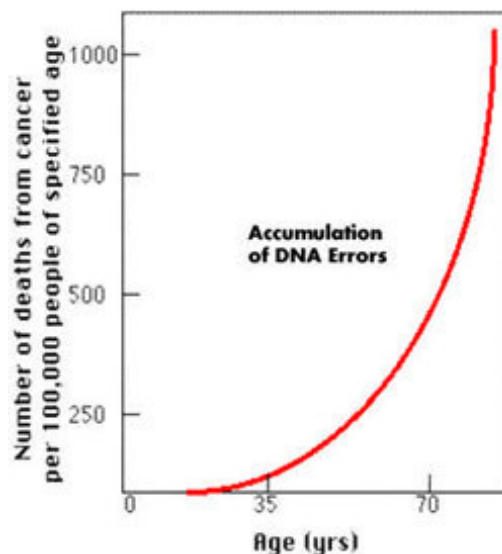


Figure 2: Interrelation between age and the number of cancer patients (Orgel, 1963).

Here are submitted the data for Bulgaria:

- 1) Varna district – 44 centenarians per 1 million of inhabitants, plain and sea regions;
- 2) Pleven district – 78 centenarians per 1 million of inhabitants, plain regions;
- 3) Teteven district – 279 centenarians per 1 million of inhabitants, hills and mountainous regions;
- 4) Bulgaria – 47 centenarians per 1 million of inhabitants.

The analogous situation is observed in the Russian North. According to G. Berdishev (Berdishev, 1989), people inhabiting the Russian North – the Yakuts and the Altaians as well as the Buryats, drink the mountain water obtained after the melting of ice. Altai and Buryat as well as Caucasus water sources in Russia are known as moderately warm, with temperatures of +8–10 °C; the water is generally ice-free in winter. This phenomenon is explained by the fact that the melt water contains a low percentage of deuterium compared with an ordinary tap water that is believed to have a positive effect on the tissue cells and metabolism. The melt water in Russia is considered to be a good folk remedy for increasing physical activity of the human body, enhancing the vitality of the organism and thought to have a beneficial effect on metabolism (Goncharuk *et al.*, 2013). In the world are also popular the water sources containing the melt water from Canada, Norway, Island and Alaska.

The analyses of water from various sources of Russia and Bulgaria show that the mountain water contains on average ~2–5% less deuterium in form of HDO, than river water and sea water. In natural waters, the deuterium content is distributed irregularly: from 0.02–0.03 mol.% for river and sea water, to 0.015 mol.% for water of Antarctic ice – the most purified from deuterium natural water containing deuterium in 1.5 times less than that of seawater. According to the international SMOW standard the isotopic shifts for D and  $^{18}\text{O}$  in sea water:  $\text{D}/\text{H} = (155.76 \pm 0.05) \cdot 10^{-6}$  (155.76 ppm) and  $^{18}\text{O}/^{16}\text{O} = (2005.20 \pm 0.45) \cdot 10^{-6}$  (2005 ppm) (Lis *et al.*, 2008). For the SLAP standard the isotopic shifts for D and  $^{18}\text{O}$  in seawater:  $\text{D}/\text{H} = 89 \cdot 10^{-6}$  (89 ppm) and for a pair of  $^{18}\text{O}/^{16}\text{O} = 1894 \cdot 10^{-6}$  (1894 ppm). In surface waters, the ratio  $\text{D}/\text{H} = \sim(1.32\text{--}1.51) \cdot 10^{-4}$ , while in the coastal seawater –  $\sim(1.55\text{--}1.56) \cdot 10^{-4}$ . Waters of other underground and surface water sources contain varied amounts of deuterium (isotopic shifts) – from  $\delta = +5,0$  D,%, SMOW (Mediterranean Sea) to  $\delta = -105$  D,%, SMOW (Volga River). The natural waters of CIS countries are characterized by negative deviations from SMOW standard to  $(1.0\text{--}1.5) \cdot 10^{-5}$ , in some places up to  $(6.0\text{--}6.7) \cdot 10^{-5}$ , but there are observed positive deviations at  $2.0 \cdot 10^{-5}$ . The content of the lightest isotopomer –  $\text{H}_2^{16}\text{O}$  in water corresponding to SMOW standard is 997.0325 g/kg (99.73 mol.%), and for SLAP standard – 997.3179 g/kg (99.76 mol.%).

The thawed snow and glacial water in the mountains and some other regions of the Earth also contain less deuterium than ordinary drinking water. On average, 1 ton of river water contains 150–200 g deuterium. The average ratio of H/D in nature makes up approximately 1:5700. According to the calculations, the human body throughout life receives about 80 tons of water containing in its composition 10–12 kg of deuterium and associated amount of heavy isotope  $^{18}\text{O}$ . Such a considerable amount of heavy isotopes in the composition of drinking water is capable to cause the genetic damage, lead to the development of cancer, and to initiate aging. According to our study, a high concentration of heavy water is toxic to the body; chemical reactions in the environment, it is slow in comparison with ordinary water, the hydrogen bonds involving deuterium conventional somewhat stronger hydrogen bonds due to the kinetic isotope effect deuterium (Ignatov & Mosin, 2014a; Ignatov & Mosin, 2014b; Ignatov & Mosin, 2014c). According to our studies the animal cells can withstand up to 25–30%  $\text{D}_2^{16}\text{O}$ , plants –

up to 60% D<sub>2</sub><sup>16</sup>O, while protozoa and the cells are able to exist on 90% D<sub>2</sub><sup>16</sup>O. Once being in the body, D<sub>2</sub><sup>16</sup>O can cause metabolic disorders, kidney and hormonal regulation. At high concentrations in the body D<sub>2</sub><sup>16</sup>O inhibited the enzymatic reactions, cell growth, carbohydrate metabolism and synthesis of nucleic acids. The effects of D<sub>2</sub><sup>16</sup>O are particularly susceptible to the systems that are most sensitive to the substitution of H<sup>+</sup> with D<sup>+</sup>, which use high speed formation and rupture of the hydrogen bonds. Such cell systems are the unit of biosynthesis of macromolecules and the respiratory chain. The last fact allows us to consider the biological effects D<sub>2</sub><sup>16</sup>O, as a complex negative effect, acting simultaneously on the functional state of the large number of systems: metabolism, biosynthetic processes, cell transport, the structure and function of deuterated macromolecules and cellular membranes. This results in inhibition of cell growth followed by cell death in D<sub>2</sub><sup>16</sup>O. This occurs even when using solutions of D<sub>2</sub><sup>16</sup>O shaped with HD<sup>16</sup>O. That is why it seems so important to purify water from heavy isotopes of D and <sup>18</sup>O.

### 3.2. Clinical studies with human blood serum testing

A convenient method for studying of liquids is non-equilibrium differential spectrum. It was established experimentally that the process of evaporation of water drops, the wetting angle  $\theta$  decreases discreetly to zero, and the diameter of the water drop basis is only slightly altered, that is a new physical effect (Antonov, 1995; Antonov & Yuskesselieva, 1983). Based on this effect, by means of the measurement of the wetting angle within equal intervals of time is determined the function of distribution of H<sub>2</sub>O molecules according to the value of  $f(\theta)$ . The distribution function is denoted as the energy spectrum of the water state. The theoretical research established the dependence between the surface tension of water and the energy of hydrogen bonds among individual H<sub>2</sub>O-molecules (Antonov, 1995).

For calculation of the function  $f(E)$  represented the energy spectrum of water, the experimental dependence between the wetting angle ( $\theta$ ) and the energy of hydrogen bonds ( $E$ ) is established:

$$f(E) = \frac{14,33f(\theta)}{[1-(1+bE)^2]^2} \quad (1)$$

where  $b = 14.33 \text{ eV}^{-1}$

The relation between the wetting angle ( $\theta$ ) and the energy ( $E$ ) of the hydrogen bonds between H<sub>2</sub>O molecules is calculated by the formula:

$$\theta = \arccos(-1 - 14.33E) \quad (2)$$

The energy spectrum of water is characterized by a non-equilibrium process of water droplets evaporation, therefore, the term non-equilibrium spectrum (NES) of water is used.

The difference  $\Delta f(E) = f(E_{\text{samples of water}}) - f(E_{\text{control sample of water}})$  – is called the “differential non-equilibrium energy spectrum of water” (DNES).

Thus, the DNES spectrum is an indicator of structural changes in water, because the energy of hydrogen bonds in water samples differ due to the different number of hydrogen bonds in water samples, which may result from the fact that different waters have different structures and composition and various intermolecular interactions – various associative elements etc (Ignatov et al, 2014; Ignatov et al., 2015). The redistribution of H<sub>2</sub>O molecules in water samples according to the energy is a statistical process of dynamics.

Figure 3 shows the average NES-spectrum of deionised water. On the X-axis are depicted three scales. The energies of hydrogen bonds among H<sub>2</sub>O molecules are calculated in eV. On the Y-axis is depicted the function of distribution of H<sub>2</sub>O molecules according to energies  $f(E)$ , measured in reciprocal unit  $\text{eV}^{-1}$ .

Arrow A designates the energy of hydrogen bonds among H<sub>2</sub>O molecules, which is accepted as most reliable in spectroscopy.

Arrow B designates the energy of hydrogen bonds among H<sub>2</sub>O molecules the value of which is calculated as:

$$\bar{E} = -0.1067 \pm 0.0011 \text{ eV} \quad (3)$$

Arrow C designates the energy at which the thermal radiation of the human body, considered like an absolute black body (ABB) with a temperature +36.6 °C, is at its maximum.

A horizontal arrow designates the window of transparency of the Earth atmosphere for the electromagnetic radiation in the middle infrared range of the Sun toward the Earth and from the Earth toward the surrounding space. It can be seen that the atmosphere window of transparency almost covers the NES-spectrum of water.

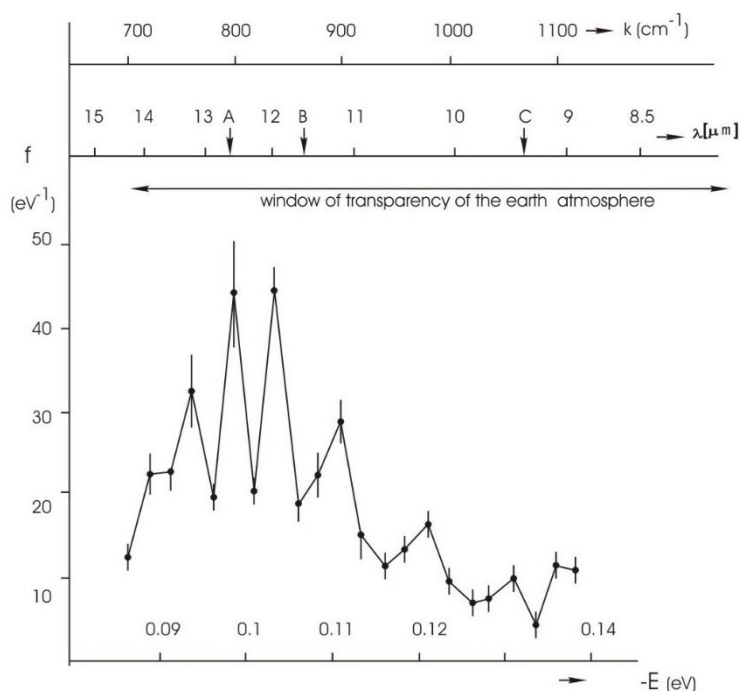


Figure 3: The NES-spectrum of deionized water (chemical purity – 99.99 %; pH – 6,5–7,5; total mineralization – 200 mg/l; electric conductivity – 10  $\mu\text{S}/\text{cm}$ ): the horizontal axis shows the energy of the H...O hydrogen bonds in the associates – E (eV); the vertical axis – the energy distribution function – f ( $\text{eV}^{-1}$ ); k – the vibration frequency of the H–O–H atoms ( $\text{cm}^{-1}$ );  $\lambda$  – wavelength ( $\mu\text{m}$ )

We have conducted studies of 1% (v/v) solution of human blood serum taken from two groups of people between 50 and 70 years of age by IR, NES and DNES spectral analysis. The first group consisted of people in excellent health. The second group consisted of people in a critical state and patients with malignant tumors. The average energy of hydrogen bonds ( $\Delta E_{\text{H...O}}$ ) between  $\text{H}_2\text{O}$  molecules in the blood serum was investigated as the main biophysical parameter. The result was registered as a difference between the NES-spectrum of 1% solution of human blood serum and the NES-spectrum of deionized water control sample – DNES-spectrum, measured as the difference  $\Delta f(E) = f(\text{samples of water}) - f(\text{control sample of water})$ . The DNES-spectrum obtained from the first group has a local extremum energy ( $\Delta E_{\text{H...O}}$ ) at  $E = -9.1 \pm 1.1$  meV and from the second group at  $E = -1.6 \pm 1.1$  meV. The results between the two groups have a statistical difference in Student's criterion at  $p < 0.05$ . For the control group of healthy people the value of the largest local maximum in the DNES-spectrum was detected at  $E = -0.1387$  eV, or at a wavelength  $\lambda = 8.95$   $\mu\text{m}$ . For the group of people in a critical health state and the patients with malignant tumors, the analogous values of the largest local maximums of the DNES-spectrum shifted to lower energies compared with the control group of people. For a group of people in critical health condition and patients with malignant tumors the greatest values of local extremum in the IR-spectrum are shifted to lower energies relative to the control group. In IR-spectrum of human blood serum are detected 8 local maxima at  $\lambda = 8.55, 8.58, 8.70, 8.77, 8.85, 9.10, 9.35$  and  $9.76$   $\mu\text{m}$  (Krasnov, Gordetsov, 2009). The resulting peak at  $\lambda = 8.95$   $\mu\text{m}$  in the IR-spectrum (Ignatov, 2012) approaching the peak at  $\lambda = 8.85$   $\mu\text{m}$  was monitored by Russian researchers. In the control group of healthy people the average value of the energy distribution function  $f(E)$  at  $\lambda = 8.95$   $\mu\text{m}$  compiles  $E = 75.3$  eV, and in a group of people in critical condition –  $E = 24.1$  eV. The norm has statistically reliable result for human blood serum for the control group of people having cancer at the local extremum of  $f(E) \sim 24.1$   $\text{eV}^{-1}$ . The level of reliability of the results is  $p < 0.05$  according to the Student's t-test. In 1995 were performed DNES-experiments with an impact on tumor mice cells in water solutions containing  $\text{Ca}^{2+}$  (Antonov, 1995). There was a decrease in the DNES-spectrum compared with the control sample of cells from a healthy mouse. The decrease was also observed in the DNES-spectrum of human blood serum of terminally ill people relative to that of healthy people. With increasing of age of long-living blood relatives, the function of distribution of  $\text{H}_2\text{O}$  molecules according to energies at  $-0.1387$  eV decreases. In this group of tested people the result was obtained by the DNES-method at  $E = -5.5 \pm 1.1$  meV; the difference in age was of 20–25 years in relation to the control group. It should be noted that many of Bulgarian centenarians inhabit the Rhodopes Mountains areas. Among to the DNES-spectrum of mountain waters the similar to the DNES-spectrum of blood serum of healthy people at  $\lambda = 8.95$   $\mu\text{m}$ , was the DNES-spectrum of water in the Rhodopes. The mountain water from Teteven, Boyana and other Bulgarian provinces has similar parameters. Tables 1, 2 and 3 show the composition of mountain water springs in Teteven

and Kuklen (Bulgaria) and local extremums in NES-spectra of water samples. The local extremums is water samples were detected at  $E = -0.11$  eV and  $E = -0.1387$  eV. The value measured at  $E = -0.11$  eV is characteristic for the presence of  $\text{Ca}^{2+}$  in water. The value measured at  $E = -0.1387$  eV is characteristic for inhibiting the growth of cancer cells. Experiments conducted by A. Antonov with cancer cells of mice in water with  $\text{Ca}^{2+}$  demonstrated a reduction of this local extremum to a negative value in spectra. Analysis by the DNES-method of aqueous solutions of natural mineral sorbents – shungite (carbonaceous mineral from Zazhoginskoe deposit in Karelia, Russia) and zeolite (microporous crystalline aluminosilicate mineral from Most village, Bulgaria) showed the presence of a local extremum at  $E = -0.1387$  eV for shungite and  $E = -0.11$  eV for zeolite (Mosin & Ignatov, 2013, Ignatov & Mosin, 2014a). It should be noted that owing to the unique porous structures both the natural minerals shungite and zeolite are ideal natural water adsorbers effectively removing from water organochlorine compounds, phenols, dioxins, heavy metals, radionuclides, and color, and gives the water a good organoleptic qualities, additionally saturating water with micro-and macro-elements until the physiological levels (Mosin & Ignatov, 2013). It is worth to note that in Bulgaria the main mineral deposits of Bulgarian zeolites are located in the Rhodope Mountains, whereat has lived the greatest number of Bulgarian centenarians. It is believed that water in these areas is cleared out in a natural way by mineral zeolite.

### 3.3. Composition of water in the mountain area in Teteven municipality, in Stara Planina Mountain, Kuklen municipality, Rhodopes Mountain (Bulgaria), and Glacier Rosenloui, Swiss Alps

The statistical data demonstrated that the difference between the age of long lived people in mountain and plain areas is reliable at the Student's  $t$ -criteria ( $p < 0.05$ ) with a confidence level of  $t = 2.36$ . The analyses of water samples obtained from various water sources show the differences regarding the chemical composition, hardness, local extrema in NES-spectra of water  $\text{eV}^{-1}$  at  $(-0.1362$ – $0.1387$  eV), and the isotopic shifts of D/H in water. Tables 1, 2, 3 and 4 show the chemical composition of mountain water springs in Teteven, Kuklen (Bulgaria) and Glacier, Rosenloui, Swiss Alps and local extremums in NES-spectra of water samples. A new parameter is entered into Tables 1, 2 and 3 – a local extremum of energy at  $(-0.1362$ – $0.1387$  eV). This value was determined by the NES-spectrum as the function of distribution of individual  $\text{H}_2\text{O}$  molecules according to energy  $f(E)$ . The function of distribution of  $\text{H}_2\text{O}$  molecules according to energy  $f(E)$  for tap water in Teteven is  $11.8 \pm 0.6 \text{ eV}^{-1}$  Tables from 1 to 6 are including the chemical composition and parameters of different types of water.

Table 1: The composition of mountain water springs in Zlatishko-Tetevenska Mountain (Teteven municipality, Bulgaria) and local extremums in NES-spectra of water

Indicators	Results of the research ( $\text{mg}/\text{dm}^3$ )	Norm
Sodium ( $\text{Na}^+$ )	0.96	< 200
Calcium ( $\text{Ca}^{2+}$ )	100.4	< 150
Magnesium ( $\text{Mg}^{2+}$ )	12.65	< 80
Iron (Fe)	0.016	<0.2
Manganese ( $\text{Mn}^{2+}$ )	0.0018	<0.2
Zinc ( $\text{Zn}^{2+}$ )	0.18	<4.0
Sulfates ( $\text{SO}_4^{2-}$ )	81.8	< 250
Chlorides ( $\text{Cl}^-$ )	3.96	< 250
Carbonates ( $\text{CO}_3^{2-}$ )	< 2.0	–
Hydrocarbonates ( $\text{HCO}_3^-$ )	184.0	–
Other values	Results	
Active reaction (pH)	7.9 alkaline	6.5–9.5
Electroconductivity	536.8 $\mu\text{S}/\text{cm}$	< 2000
Hardness of water	16.5 dH Hard	<33.7
Local extremum* $\text{eV}^{-1}$ at (-0.1362–0.1387 eV)	36.9	>24.1

\*Function of distribution of  $\text{H}_2\text{O}$  molecules according to energy  $f(E)$

Table 2: The composition of mountain water springs in Vasiliovka Mountain (Teteven municipality, Bulgaria) and local extremums in NES-spectra of water

Indicators	Results of the research (mg/dm <sup>3</sup> )	Norm
Sodium (Na <sup>+</sup> )	4.5	< 200
Calcium (Ca <sup>2+</sup> )	55.5	< 150
Magnesium (Mg <sup>2+</sup> )	2.28	< 80
Iron (Fe)	0.0127	<0.2
Manganese (Mn <sup>2+</sup> )	0.0014	<0.2
Zinc (Zn <sup>2+</sup> )	0.006	<4.0
Sulfates (SO <sub>4</sub> <sup>2-</sup> )	16.9	< 250
Chlorides (Cl <sup>-</sup> )	3.4	< 250
Carbonates (CO <sub>3</sub> <sup>2-</sup> )	< 2.0	–
Hydrocarbonates (HCO <sub>3</sub> <sup>-</sup> )	118.0	–
Other values	Results	
Active reaction (pH)	7.4 alkaline	6.5–9.5
Electroconductivity	285.0 μS/cm	< 2000
Hardness of water	7.9 dH slightly hard	<33.7
Local extremum* eV <sup>-1</sup> at (-0.1362–0.1387 eV)	40.1	>24.1

\*Function of distribution of H<sub>2</sub>O molecules according to energy f(E)

Table 3: The composition of mountain water spring Eco Hotel Zdravetz, Rhodopes Mountain (Kuklen municipality, Bulgaria) and local extremums in NES-spectra of water

Indicators	Results of the research (mg/dm <sup>3</sup> )	Norm
Sodium (Na <sup>+</sup> )	7.6	< 200
Calcium (Ca <sup>2+</sup> )	3.5	< 150
Magnesium (Mg <sup>2+</sup> )	0.63	< 80
Iron (Fe)	0.007	<0.2
Manganese (Mn <sup>2+</sup> )	0.002	<0.2
Zinc (Zn <sup>2+</sup> )	0.007	<4.0
Sulfates (SO <sub>4</sub> <sup>2-</sup> )	26.8	< 250
Chlorides (Cl <sup>-</sup> )	3.00	< 250
Carbonates (CO <sub>3</sub> <sup>2-</sup> )	< 2.0	–
Hydrocarbonates (HCO <sub>3</sub> <sup>-</sup> )	21.3	–
Other values	Results	
Active reaction (pH)	5.93 Normal	6.5–9.5
Electroconductivity	536.8 μS/cm	< 2000
Hardness of water	1.4 dH Soft	<33.7
Local extremum* eV <sup>-1</sup> at (-0.1362–0.1387 eV)	59.3	>24.1

\*Function of distribution of H<sub>2</sub>O molecules according to energy f(E).



Table 4: The composition of mountain melt spring water Glacier Rosenloui, Swiss Alps and local extremums in NES-spectra of water

Indicators	Results of the research (mg/dm <sup>3</sup> )	Norm
Sodium (Na <sup>2+</sup> )	0.53	< 200
Calcium (Ca <sup>2+</sup> )	8.7	< 150
Magnesium (Mg <sup>2+</sup> )	0.6	< 80
Iron (Fe)	0.106	<0.2
Manganese (Mn <sup>2+</sup> )	0.0023	<0.2
Zinc (Zn <sup>2+</sup> )	0.009	<4.0
Sulfates (SO <sub>4</sub> <sup>2-</sup> )	8.4	< 250
Chlorides (Cl <sup>-</sup> )	< 1.0	< 250
Carbonates (CO <sub>3</sub> <sup>2-</sup> )	< 2.0	–
Hydrocarbonates (HCO <sub>3</sub> <sup>-</sup> )	36.0	–
Other values	Results	
Active reaction (pH)	7.3 alkaline	6.5–9.5
Electroconductivity	82.3 μS/cm	< 2000
Hardness of water	<1.4 dH Soft	<33.7
Local extremum* eV <sup>-1</sup> at (-0.1362–0.1387 eV)	70.1	>24.1

\*Function of distribution of H<sub>2</sub>O molecules according to energy f(E)

Table 5 shows the results on water composition in field area of Dolni Dabnik. The maximum extremum in NES-spectra of Dolni Dabnik water (eV<sup>-1</sup>) is detected at (-0.1362–0.1387 eV), in water from Danubian Plain is detected at 23.2 eV<sup>-1</sup>, and in water from Thracian Valley – at 21.3 eV<sup>-1</sup>. Additionally, in water samples from Danubian Plain and Thracian Valley there are data for presence of nitrites (NO<sub>2</sub><sup>-</sup>), nitrates (NO<sub>3</sub><sup>-</sup>), ammonia (NH<sub>4</sub><sup>+</sup>), phosphates (HPO<sub>4</sub><sup>2-</sup>) more than the norm.

Table 5: The composition of artesian spring Sadovetz, Dolni Dabnik municipality and local extremums in NES-spectra of water

Indicators	Results of the research (mg/dm <sup>3</sup> )	Norm
Sodium (Na <sup>+</sup> )	14.2	< 200
Calcium (Ca <sup>2+</sup> )	103.3	< 150
Sulfates (SO <sub>4</sub> <sup>2-</sup> )	19.2	< 250
Magnesium (Mg <sup>2+</sup> )	64.0	< 80
Chlorides (Cl <sup>-</sup> )	9.2	< 250
Carbonates (CO <sub>3</sub> <sup>2-</sup> )	< 2.0	–
Hydrocarbonates (HCO <sub>3</sub> <sup>-</sup> )	184.4	–
Other values	Results	
Active reaction (pH)	7.3 alkaline	6.5–9.5
Hardness of water	29.1 dH Very hard	<33.7
Local extremum* eV <sup>-1</sup> at (-0.1362–0.1387 eV)	23.2	>24.1

\*Function of distribution of H<sub>2</sub>O molecules according to energy f(E)

Table 6 shows the optimal chemical composition of water, hardness, the local extremum (eV<sup>-1</sup>) at (-0.1362–0.1387 eV), and total mineralization of water as the middle result of different studies. The water samples were taken from areas between 600 m and 1300 m attitude in Bulgaria and from Caucasus region, Russia. It is worth to note that these areas are populated by long living people.

Table 6: The chemical composition of water, hardness, local extremum ( $eV^{-1}$ ) at  $(-0.1362-0.1387 eV)$  and total mineralization of water

Indicators	Results of melt and mountain water (Bulgaria) ( $mg/dm^3$ )	Results of melt water (Russia) ( $mg/l$ )
Sodium( $Na^+$ ) + Potassium ( $K^+$ )	6.1	< 30
Calcium ( $Ca^{2+}$ )	29.5	< 50
Magnesium ( $Mg^{2+}$ )	1.5	< 10
Iron (Fe)	0.083	–
Manganese ( $Mn^{2+}$ )	0.0017	–
Zinc ( $Zn^{2+}$ )	0.007	–
Sulfates ( $SO_4^{2-}$ )	21.9	< 100
Chlorides ( $Cl^-$ )	3.2	< 70
Carbonates ( $CO_3^{2-}$ )	< 2.0	–
Hydrocarbonates ( $HCO_3^-$ )	69.7	< 100
Other values	Results	
Active reaction (pH)	6.7 normal	6.5–7.0
Electroconductivity	410.9 $\mu S/cm$	< 2000
Hardness of water	4.65 dH Moderately soft	<33.7
Total mineralization (g/l)	0.132	< 0.3
Local extremum* $eV^{-1}$ at $(-0.1362-0.1387 eV)$	49.7	>24.1

\*Function of distribution of  $H_2O$  molecules according to energy  $f(E)$

### 3.4. Effects of $Ca^{2+}$ , $Mg^{2+}$ , $Zn^{2+}$ and $Mn^{2+}$ in water on biophysical and biochemical processes in the human body

The research of distribution of local extremums ( $eV^{-1}$ ) in spectra of various water samples as a function of distribution of  $H_2O$  molecules according to energy  $f(E)$  at  $\lambda = 8.95 \mu m$  shows the analogue extremum at analogous values of  $f(E)$ ,  $E$  and  $\lambda$ , which was detected in water with  $Ca^{2+}$  ions earlier demonstrated inhibiting the growth of cancer cells. Magnesium ( $Mg^{2+}$ ), zinc ( $Zn^{2+}$ ) and manganese ( $Mn^{2+}$ ) ions dissolved in water have influence on enzymes, which are antioxidants (Ignatov & Mosin, 2015a). The research of China team was categorized three groups of elements from the rice and drinking water according to their effect on longevity: Sr, Ca, Al, Mo, and Se, which were positively correlated with longevity: Fe, Mn, Zn, Cr, P, Mg, and K, which had a weak effect on local longevity, and Cu and Ba, which had a negative effect on longevity (Lv et al., 2011). There was a positive correlation between the eSOD activity and the age and a negative correlation between the eSOD activity and concentration of  $Zn^{2+}$  in plasma. An inverse correlation was also found between the content of  $Zn^{2+}$  ions in plasma relative to the age. The prevalence of  $Zn^{2+}$  deficiency is increased with age; with normal  $Zn^{2+}$  levels it is observed in about 80% of adult people and only in 37 % of the non-agenarians. Aging is an inevitable biological process that is associated with gradual and spontaneous biochemical and physiological changes and the increased susceptibility to diseases. Because the nutritional factors are involved in improving the immune functions, metabolic balance, and antioxidant defense, some nutritional factors, such as Zn, may modify susceptibility to disease and promote healthy aging. *In vitro* (human lymphocytes exposed to endotoxins) and *in vivo* (old or young mice fed with low zinc dietary intake) studies revealed that zinc is important for immune efficiency (innate and adaptive), antioxidant activity (superoxide dismutase), and cell differentiation *via* clusterin/apolipoprotein J. The intracellular Zn homeostasis is regulated by metallothioneins (MT) *via* an ion release through the reduction of thiol groups in the MT molecule (Mocchegiani, 2007). Zinc in composition of water improves the antioxidative enzymes in red blood cells (Malhotra & Dhawan, 2008).

The magnesium deficiency and oxidative stress have both been identified as pathogenic factors in aging and in several age-related diseases. The link between these two factors is unclear in humans although, in experimental animals, severe  $Mg^{2+}$  deficiency has been shown to lead to the increased oxidative stress (Begona et al, 2000). The antioxidants against free radical damage include tocopherol (vitamin E), ascorbic acid (vitamin C),  $\beta$ -carotene, glutathione, uric acid, bilirubin, and several metalloenzymes including glutathione peroxidase (Se),

catalase (Fe), and superoxide dismutase (Cu, Zn, Mn) and proteins such as ceruloplasmin (Co). The extent of the tissue damage is the result of the balance between the free radicals generated and the antioxidant protective defense system (Machlin & Bendich, 1988). There was reported the antioxidant effects of water on rats (Abdullah, 2012). The norm in water for  $Zn^{2+}$  and  $Mg^{2+}$  according to the World Health Organization (WHO) should be less than 20  $\mu g$ . For the  $Na^+$  content the norm according to the WHO is less than 20 mg.

The interesting results on the concentration of  $Ca^{2+}$  in water were obtained in USA and Canada. According to the statistical information the most number of centenarians in Canada per 1 million of population is observed in Nova Scotia (210 of centenarians per 1 million). In the water from Nova Scotia the  $Ca^{2+}$  content makes up 6.8 mg/l. N. Druzhyak, Russia showed that in the places wherein live the most number of centenarians the  $Ca^{2+}$  content in water was 8–20 mg/l. The only risk factor regarding the increased  $Ca^{2+}$  content in water is cardiovascular diseases.

The following reactions occur in water if there are high concentrations of  $Ca^{2+}$  and  $Mg^{2+}$  ions: the reaction of limestone ( $CaCO_3$ ) and gypsum ( $CaSO_4 \cdot 2H_2O$ ) with water to separate the calcium ( $Ca^{2+}$ ), carbonates ( $CO_3^{2-}$ ) and sulfate ( $SO_4^{2-}$ ) ions. By increasing the mineralization of water the content of  $Ca^{2+}$  ions decreases. During the concentration of the solutions  $Ca^{2+}$  ions are precipitated. With the increase of carbon dioxide ( $CO_2$ ) in water and decreasing of the pH value the content of  $Ca^{2+}$  increases. The reaction of interaction of dolomite ( $CaCO_3 \cdot MgCO_3$ ) with water makes the formation of  $Mg^{2+}$  ions. Hydrocarbonates ( $HCO_3^-$ ) and carbonates ( $CO_3^{2-}$ ) ions are formed by reaction of interaction of karst rocks,  $CO_2$  and water. For example, in Zamzam water there is  $Ca^{2+} - 299.7$  mg/l;  $Mg^{2+} - 18.9$  mg/l;  $Zn^{2+} - 0.001$  mg/l.

### 3.5. Results on water after influence of Risimanski.

The main results of the research are demonstrated in Table 7 which presents the local extremums in NES spectra of water samples of different origin.

Table 7: The local extremums in NES spectra of water samples of different origin

Sources and Types of Waters	Local extremum at (-0.1112...-0.1137 eV) <sup>1</sup> eV <sup>-1</sup> norm (>24.1)	Local extremum at (-0.1362...-0.1387 eV) <sup>2</sup> eV <sup>-1</sup> norm (>24.1)	[%,(E <sub>value</sub> )* / (-E <sub>total value</sub> )**] -0.1112 eV	[%,(E <sub>value</sub> )* / (-E <sub>total value</sub> )**] -0.1137 eV	[%,(E <sub>value</sub> )* / (-E <sub>total value</sub> )**] -0.1362 eV	[%,(E <sub>value</sub> )* / (-E <sub>total value</sub> )**] -0.1387 eV
1. Zlatishko-Tetevenska Mountain (Bulgaria)	46.1±2.3	36.9±1.9	4.1	7.0	4.0	7.4
2. Vasiliovska Mountain (Bulgaria)	12.0±0.6	44.9±2.2	1	2	5	6.2
3. Rhodops Mountain (Eco hotel Zdravetz) (Bulgaria)	53.3±1.6	59.3±3.0	11.0	3.6	5.5	13.0
4. Danubian Plain, Sadovetz (Bulgaria)	25±1.25	23.2±1.7	0	6.3	0	3.1
5. Tap Water Teteven (Bulgaria)	16.0±0.8	16.0±0.8	4.0	0	0	4.0
6. Glacier Rosenlauri (Switzerland)	129.0±6.3	70.1±3.5	22.6	9.7	6.5	12.9
7. Deionized water after bioinfluence of Risimanski	45.5±2.3	59.6±3.00	11.7	3.8	3.8	15.5
9. Mountain water after bioinfluence of Risimanski	93.1±4.7	93.1±4.7	17.3	4.7	4.7	17.3
10. Deionized water	38.7±1.9	32.3±1.6	3.2	6.4	4.8	3.2

Notes:

<sup>1</sup>The values (E = -0.1112...-0.1137 eV) correspond to the wavelengths ( $\lambda = 10.91-11.91 \mu m$ ).

<sup>2</sup>The values (E = -0.1362...-0.1387 eV) correspond to the wavelengths ( $\lambda = 8.95- 9.10 \mu m$ ).

\* The result (-E<sub>value</sub>) is the result of hydrogen bonds energy for one value of (-E)

\*\* The result (-E<sub>total</sub>) is the total result of hydrogen bonds energy

There are the following conclusions from analyzing the NES spectra of deionized water after bioinfluence of Risimanski. The deionized water after the bioinfluence of Risimanski has the energy at E = -0.1387 eV; there is the local extremum with f(E) value measured at 76.9±3.8 eV<sup>-1</sup>. The mountain water after the bioinfluence of Risimanski has the energy at E = -0.1387 eV; there was the local extremum with f(E) value measured at 93.1±4.7 eV<sup>-1</sup>. In 1992 A. Antonov demonstrated that in aqueous solutions of tumor cells at E = -0.1387 eV there was detected a decrease of local extremum corresponding to a statistical error. NES-spectra of aqueous solution containing  $Ca^{2+}$  (67 mg/l) had a local extremum of energy at -0,11 eV in NES-spectra. In 1992 it was established

by A. Antonov that the differential spectra of karst water and water solutions of calcium carbonate ( $\text{CaCO}_3$ ) with the same content of calcium ( $\text{Ca}^{2+}$ ) ions were similar at statistical level to the Student  $t$ -criterion at  $p < 0.05$ . For the deionized water the local extremum at  $E = -0.1112$  eV is  $46.1 \pm 2.3$  eV $^{-1}$ . For the mountain water the local extremum at  $E = -0.1112$  eV is  $74.4 \pm 3.7$  eV $^{-1}$ . There are proofs from electrochemically water anolite for connection between local extremum at  $E = -0.1212$  eV and anti-inflammatory effect. The deionized water after the bioinfluence of Risimanski has the energy at  $E = -0.1212$  eV; there is the local extremum with  $f(E)$  value measured at  $46.2 \pm 2.3$  eV $^{-1}$ . The mountain water after the bioinfluence of Risimanski has the energy at  $E = -0.1212$  eV; there is the local extremum with  $f(E)$  value measured at  $74.4 \pm 3.7$  eV $^{-1}$ . These data may indicate that on the molecular level water after bioinfluence of Risimanski supposedly is more structurally organized than tap water and other analyzed water samples.

In 2012 the research of 1% solution of human blood serum was made by I. Ignatov and O. Mosin with the collaboration of K. Naneva from Municipality hospital, Teteven, Bulgaria (Ignatov et al., 2012). In the control group of healthy people, the function of distribution of individual  $\text{H}_2\text{O}$  molecules according to energy  $f(E)$  at  $\lambda = 8.95$   $\mu\text{m}$  was detected at an average value of  $f(E)$   $75.3 \pm 3.8$  eV $^{-1}$ . In the group of people in critical condition this value was  $24.1 \pm 1.2$  eV $^{-1}$ . The confidence level of the obtained results according to the Student  $t$ -criterion was at  $p < 0.05$ . The result for Dimitar Risimanski compiles  $76.9 \pm 3.8$  eV $^{-1}$  and  $93.1 \pm 4.7$  eV $^{-1}$ . On the molecular level there was reported a possibility for decreasing the number of tumor cells in various water samples with  $\text{Ca}^{2+}$  ions. There is also anti-inflammatory effect. However, this depends on the health status and other factors – heredity, the quality of water and medical prophylactics.

The distribution [% ,  $(-E_{\text{value}})/(-E_{\text{total value}})$ ] of  $\text{H}_2\text{O}$  molecules in deionized water after the influence of Risimanski according to energies of hydrogen bonds of  $\text{H}_2\text{O}$  molecules and local extremums in NES and DNES spectra of mountain and melt water are shown in Table 7 in the ranges of  $(-0.1112 \dots -0.1137$  eV) and  $(-0.1362 \dots -0.1387$  eV). The average energy ( $E_{\text{H}\dots\text{O}}$ ) of hydrogen  $\text{H}\dots\text{O}$ -bonds among individual  $\text{H}_2\text{O}$  molecules in deionized water after the bioinfluence of Risimanski is measured at  $E = -0.1212$  eV. The result for the control sample (deionized water) is  $E = -0.1140$  eV. The results obtained with the NES method were recalculated with the DNES method as a difference of the NES (deionized water after the bioinfluence of Risimanski) minus the NES (control sample from tap water) equalled the DNES spectrum of water. Thus, the result, which is recalculated with the DNES method is  $\Delta E = 0.0072 \pm 0.0011$  eV. The results show the increasing the values of the energy of hydrogen bonds after the bioinfluence of Risimanski.

The distribution [% ,  $(-E_{\text{value}})/(-E_{\text{total value}})$ ] of  $\text{H}_2\text{O}$  molecules in mountain water after the influence of Risimanski according to energies of hydrogen bonds of  $\text{H}_2\text{O}$  molecules and local extremums in NES and DNES spectra of mountain and melt water are shown in Table 7 in the ranges of  $(-0.1112 \dots -0.1137$  eV) and  $(-0.1362 \dots -0.1387$  eV). The average energy ( $E_{\text{H}\dots\text{O}}$ ) of hydrogen  $\text{H}\dots\text{O}$ -bonds among individual  $\text{H}_2\text{O}$  molecules in mountain water after the bioinfluence of Risimanski is measured at  $E = -0.1250$  eV. The result for the control sample (mountain water) is  $E = -0.1215$  eV. The results obtained with the NES method were recalculated with the DNES method as a difference of the NES (deionized water after the bioinfluence of Risimanski) minus the NES (control sample from tap water) equalled the DNES spectrum of water. Thus, the result, which is recalculated with the DNES method is  $\Delta E = 0.0035 \pm 0.0011$  eV. The results show the increasing the values of the energy of hydrogen bonds after the bioinfluence of Risimanski.

Another important physical parameter was calculated with using the NES method – the average energy ( $E_{\text{H}\dots\text{O}}$ ) of  $\text{H}\dots\text{O}$ -bonds between  $\text{H}_2\text{O}$  compiled  $-0.1067 \pm 0.0011$  eV.

According to the analysis of various water samples by the NES and DNES methods can be drawn the main conclusions:

- The energy of hydrogen bonds of water in the samples was differed because of the different number of hydrogen bonds between  $\text{H}_2\text{O}$  molecules in the water samples, which may result from the fact that different waters have a different structure and various intermolecular interactions – various associative elements with different structure, clusters of formula  $(\text{H}_2\text{O})_n$  with different  $n$ , connected into the molecular associates;
- As a result of different energies of hydrogen bonds, the surface tension of water samples was increasing or decreasing. For water after bioinfluence of Risimanski there is increasing of surface tension regarding the control samples;
- The redistribution of  $\text{H}_2\text{O}$  molecules in water samples according to the energy (statistical process of dynamics);
- The hydrogen bond network may be stabilized with metal cations and anions, contained in water. In ice the hydrogen bonds have the energy of 4.6 kcal/mol or 0.1995 eV. For liquid water the energy of hydrogen bonds makes up 1–3 kcal/mol or 0.043–0.13 eV.

The further empirical results obtained under the project of “Water, Ecology and Longevity” on the research of the water quality, DNES-spectra of human blood serum and long living people in Bulgaria from 2012 till 2015 (Ignatov & Mosin, 2015a), showed the difference in the age of the people who lived in mountainous and plain areas in Bulgaria that was statistically proven by the Student  $t$ -criterion at a confidence level  $p < 0.05$ . The most adult person in mountain was 104 and in plain areas 97 years old. The difference between mountainous and

plain areas is 50–70 km. For the average lifespan of long living people in plain areas the result was 90.6 years. For the brothers and sisters of long living people from mountain areas the average lifespan is 88.5 years. The analyses show the difference in the water quality derived from different water springs and the differences in DNES-spectra of the human blood serum of tested people. With increasing of age of long-living blood relatives, the function of distribution of H<sub>2</sub>O molecules in DNES-spectra of human blood serum according to energies f(E) at -0.1387 eV is decreasing. In this group of tested people the result obtained by the DNES method was  $-\Delta E = -5.5 \pm 1.1$  meV; the difference in age was of 20–25 years in relation to the control group.

### 3.6. Mathematical model of water after bioinfluence of Dimitar Risimanski

The research with the NES method of water drops was received with tap water from Plovdiv and Kangen Water<sup>®</sup>, which was prepared from Plovdiv tap water. The second sample of Kangen Water<sup>®</sup> was prepared from Sofia tap water. The mathematical model of Kangen Water<sup>®</sup> gives the valuable information on the possible number of hydrogen bonds as percent of H<sub>2</sub>O molecules with different values of distribution of energies (Table 8 and Figure 4) and (Table 9). These distributions are basically connected with the restructuring of H<sub>2</sub>O molecules having the same energies.

Table 8: The distribution (% , (-E<sub>value</sub>)/(-E<sub>total value</sub>)) of H<sub>2</sub>O molecules in control deionized water and deionized water after the bioinfluence of Dimitar Risimanski.

-E(eV) x-axis	Deionized water after bioinfluence of Risimanski y-axis (%((-E <sub>value</sub> )/ (-E <sub>total value</sub> ))**	Deionized water y-axis (%((-E <sub>value</sub> )/ (-E <sub>total value</sub> ))**	-E(eV) x-axis	Deionized water after bioinfluence of Risimanski y-axis (%((-E <sub>value</sub> )/ (-E <sub>total value</sub> ))**	Deionized water y-axis (%((-E <sub>value</sub> )/ (-E <sub>total value</sub> ))**
0.0937	0	0	0.1187	3.8	5.3
0.0962	0	10.5	0.1212	<b>11.7<sup>2</sup></b>	5.3
0.0987	0	10.5	0.1237	3.8	5.3
0.1012	3.8	5.3	0.1262	3.8	5.3
0.1037	3.8	5.3	0.1287	7.7	5.3
0.1062	7.7	5.3	0.1312	3.8	0
0.1087	3.8	5.3	0.1337	3.8	6.5
0.1112	<b>11.7<sup>1</sup></b>	5.3	0.1362	3.8	2.6
0.1137	3.8	5.3	0.1387	<b>15.5<sup>3</sup></b>	5.3
0.1162	7.7	5.3	–	–	–

Notes:

\* The result (-E<sub>value</sub>) is the result of hydrogen bonds energy for one parameter of (-E)

\*\* The result (-E<sub>total value</sub>) is the total result of hydrogen bonds energy

E= -0.1112 eV is the local extremum for improvement of nervous conductivity

E=-0.1212 eV is the local extremum for anti inflammatory effect

E= -0.1387 eV is the local extremum for inhabitation of development of tumor cells of molecular level

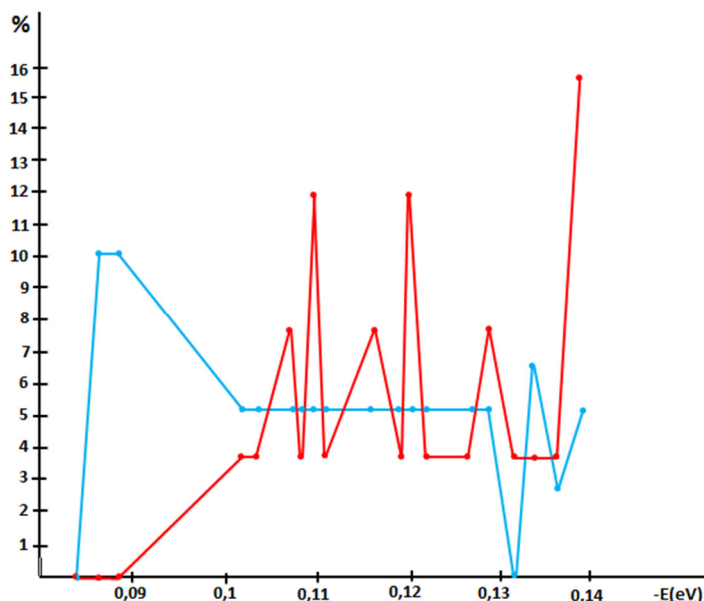


Fig. 4. Mathematical model of water (Ignatov, Mosin, 2013). Results of Risimanski

Figure 4 shows the distribution ( $\%, (-E_{\text{value}})/(-E_{\text{total value}})$ ) of  $\text{H}_2\text{O}$  molecules in control sample deionized water (blue line) and the same water after the bioinfluence of Dimitar Risimanski (red line).

Notes:

$E = -0.1112 \text{ eV}$  is the local extremum for improvement of nervous conductivity

$E = -0.1212 \text{ eV}$  is the local extremum for anti inflammatory effect

$E = -0.1387 \text{ eV}$  is the local extremum for inhabitation of development of tumor cells of molecular level

Table 9: The distribution ( $\%, (-E_{\text{value}})/(-E_{\text{total value}})$ ) of  $\text{H}_2\text{O}$  molecules in control mountain water (Zlatishko-Tetevenska mountain, Bulgaria) and mountain water after the bioinfluence of Dimitar Risimanski.

-E(eV) x-axis	Mountain water y-axis ( $\%((-E_{\text{value}})/(-E_{\text{total value}}))^{**}$ )	Mountain water after the bioinfluence of Risimanski y-axis ( $\%((-E_{\text{value}})/(-E_{\text{total value}}))^{**}$ )	-E(eV) x-axis	Mountain water y-axis ( $\%((-E_{\text{value}})/(-E_{\text{total value}}))^{**}$ )	Mountain water after the bioinfluence of Risimanski y-axis ( $\%((-E_{\text{value}})/(-E_{\text{total value}}))^{**}$ )
0.0937	0	0	0.1187	4.7	7.5
0.0962	0	0	0.1212	<b>11.6<sup>2</sup></b>	5.0
0.0987	2.3	2.5	0.1237	2.3	5.0
0.1012	2.3	0	0.1262	3.6	5.0
0.1037	0	2.5	0.1287	5.8	7.5
0.1062	7.0	5.0	0.1312	4.7	7.5
0.1087	0	0	0.1337	4.7	5.0
0.1112	<b>17.3<sup>1</sup></b>	15.0	0.1362	4.7	7.5
0.1137	4.7	2.5	0.1387	<b>17.3<sup>3</sup></b>	12.5
0.1162	7.0	10.0	–	–	–

$E = -0.1112 \text{ eV}$  is the local extremum for improvement of nervous conductivity

$E = -0.1212 \text{ eV}$  is the local extremum for anti inflammatory effect

$E = -0.1387 \text{ eV}$  is the local extremum for inhabitation of development of tumor cells of molecular level

Notes:

\* The result ( $-E_{\text{value}}$ ) is the result of hydrogen bonds energy for one parameter of ( $-E$ )

\*\* The result ( $-E_{\text{total}}$ ) is the total result of hydrogen bonds energy

The experimental data obtained testified the following conclusions from the mathematical models of deionized and mountain water after the bioinfluence of Risimanski according to the mathematical models of control water samples. The distribution ( $\%, (-E_{\text{value}})/(-E_{\text{total value}})$ ) of water molecules in deionized water after bioinfluence of Risimanski according control sample is different. The distribution ( $\%, (-E_{\text{value}})/(-E_{\text{total value}})$ ) of water molecules in mountain water after bioinfluence of Risimanski according control sample is different. However, for the value  $E = -0.1387 \text{ eV}$  or  $\lambda = 8.95 \mu\text{m}$  there is the biggest local extremum corresponding to the re-structuring

of hydrogen bonds among H<sub>2</sub>O molecules. This difference may indicate on the different number of hydrogen bonds in water samples, as well as their physical parameters (pH, ORP, E<sub>h</sub>), resulting in different distribution of H<sub>2</sub>O molecules and different values of H<sub>2</sub>O molecules with ratios of  $(-E_{\text{value}})/(-E_{\text{total value}})$ . Particularly it was observed the statistical re-structuring of H<sub>2</sub>O molecules in water samples according to the energies. The experimental data may prove that stipulates the restructuring of H<sub>2</sub>O molecules on molecular level and may be used for the prophylaxis of development of tumor cells. For the value  $E = -0.1112 \text{ eV}$  or  $\lambda = 11.15 \text{ }\mu\text{m}$  there is the bigger local extremum corresponding to the re-structuring of hydrogen bonds among H<sub>2</sub>O molecules. The experimental data may prove that bioinfluence stipulates the restructuring of H<sub>2</sub>O molecules on molecular level and has biophysical effect for improvement of nervous conductivity. For the value  $E = -0.1212 \text{ eV}$  or  $\lambda = 10.23 \text{ }\mu\text{m}$  there is the bigger local extremum corresponding to the re-structuring of hydrogen bonds among H<sub>2</sub>O molecules. The experimental data may prove that stipulates the restructuring of H<sub>2</sub>O molecules on molecular level and has biophysical effect for improvement of nervous conductivity.

### 3.7. Studying in water the water associates (H<sub>2</sub>O)<sub>n</sub>, where n = 3–50.

The peculiarities of chemical structure of H<sub>2</sub>O molecule and weak bonds caused by electrostatic forces and donor-acceptor interaction between hydrogen and oxygen atoms in H<sub>2</sub>O molecules create favorable conditions for formation of directed intermolecular hydrogen bonds (O–H...O) with neighboring H<sub>2</sub>O molecules, binding them into complex intermolecular associates which composition represented by general formula (H<sub>2</sub>O)<sub>n</sub>, where n can vary from 3 to 50 (Keutsch & Saykally, 2011). The hydrogen bond is a form of association between the electronegative O-atom and H-atom, covalently bound to another electronegative O-atom, is of vital importance in the chemistry of intermolecular interactions, based on weak electrostatic forces and donor-acceptor interactions with charge-transfer (Pauling, 1960). It results from interaction between electron-deficient H-atom of one H<sub>2</sub>O molecule (hydrogen donor) and unshared electron pair of an electronegative O-atom (hydrogen acceptor) on the neighboring H<sub>2</sub>O molecule; the structure of hydrogen bonding, therefore may be defined as O...H<sup>δ+</sup>–O<sup>δ-</sup>. As the result, the electron of the H-atom due to its relatively weak bond with the proton easily shifts to the electronegative O-atom. The O-atom with increased electron density becomes partly negatively charged – δ<sup>-</sup>, while the H-atom on the opposite side of the molecule becomes positively charged – δ<sup>+</sup> that leads to the polarization of O<sup>δ-</sup>–H<sup>δ+</sup> covalent bond. In this process the proton becomes almost bared, and due to the electrostatic attraction forces are provided good conditions for convergence of O...O or O...H atoms, leading to the chemical exchange of a proton in the reaction O–H...O ↔ O...H–O. Although this interaction is essentially compensated by mutual repulsion of the molecules' nuclei and electrons, the effect of the electrostatic forces and donor-acceptor interactions for H<sub>2</sub>O molecule compiles 5–10 kcal per 1 mole of substance. It is explained by a negligible small atomic radius of hydrogen and shortage of inner electron shells, which enables the neighboring H<sub>2</sub>O molecule to approach the hydrogen atom of another molecule at very close distance without experiencing any strong electrostatic repulsion. The H<sub>2</sub>O molecule has four sites of hydrogen bonding – two uncompensated positive charges at H-atoms and two negative charges at the O-atom. Their mutual disposition is characterized by direction from the centre of regular tetrahedron (nucleus of O-atom) towards its vertexes. This allows to one H<sub>2</sub>O molecule in condensed state to form up to 4 classical hydrogen bonds, two of which are donor bonds and the other two – acceptor ones (taking into consideration the bifurcate (“two-forked”) hydrogen bond – 5) (Pasichnyk *et al.*, 2008).

A hydrogen bond according to Bernal–Fowler rules (Bernal & Fowler, 1933) is characterized by the following parameters:

- a) O-atom of each H<sub>2</sub>O molecule is bound with four neighboring H-atoms: by covalent bonding with two own H-atoms, and by hydrogen bonding – with two neighboring H-atoms (as in the crystalline structure of ice); each H-atom in its turn is bound with O-atom of neighbouring H<sub>2</sub>O molecule.
- b) On the line of O-atom – there can be disposed only one proton H<sup>+</sup>;
- c) The proton, which takes part in hydrogen bonding situated between two O-atoms, therefore has two equilibrium positions: it can be located near its O-atom at approximate distance of 1 Å, and near the neighboring O-atom at the distance of 1.7 Å as well, hence both a usual dimmer HO–H...OH<sub>2</sub> and an ion pair HO...H–OH<sub>2</sub> may be formed during the hydrogen bonding, i.e. the hydrogen bond is partly electrostatic (~90%) and partly (~10%) covalent (Isaacs *et al.*, 2000). The state of “a proton near the neighboring oxygen” is typical for the interphase boundary, i.e. near water–solid body or water–gas surfaces.
- d) The hydrogen bonding of a triad O–H...O possess direction of the shorter O–H (→) covalent bond; the donor hydrogen bond tends to point directly at the acceptor electron pair (this direction means that the H-atom being donated to the H-atom acceptor on another H<sub>2</sub>O molecule).

The most remarkable peculiarity of hydrogen bond consists in its relatively low strength; it is 5–10 times weaker than chemical covalent bond (Pimentel & McClellan, 1960). In respect of energy the hydrogen bond has an intermediate position between covalent bonds and intermolecular van der Waals forces, based on dipole-dipole interactions, holding the neutral molecules together in gasses or liquefied or solidified gasses. Hydrogen bonding produces interatomic distances shorter than the sum of van der Waals radii, and usually involves a limited number

of interaction partners. These characteristics become more substantial when acceptors bind H-atoms from more electronegative donors. Hydrogen bonds hold H<sub>2</sub>O molecules on 15% closer than if water was a simple liquid with van der Waals interactions. The hydrogen bond energy compiles 5–10 kcal/mole, while the energy of O–H covalent bonds in H<sub>2</sub>O molecule – 109 kcal/mole (Arunan *et al.*, 2011). The values of the average energy ( $\Delta E_{H...O}$ ) of hydrogen H...O-bonds between H<sub>2</sub>O molecules make up  $0.1067 \pm 0.0011$  eV (Antonov & Galabova, 1992). With fluctuations of water temperature the average energy of hydrogen H...O-bonds in of water molecule associates changes. That is why hydrogen bonds in liquid state are relatively weak and unstable: it is thought that they can easily form and disappear as the result of temperature fluctuations (Ignatov & Mosin, 2013).

Another key feature of hydrogen bond consists in its cooperatively coupling. Hydrogen bonding leads to the formation of the next hydrogen bond and redistribution of electrons, which in its turn promotes the formation of the following hydrogen bond, which length increasing with distance. Cooperative hydrogen bonding increases the O–H bond length, at the same time causing a reduction in the H...O and O...O distances (Goryainov, 2012). The protons held by individual H<sub>2</sub>O molecules may switch partners in an ordered manner within hydrogen networks (Bartha *et al.*, 2003). As the result, aqueous solutions may undergo autoprotolysis, i.e. the H<sup>+</sup> proton is released from H<sub>2</sub>O molecule and then transferred and accepted by the neighboring H<sub>2</sub>O molecule resulting in formation of hydronium ions as H<sub>3</sub>O<sup>+</sup>, H<sub>5</sub>O<sub>2</sub><sup>+</sup>, H<sub>7</sub>O<sub>3</sub><sup>+</sup>, H<sub>9</sub>O<sub>4</sub><sup>+</sup>, etc. This leads to the fact, that water should be considered as associated liquid composed from a set of individual H<sub>2</sub>O molecules, linked together by hydrogen bonds and weak intermolecular van der Waals forces (Liu *et al.*, 1996). The simplest example of such associate is a dimer of water: (H<sub>2</sub>O)<sub>2</sub> = H<sub>2</sub>O · HOH.

The energy of the hydrogen bonding in the water dimer is 0.2 eV (~5 kcal/mol), which is larger than the energy of thermal motion of the molecules at the temperature of 300 K. Hydrogen bonds are easily disintegrated and re-formed through an interval of time, which makes the water structure quite unstable and changeable (George, 1997). This process leads to structural inhomogeneity of water characterizing it as an associated heterogeneous two-phase liquid with short-range ordering, i.e. with regularity in mutual positioning of atoms and molecules, which reoccurs only at distances comparable to distances between initial atoms, i.e. the first H<sub>2</sub>O layer. As it is known, a liquid in contrast to a solid body is a dynamic system: its atoms, ions or molecules, keeping short-range order in mutual disposition, participate in thermal motion, the character of which is much more complicated than that of crystals. For example H<sub>2</sub>O molecules in liquid state under normal conditions (1 atm, +22 °C) are quiet mobile and can oscillate around their rotation axes, as well as to perform the random and directed shifts. This enabled for some individual molecules due to cooperative interactions to “jump up” from one place to another in an elementary volume of water. The random motion of molecules in liquids causes continuous changes in the distances between them. The statistical character of ordered arrangement of molecules in liquids results in fluctuations – continuously occurring deviations not only from average density, but from average orientation as well, because molecules in liquids are capable to form groups, in which a particular orientation prevails. Thus, the smaller these deviations are, the more frequently they occur in liquids.

In 2005 R. Saykally (USA) calculated the possible number of hydrogen bonds and the stability of water clusters depending on the number of H<sub>2</sub>O molecules (Figure 5) (Saykally, 2005). It was also estimated the possible number of hydrogen bonds (100) depending on the number of H<sub>2</sub>O molecules (250) in clusters (Sykes, 2007). O. Loboda and O.V. Goncharuk provided data about the existence of icosahedral water clusters consisting of 280 H<sub>2</sub>O molecules with the average size up to 3 nm (Loboda & Goncharuk, 2010). The ordering of H<sub>2</sub>O molecules into associates corresponds to a decrease in the entropy (randomness), or decrease in the overall Gibbs energy ( $G = \Delta H - T\Delta S$ ). This means that the change in enthalpy  $\Delta H$  minus the change in entropy  $\Delta S$  (multiplied by the absolute temperature T) is a negative value. These results are consistent with our research of the DNES spectrum of water on which it may make conclusion about the number of H<sub>2</sub>O molecules in elemental water clusters (Ignatov & Mosin, 2015b). The DNES spectrum of water has energy ranges from -0.08 to -0.14 eV. The spectral range lies in the middle infrared range from 8 to 14  $\mu\text{m}$  (“window” of the atmosphere transparency to electromagnetic radiation). Under these conditions, the relative stability of water clusters depends on external factors, primarily on the temperature. We demonstrated that H<sub>2</sub>O molecules change their position in clusters depending on the energy of intermolecular H...O hydrogen bonds. The values of the average energy ( $E_{H...O}$ ) of hydrogen bonds between H<sub>2</sub>O molecules in the formation of cluster associates with the formula (H<sub>2</sub>O)<sub>n</sub> compile  $-0.1067 \pm 0.0011$  eV. As the energy of hydrogen bonds between H<sub>2</sub>O molecules increases up to -0.14 eV, the cluster formation of water becomes “restructuring”. In this case, the redistribution of energies among the individual H<sub>2</sub>O molecules occurs.



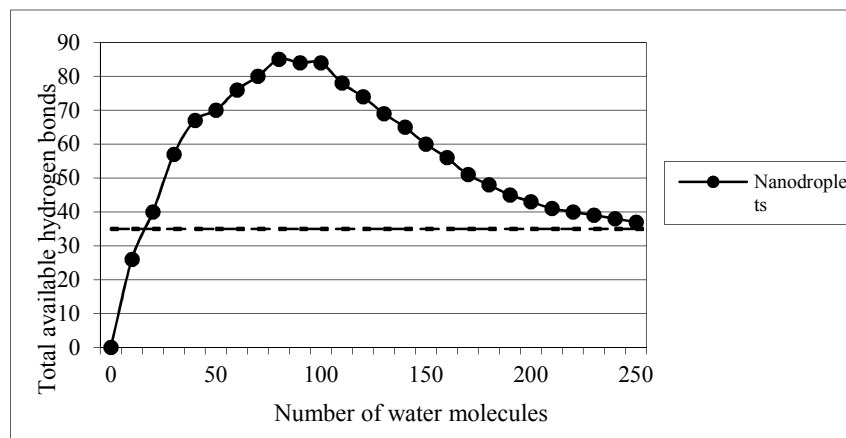


Figure 5: The total number of hydrogen bonds depending on the number of H<sub>2</sub>O molecules in clusters.

All these experimental data including our data indicate that water is a complex associated non-equilibrium liquid consisting of associative groups containing according to the present data, from 3 to 20 individual H<sub>2</sub>O molecules (Tokmachev *et al.*, 2010). The associates can be perceived as unstable groups (dimers, trimers, tetramers, pentamers, hexamers etc.) in which H<sub>2</sub>O molecules are linked by van der Waals forces, dipole-dipole and other charge-transfer interactions, including hydrogen bonding. At room temperature, the degree of association of H<sub>2</sub>O molecules may vary from 2 to 6. In 2000 it was deciphered the structure of the water trimer, and in 2003 – tetramer, pentamer and the hexamer (Wang & Jordan, 2003). In 1993 K. Jordan (USA) (Tsai & Jordan, 1993) calculated the possible structural modifications of small water clusters consisting of six H<sub>2</sub>O molecules (Figure 6a–c). Subsequently, it was shown that H<sub>2</sub>O molecules capable of hydrogen bonding by forming the structures representing topological 1D rings and 2D chains composed from numerous H<sub>2</sub>O molecules. Interpreting the experimental data, they are considered as pretty stable elements of the structure. According to computer simulations, elemental clusters are able to interact with each other through the exposed protons on the outer surfaces of hydrogen bonds to form more complicated clusters of more complex structure.

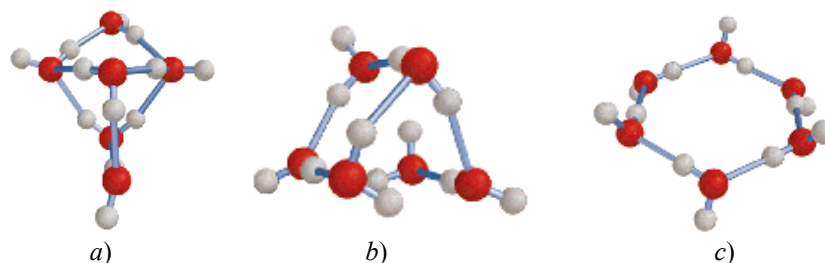


Figure 6: Computer calculations of small water cluster structures (a–c) with general formula (H<sub>2</sub>O)<sub>n</sub>, where n = 6 (Tsai & Jordan, 1993).

The quantum-chemical calculations of middle size clusters with the general formula (H<sub>2</sub>O)<sub>n</sub>, where n = 6–20, have shown that the most stable structures are formed by the interaction of tetrameric and pentameric structures (Maheshwary *et al.*, 2001; Choi & Jordan, 2010). Thus the structures of (H<sub>2</sub>O)<sub>n</sub>, where n = 8, 12, 16, and 20 are cubic, and structures (H<sub>2</sub>O)<sub>n</sub> where n = 10 and 15 – pentagons. Other structures with n = 9, 11, 13, 14, 17, 18 and 19 evidently have a mixed composition. Large tetrahedron clusters as (H<sub>2</sub>O)<sub>196</sub>, (H<sub>2</sub>O)<sub>224</sub>, (H<sub>2</sub>O)<sub>252</sub> (Figure 10) composed from the smaller ones formed a vertex of a (H<sub>2</sub>O)<sub>14</sub> tetrahedron are also described (Chaplin, 2011).

It is reasonable that the structure of liquid water should be related to the structure of hexagonal ice, formed from H<sub>2</sub>O tetrahedrons, which exist under atmospheric pressure. In the computer simulation H<sub>2</sub>O tetrahedrons grouped together, to form a variety of 3D-spatial and 1D, 2D-planar structures, the most common of which is hexagonal structure where 6 H<sub>2</sub>O molecules (tetrahedrons) are combined into a ring. A similar type of structure is typical for ice I<sub>h</sub> crystals. When ice melts, its hexagonal structure is destroyed, and a mixture of clusters consisting of tri-, tetra-, penta-, and hexamers of water and free H<sub>2</sub>O molecules is formed. Structural studies of these clusters are significantly impeded, since the water is perceived as a mixture of different clusters that are in dynamic equilibrium with each other.

In ice I<sub>h</sub> the carcasses of hydrogen bonds allocate H<sub>2</sub>O molecules in form of a spatial hexagon network with internal hollow hexagonal channels. In the nodes of this network O-atoms are orderly organized (crystalline state), forming regular hexagons, while H-atoms have various positions along the bonds (amorphous state). When ice melts, its network structure is destroyed: H<sub>2</sub>O molecules begin to fall down into the network hollows, resulting

in a denser structure of the liquid – this explains why water is heavier than ice. The hydrogen bonding explains other anomalies of water (abnormality of temperature, pressure, density, viscosity, fluidity etc. According to theoretical calculations, at the melting of the ice breaks about 15% of all hydrogen bonds (Mosin & Ignatov, 2012a); by further heating up to +40 °C breaks down about half of hydrogen bonds in water associates.

The clusters formed of D<sub>2</sub>O are some more stable and resistant than those ones from H<sub>2</sub>O due to isotopic effects of deuterium caused by 2-fold increasing nuclear mass of deuterium (molecular mass of D<sub>2</sub>O is more by 11% than that of H<sub>2</sub>O). The structure of D<sub>2</sub>O molecule is the same, as that of H<sub>2</sub>O, with small distinction in values of lengths of covalent bonds. D<sub>2</sub>O crystals have the same structure as a conventional ice I<sub>h</sub>, the difference in unit cell size is very insignificant (0.1%). But they are heavy (0.982 g/cm<sup>3</sup> at 0°C over 0.917 g/cm<sup>3</sup> for conventional ice). D<sub>2</sub>O boils at +101.44 °C, freezes at +3.82 °C, has density at +20 °C 1.105 g/cm<sup>3</sup>, and the maximum density occurs not at +3.89 °C, as for H<sub>2</sub>O, but at +11.2 °C (1.106 g/cm<sup>3</sup>). The mobility of D<sub>3</sub>O<sup>+</sup> ion on 28.5% lower than that of H<sub>3</sub>O<sup>+</sup> ion and OD<sup>-</sup> ion – 39.8% lower than that of OH<sup>-</sup> ion, the constant of ionization of D<sub>2</sub>O is less than the constant of ionization of H<sub>2</sub>O, which means that D<sub>2</sub>O has a bit more hydrophobic properties than H<sub>2</sub>O. All these effects lead that the hydrogen bonds formed by deuterium atoms differ in strength and energy from ordinary hydrogen bonds (O–H length 1.01 Å, O–D length 0.98 Å, D–O–D angle 106°). Commonly used molecular models use O–H lengths ~0.955 Å and 1.00 Å and H–O–H angles from ~105.5° to ~109.4°. The substitution of H with D atom affects the stability and geometry of hydrogen bonds in apparently rather complex way and may, through the changes in the hydrogen bond zero-point vibrational energies, alter the conformational dynamics of hydrogen (deuterium)-bonded structures of associates. In general, isotopic effects stabilize hydrogen bond with participation of deuterium, resulting in somewhat greater stability of associates (clusters) formed from D<sub>2</sub>O molecules (Mosin & Ignatov, 2012b, Ignatov, Mosin, 2015b).

The mathematical model of water after bioinfluence of Risimanski (Tables 8 and 9, Figure 4) gives the valuable information on the possible number of hydrogen bonds as percent of H<sub>2</sub>O molecules with different values of distribution of energies. These distributions are basically connected with the restructuring of H<sub>2</sub>O molecules having the same energies in water clusters. The values of the average energy ( $E_{H...O}$ ) of hydrogen bonds among H<sub>2</sub>O molecules in the formation of the elemental clusters  $E_{\text{compile}} = -0.1067 \pm 0.0011$  eV. As the energy of hydrogen bonds between H<sub>2</sub>O molecules increases up to -0.1112; -0.1212; -0.1387 eV, the cluster formations of water become “restructuring”.

### 3.8. Results with color coronal spectral analysis

Coronal gas discharge effect is indicated by the glow corona electrical discharge (flooding, crown, streamer) on the surface of objects being placed in the alternating electric field of high frequency (10–150 kHz) and electric voltage (5–30 kV) (Kilrian, 1949). In this process in the ionization zone develops the gas corona discharge sliding on dielectric surface, occurring in a nonuniform electric field near the electrode with a small radius of curvature. In the thin air layer with thickness of ~10–100 μm between the studied object and the electrode are developed the following processes:

- 1) Excitation, polarization and ionization by electric field of high frequency the main components of air – the molecules of nitrogen (78 % N<sub>2</sub>), oxygen (21 % O<sub>2</sub>) and carbon dioxide (0.046 % CO<sub>2</sub>). In the result of this is formed an ionized gas, i.e. gas with separated electrons having negative charges, creating a conductive medium as plasma;
- 2) Formation of a weak electric current in the form of free electrons separated from molecules of N<sub>2</sub>, O<sub>2</sub> and CO<sub>2</sub>, which generate gas discharge between the studied object and the electrode. The form of gas discharge glowing, its density and surface brightness distribution is determined mainly by electromagnetic properties of the object;
- 3) The transition of electrons from lower to higher energy levels and back again, during which there appears a discrete quantum of light radiation in the form of photon radiation. The transition energy of electrons depends on the external electric field and the electronic state of the studied object. Therefore, in different areas surrounding the electric field, the electrons receive different energy impulses, i.e. “skipping” at different energy levels those results in emission of photons with different wavelengths (frequencies) and the energy, coloring the contour of the glow in various spectral colors.

Processes outlined above form the total gas electric effect (Ignatov & Mosin, 2012), allows studying the electrical properties of the object at its interaction with an external electromagnetic field (Ignatov & Mosin, 2013a; Ignatov & Mosin, 2013b). It was shown that the electrical conductivity of the object has almost no effect on the formation of the electric images, which mostly depends on the dielectric constant (Pehek et al., 1976).

There is a relationship (1) of the electric discharge per unit area of the recording medium on the following parameters:

$$\sigma = [\alpha - U_p(d_2 + \delta)/d_2] \varepsilon_0(d_2 + \delta)/\delta d_2, \quad (1)$$

where:  $\delta = d_1/\varepsilon_1 + d_3/\varepsilon_3$

$\alpha$  – slope rate of electrical pulse;

T – duration of the electrical pulse;

$U_p$  – breakdown voltage of the air layer between the subject and the recording medium;

$d_1$  – the width of the object;

$d_2$  – width of the zone of influence of the electromagnetic field;

$d_3$  – width of the recording medium;

$\epsilon_0$  – dielectric permittivity of the air ( $\epsilon_0 = 1.00057$  F/m);

$\epsilon_1$  – dielectric permittivity of the studied object;

$\epsilon_3$  – dielectric permittivity of the medium.

To calculate the breakdown voltage of the air layer is used this formula:

$$U_p = 312 + 6,2d_2 \quad (2)$$

As a result of mathematical transformations is obtained a quadratic equation describing the width of the air layer:

$$6,2d_2^2 - (\alpha T - 6,2\delta - 312)d_2 + 312\delta = 0 \quad (3)$$

This equation has two solutions:

$$d_2 = [\alpha T - 6,2\delta - 312] \pm [(\alpha T - 6,2\delta - 312)^2 - 7738\delta]^{1/2} \quad (4)$$

The above equations allow to calculate maximum and minimum width of the air layer for the occurrence of electric discharge under which is being formed the electrical image of the studied object. Gas discharge characteristics for various biological objects vary in character and light intensity, size of contour glow and color spectrum and depend both on its own electromagnetic radiation and the dielectric constant of the object. The intensity depends on the electric voltage applied on the electrode. Studies have shown that the contours of gas discharge glow at 12 kHz and 15 kHz are homogeneous in their structure. The contour at 12 kHz is 55 % of the contour at 15 kHz and at 24 kHz – only 15 % of the contour at 15 kHz that is important for further analysis and identification of images. The incidence of bioelectrical activity of the body reducing the intensity of gas discharge glow. Pathology in the organism and surrounding tissues also alter the bioelectric activity and the shape and color of gas discharge glow, which is determined mainly by energy of photon emission at the transition of electrons from higher energy levels to the lower ones when being excited by the external electric field. Thus, for red colour of the electromagnetic spectrum this energy compiles 1.82 eV, for orange color – 2.05 eV, yellow – 2.14 eV, blue-green (cyan) – 2.43 eV, blue – 2.64 eV, and violet – 3.03 eV. The reliable result norm is at  $E \geq 2.53$  eV.

The spectral range of the photon emission for different colors is within 380-495 nm and 570-750 nm $\pm$ 5 nm. The photons, corresponding to the emission with green color in the visible electromagnetic spectrum, are not being detected under those experimental conditions. Thus, the more predominant in the color spectrum yellow, orange, blue, blue-green and purple colors, the more pronounced is gas discharge glow and bioelectric properties of the object. According to the data obtained, the incidence of bioelectrical activity of the body reducing the intensity of gas discharge glow. Studies carried out by A. Antonov and I. Ignatov on 1120 patients shown that the overall drop in the bioelectric activity of the body, as well as pathology in organism alter the bioelectric activity and reduce the apparent size of the gas discharge glow. This dependence is observed for many disorders, although there are not statistical reliable results that this method can be applied in medical diagnostics. The research area was from part of the thumb contacted with transparent electrode. The norm of energy of photon emission compiles 2.54 eV. If the value is over than 2.54 eV this is an indicator of normal bioelectrical status. Some people with high energy status possess the values of photon emission over 2.90 eV. The high values of this parameter are possible with practicing of yoga, sport etc. The emission less than 2.53 eV is characteristic for people with low bioelectrical status. These results are interesting from scientific point of view, because they may provide brilliant prospects for further using of this method for biophysical studies. interesting from scientific point of view, because they may provide prospects for further using of this method for biophysical studies.

Color Kirlian images of water droplets of different types of water are studied with Method of Color Coronal Spectral Analysis (Ignatov, 2010). This experiment also shows the relationship between the electric glow and the rotation of the plane of polarization of water molecules in the respective water. Water molecules are polar and they orient themselves according to the external electric field. In the Coronal discharge method the conductivity of the object does not affect the electric image. Its formation depends on the distribution of dielectric permittivity (Antonov, 1984). The coronal effect is also related to the bioelectric glow of a living object.

When examining the spectrum of water droplets, the electric glow is associated with the polarity of water molecules and their arrangement as a result of the applied external electric field. Polarization is a phenomenon that occurs in electromagnetic waves in which the electromagnetic field oscillates (hesitates, flickers) in one particular plane.

The photographing of the coronal spectrum is one of the physical methods in which the image has a much better quality on photographic film, than the electric images filmed with digital methods and with Polaroid (Figure 7). The experiment shows that for different water a different electric image is obtained ( Ignatov, 2010). The dielectric permittivity of water is high and this is important for its properties as a solvent. Coronal images of water droplets show that different water perceives differently the electric field.

Color Kirlian images of water droplets of different types of water are studied with Method of Color Coronal Spectral Analysis (Ignatov, 2010). This experiment also shows the relationship between the electric glow

and the rotation of the plane of polarization of water molecules in the respective water. Water molecules are polar and they orient themselves according to the external electric field. In the Coronal discharge method the conductivity of the object does not affect the electric image. Its formation depends on the distribution of dielectric permittivity (Antonov, 1984). The coronal effect is also related to the bioelectric glow of a living object.

When examining the spectrum of water droplets, the electric glow is associated with the polarity of water molecules and their arrangement as a result of the applied external electric field. Polarization is a phenomenon that occurs in electromagnetic waves in which the electromagnetic field oscillates (hesitates, flickers) in one particular plane.

The photographing of the coronal spectrum is one of the physical methods in which the image has a much better quality on photographic film, than the electric images filmed with digital methods and with Polaroid (Figure 7). The experiment shows that for different water a different electric image is obtained ( Ignatov, 2010). The dielectric permittivity of water is high and this is important for its properties as a solvent. Coronal images of water droplets show that different water perceives differently the electric field.

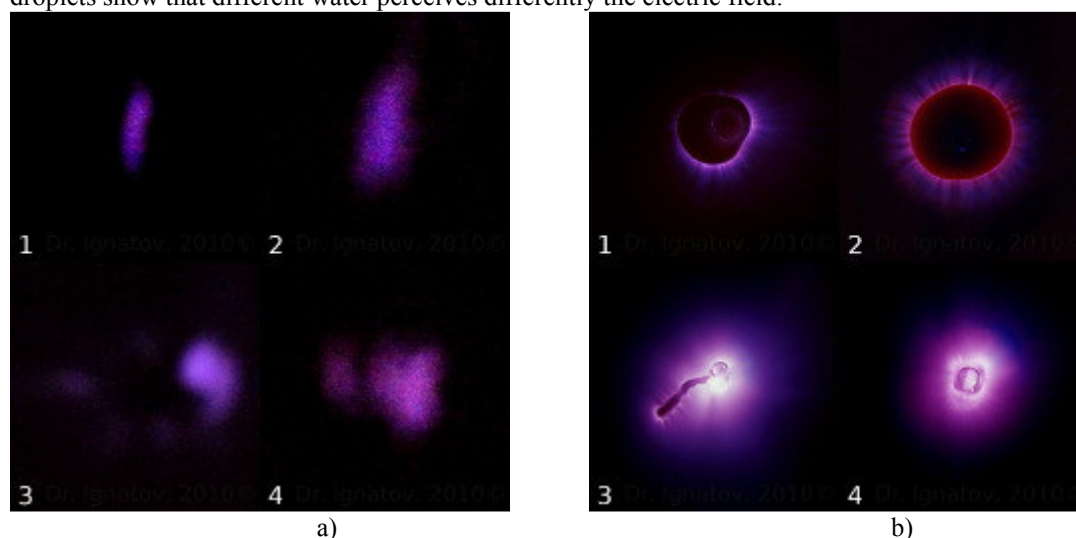


Fig. 7. Digital Color Coronal Photography of water drops (a) and on photographic film (b):  
1 drop - tap water, 2 mountain water drop, Teteven, Bulgaria, 3 drop - seawater, Hammamet, Tunisia,  
4 drop - karst and mineral water, Zlatna Panega, Bulgaria,;

Experiments with the electric glow of water droplets prove the self-organization as a result of the polarization of water clusters with a tendency to store information in a living cell. Coronal glow is basically related to dielectric permittivity and respectively the polarization of the water clusters from an electric field. The best structuring belongs to the water molecules in mineral waters that interact with calcium carbonate and then to sea water, depending on their polarization. A parallel spectral analysis of water shows that the water with the more pronounced electrical images has more pronounced peaks in the spectrum.

Figure 8 shows the Color coronal glow on photographic film of water drops from the control sample from deionized water (a) and deionized water after the bioinfluence of Dimitar Risimanski (b). The photon emission of the drop from the control sample is 2.07 eV. The photon emission of the drop from the sample is 2.71 eV. There is increasing of photon emission after the influence of Risimanski with 0.64 eV. This is the proof for increasing of electric permittivity as result of restructuring of water molecules after bioinfluence of Dimitar Risimanski.

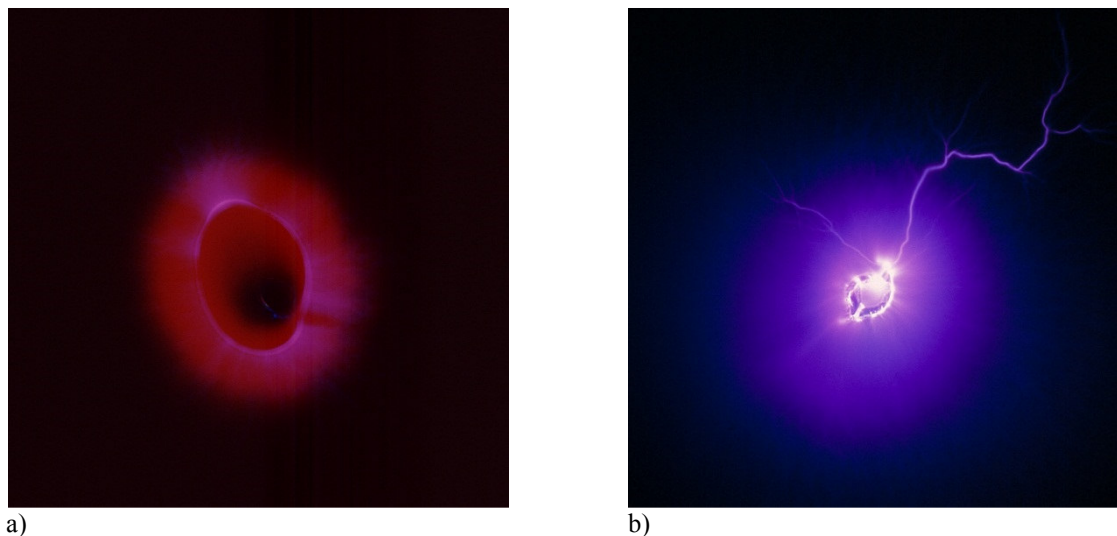


Figure 8. Color coronal glow on photographic film of water drops from the control sample from deionized water (a) and deionized water after the bioinfluence of Dimitar Risimanski (b).

#### 4. Conclusion

The composition of various samples of water from Bulgarian water springs: the melt water from Glacier Rosenloui, Swiss Alps, Kangen Water<sup>®</sup> as well as human blood serum of people with excellent health and cancer patients was studied by IR, NES and DNES-methods. In frames of the research 415 people living in the municipalities of Teteven, Yablanitza, Ugarchin, Lukovit, Lovech district; Dolni Dabnik, Pleven district, Kuklen, Pleven district (Bulgaria), where is lived the largest number of long lived people and their siblings, were also investigated regarding the water consumption. The research conducted by us shows that the natural mountain water and melt water with unique chemical composition, the pH value and less amount of deuterium seems to be one of the most important factors for human health. In Bulgaria, most long lived people and centenarians live in the Rhodope Mountains, while in Russia – in Dagestan and Yakutia. It worth to note that IR-spectrum of mountain water is most similar to the IR-spectrum of blood serum of healthy group of people with a local maximum at  $\lambda = 8.95 \mu\text{m}$ . The similar spectral characteristics possess mountain water from Teteven and other Bulgarian sources. Studying the human blood serum by NES and DNES-methods show that by measuring the average energy of hydrogen bonds among  $\text{H}_2\text{O}$  molecules and the distribution function of  $\text{H}_2\text{O}$  molecules on energies it is possible to show a vital status of a person and associated life expectancy. Our data indicates that water in the human body has the IR-spectrum resembling the IR-spectrum of human blood serum. On the characteristics of the IR-spectrum of water also exerts an influence the presence of deuterium in water samples. In the research there is the optimal composition of mountain and melt water from areas where are lived the long live people and centenarians. The decreased content of deuterium in studied water samples with residual deuterium content of 60-100 ppm, the variety of ions ( $\text{K}^+$ ,  $\text{Na}^+$ ,  $\text{Ca}^{2+}$ ,  $\text{Mg}^{2+}$ ,  $\text{Mn}^{2+}$ ,  $\text{Fe}^{2+}$ ,  $\text{Fe}^{3+}$ ,  $\text{Zn}^{2+}$ ,  $\text{SO}_4^{2-}$ ,  $\text{Cl}^-$ ,  $\text{HCO}_3^-$ ,  $\text{CO}_3^{2-}$ ), and chemical-physical parameters (pH, electroconductivity) of studied water samples renders beneficial effects of this type of water on human health. We have also obtained new proofs for biophysical and biochemical effects of  $\text{Ca}^{2+}$ ,  $\text{Mg}^{2+}$ ,  $\text{Zn}^{2+}$  and  $\text{Mn}^{2+}$  in composition of water on human organism and DNES-spectra of water. There are obtained new results of chemical composition of water from Glacier Rosenloui, Swiss Alps.

There is comparison between the results of different types of water for human health and restructuring water after bioinfluence of Risimanski.

- The energy of hydrogen bonds of water in the samples is differed because of the different number of hydrogen bonds in the water samples, which may result from the fact that different waters have a different structure and various intermolecular interactions – various associative elements with different structure, clusters of formula  $(\text{H}_2\text{O})_n$  with different  $n$ , connected into the molecular associates;
  - There is increasing of photon emission from water drops after the influence of Risimanski. This is the proof for increasing of electric permittivity as result of restructuring of water molecules after bioinfluence of Dimitar Risimanski.
  - There are the following effects as results of restructuring of water molecules and reliable extremums in water spectrum - improvement of nervous conductivity, anti inflammatory effect, inhabitation of development of tumor cells of molecular level;
  - As a result of different energies of hydrogen bonds, the surface tension of water samples is increasing.
  - The redistribution of  $\text{H}_2\text{O}$  molecules in water samples according to the energy (statistical process of dynamics);
- The mathematical model of water after bioinfluence of Risimanski gives the valuable information on the possible

number of hydrogen bonds as percent of H<sub>2</sub>O molecules with different values of distribution of energies. These distributions are basically connected with the restructuring of H<sub>2</sub>O molecules having the same energies in water clusters. The values of the average energy ( $E_{H..O}$ ) of hydrogen bonds among H<sub>2</sub>O molecules in the formation of the elemental clusters  $E_{\text{compile}} = -0.1067 \pm 0.0011$  eV. As the energy of hydrogen bonds between H<sub>2</sub>O molecules increases up to -0.1112; -0.1212; -0.1387 eV, the cluster formations of water become “restructuring”.

#### References:

- Abdullah, A.M., Abdelsalam, E., Abdullah, B. & Khaled, A. (2012) Antioxidant Effects of Zamzam Water in Normal Rats and Those Under Induced-oxidant Stress, *Journal of Medicinal Plants Research*, 6(42):5507-5512.
- Adelman, R., Saul, R. & Ames, B. (1988) Oxidative damage to DNA: relation to species metabolic rate and life span, *PNAS*, 85(8): 2706-2708.
- Antonov, A. (1995) Research of the Non-equilibrium Processes in the Area in Allocated Systems. Dissertation thesis for degree “Doctor of physical sciences”, Blagoevgrad, Sofia.
- Antonov, A. & Yuskesseliyeva, L. (1985) Selective high frequency discharge (Kirlian effect). *Acta Hydrophysica*, 5: 29.
- Atanasov, A., Karadzhev, S., Ivanova, E., Mosin, O.V. & Ignatov I. (2014) Study of the effects of electrochemical aqueous sodium chloride solution (anolite) on the virus of classical swine fever virus. Mathematical models of anolyte and catholyte as types of water. *Journal of Medicine, Physiology and Biophysics*, 4: 1–26.
- Begona, M. et al. (2000) Magnesium Status and Parameters of the Oxidant-Antioxidant Balance in Patients with Chronic Fatigue: Effects of Supplementation with Magnesium, *Journal of American College for Nutrition*, 19 (3): 374-382.
- Berdishev, G.G. (1989) *Reality and Illusion of Immortality Longevity*, Moscow, Politizdat, 1-89 [in Russian].
- Bai J., Wang J. & Zeng C. (2006) Multiwalled Ice Helices and Ice Nanotubes. *Proc. Natl. Acad. Sci.*, 3, 104-117.
- Bartha F., Kapuy O., Kozmutza C & Van Alsenoy C. (2003) Analysis of weakly bound structures: hydrogen bond and the electron density in a water dimer. *J. Mol. Struct. (Theochem)* 666, 117–122.
- Bernal J.D. & Fowler R.H. (1933) A Theory of Water and Ionic Solutions, with Particular Reference to Hydrogen and Hydroxyl Ions. *J. Chem. Phys.*, 1, 515–548.
- Berdishev, G.G. (1989) Reality and illusion of immortality longevity. – Moscow: Politizdat, 1989. [in Russian].
- Bild, W., Stefanescu, I., Haulica, I. et al. (1999) Research Concerning the Radioprotective and Immunostimulating Effects of Deuterium-depleted Water. *Rom. J. Physiol.*, 36(3–4): 205–218.
- Brubach, J.B., Mermet, A., Filabozzi, A., Gerschel, A. & Roy, P. (2005) Signatures of the Hydrogen Bonding in the Infrared Bands of Water. *J. Chem. Phys.*, 122: 184509.
- Burger, O., Baudish, A. & Vaupel, J. W. (2012) Human mortality improvement in evolutionary context, *PNAS*, 109(44): 18210–18214.
- Choi T.N. & Jordan K.D. (2010) Application of the SCC-DFTB Method to H<sup>+</sup>(H<sub>2</sub>O)<sub>6</sub>, H<sup>+</sup>(H<sub>2</sub>O)<sub>21</sub>, and H<sup>+</sup>(H<sub>2</sub>O)<sub>22</sub>. *J. Phys. Chem. B*, 114, 6932–6936.
- Druzhyak, N. G. (2005) Water for Health and Longevity, *Neva*. [in Russian].
- Eisenberg, D. & Kauzmann, W. (1969) The Structure and Properties of Water. *Oxford University Press*, London.
- Gluhchev, G., Ignatov, I., Karadzhev, S., Miloshev, G., Ivanov, N. & Mosin, O.V. (2015) Electrochemically Activated Water. Biophysical and Biological Effects of Anolyte and Catholyte as Types of Water, *Journal of Medicine, Physiology and Biophysics*, 10: 1-17.
- Goryainov S.V. (2012) A Model of Phase Transitions in Double-well Morse Potential: Application to Hydrogen Bond. *Physica B*, 407, 4233–4237.
- Gluhchev, G., Ignatov, I., Karadzhev, S., Miloshev, G., Ivanov, N. & Mosin, O.V. (2015) Studying the Antimicrobial and Antiviral Effects of Electrochemically Activated NaCl Solutions of Anolyte and Catholyte on a Strain of E. Coli DH5 and Classical Swine Fever (CSF) Virus, *European Journal of Medicine*, 9 (3): 124-138.
- Howard, C. & Hopps (1986) Chemical qualities of water that contribute to human health in a positive way, *Science of the total environment*, 54: 207-216.
- Ignatov, I., Mosin, O. V. & Naneva, K. (2012) Water in the Human Body is Information Bearer about Longevity. *Euromedica*, Hanover: 110-111.
- Ignatov I. (2012) Conference on the Physics, Chemistry and Biology of Water, Water in the Human Body is Information Bearer about Longevity, NY, Vermont Photonics.
- Ignatov I. & Mosin, O.V. (2013) Possible Processes for Origin of Life and Living Matter with Modeling of Physiological Processes of Bacterium *Bacillus subtilis* in Heavy Water as Model System. *Journal of Natural Sciences Research*, 3(9): 65-76.
- Ignatov, I. & Mosin, O.V. (2013) Modeling of Possible Processes for Origin of Life and Living Matter in Hot

- Mineral and Seawater with Deuterium. *Journal of Environment and Earth Science*, 3(14): 103-118.
- Ignatov, I. & Mosin, O.V. (2014) The Structure and Composition of Carbonaceous Fullerene Containing Mineral Shungite and Microporous Crystalline Aluminosilicate Mineral Zeolite. Mathematical Model of Interaction of Shungite and Zeolite with Water Molecules. *Advances in Physics Theories and Applications*, 28: 10-21.
- Ignatov, I. & Mosin, O.V. (2013) Structural Mathematical Models Describing Water Clusters. *Journal of Mathematical Theory and Modeling*, 3(11): 72-87.
- Ignatov, I., Mosin, O.V., Velikov, B., Bauer, E. & Tyminski, G. (2014) Longevity Factors and Mountain Water as a Factor. Research in Mountain and Field Areas in Bulgaria, *Civil and Environmental Research*, 6 (4): 51-60.
- Ignatov, I., Mosin, O.V. & Velikov, B. (2014) Longevity Factors and Mountain Water of Bulgaria in Factorial Research of Longevity, *Journal of Medicine, Physiology, Biophysics*, 1:13-33.
- Ignatov, I., Mosin, O.V., Velikov, B., Bauer, E. & Tyminski, G. (2014) Research of Longevity Factors and Mountain Water as a Factor in Teteven Municipality, Bulgaria, *Journal of Medicine, Physiology and Biophysics*, 2: 37-52.
- Ignatov, I. & Mosin, O. V. (2014) Nature of Hydrogen Bonds in Liquids and Crystals. Ice Crystal Modifications and Their Physical Characteristics, *Journal of Medicine, Physiology and Biophysics*, 4: 58-80.
- Ignatov, I., Mosin, O.V., Velikov, B., Bauer, E. & Tyminski, G. (2014) Research of Longevity Factors and Mountain Water as a Factor in Teteven, Yablanitsa and Ugarchin Municipalities, Lovech Region, Bulgaria, *Journal of Health, Medicine and Nursing*, 4: 21-36.
- Ignatov, I. Mosin, O.V., Velikov, B. Bauer, E. & Tyminski, G. (2014) Mountain Water as Main Longevity Factor in Research of Phenomenon of Longevity in Mountain Areas in Bulgaria, *European Journal of Molecular Biotechnology*, 4 (2): 52-71.
- Ignatov, I. & Mosin, O. V. (2014a) Hydrogen Bonds among Molecules in Liquid and Solid State of Water. Modifications of Ice Crystals, *Journal of Health, Medicine and Nursing*, 5: 56-79.
- Ignatov, I. & Mosin, O.V. (2014b) Methods for Measurements of Water Spectrum. Differential Non-equilibrium Energy Spectrum Method (DNES), *Journal of Health, Medicine and Nursing* 6: 50-72.
- Ignatov, I. & Mosin, O.V. (2014c) Isotopic Composition of Water as Main Factor for Longevity, *Drug Development and Registration*, 9 (4): 146-155. [in Russian].
- Ignatov, I., Mosin, O. V., Velikov, B. & Bauer, E. (2014) Influence of Isotopic Composition of Water with Varying Deuterium Content in Composition with Mountain Water of Bulgaria on Human Longevity, *Journal of Medicine, Physiology and Biophysics*, 7: 46-78.
- Ignatov, I., Karadzhov, S., Atanasov, A., Ivanova, E. & Mosin, O.V. (2014) Electrochemical aqueous sodium chloride solution (anolyte and catholyte) as types of water. Mathematical models. Study of effects of anolyte on the virus of classical swine fever virus. *Journal of Health, Medicine and Nursing*, 8: 1-28.
- Ignatov, I., Mosin, O.V. & Velikov, B. (2015) Mountain Water as a Factor of Human Longevity. Local Extremum at 8.95  $\mu\text{m}$  in Spectrum of Water as Indicator for Health and Longevity, *Journal of Medicine, Physiology and Biophysics*, 9: 51-81.
- Ignatov, I. & Mosin, O.V. (2015a) Methods for Research of Mountain and Melt Water as Factor of Longevity. Chemical Composition, NES and DNES Methods for Spectral Analysis. Effects of Calcium, Magnesium, Zinc and Manganese, *Advances in Physics Theories and Applications*, 44: 48-64.
- Ignatov, I., Mosin, O. V., Niggli, H., Drossinakis, Ch. (2014) Evaluating of Possible Methods and Approaches for Registering Electromagnetic Waves Emitted from the Human Body, *Nanotechnology Research and Practice*, 2 (2): 96-116.
- Ignatov, I., Mosin, O. V. (2014) Coronal Gas Discharge Effect in Modeling of Non-Equilibrium Conditions with Gas Electric Discharge Simulating Primary Atmosphere and Hydrosphere for Origin of Life and Living Matter, *Journal of Medicine, Physiology and Biophysics*, 5: 47-70.
- Ignatov, I., Mosin, O.V. & Stoyanov, Ch. (2014) Biophysical Fields. Color Coronal Spectral Analysis. Registration with Water Spectral Analysis. Biophoton Emission, *Journal of Medicine, Physiology and Biophysics*, 6: 1-22.
- Ignatov, I. & Mosin, O.V. (2015b) Water: Solid and Liquid Phases. Nano Structures in the Water in Solid and Liquid Phases, *Journal of Medicine, Physiology and Biophysics*, 9: 82-109.
- Gluhchev, G., Ignatov, I., Karadzhov, S., Miloshev, G., Ivanov, I. & Mosin, O. V. (2015) Studying of Virucidal and Biocidal Effects of Electrochemically Activated Anolyte and Catholyte Types of Water on Classical Swine Fever Virus (CSF) and Bacterium *E. coli* DH5, *Journal of Medicine, Physiology and Biophysics*, 13:1-17.
- Ignatov, I., Gluhchev, G., Karadzhov, S., Miloshev, G., Ivanov, I. & Mosin, O. V. (2015) Preparation of Electrochemically Activated Water Solutions (Catholyte/Anolyte) and Studying of their Physical-Chemical Properties, *Journal of Medicine, Physiology and Biophysics*, 13:18-38.

- Ignatov, I. & Mosin, O.V. (2015) Nanostructures in Solid and Liquid Phases of Water, *Journal of Medicine, Physiology and Biophysics*, 12:31-57.
- Ignatov, I. & Mosin, O. V. (2014) Isotopic Composition of Water as Main Factor for Longevity, *Drug Development and Registration*, 9 (4): 146-155.
- Ignatov, I. & Mosin, O.V. (2015) Methods for Research of Mountain and Melt Water as Factor of Longevity. Chemical Composition, NES and DNES Methods for Spectral Analysis. Effects of Calcium, Magnesium, Zinc and Manganese, *Advances in Physics Theories and Applications*, 44:48-64.
- Ignatov, I., Mosin, O.V. & Bauer, E. (2015) Vortex Power Spring Water: Physical-Chemical Qualities of this Water compared to Mountain and Melt Water from Bulgaria, Russia and Glacier Rosenlauri from Swiss Alps, *Advances in Physics Theories and Applications*, 45:6-29.
- Gluhchev, G., Ignatov, I., Karadzhev, S., Miloshev, G., Ivanov, N. & Mosin, O.V. (2015) Electrochemically Activated Water: Biophysical and Biological Effects of Anolyte and Catholyte Types of Water, 7. (1): 12-26.
- Ignatov, I., Mosin, O.V., Karadzhev, S., Miloshev, G. & Ivanov, N. (2015) The Evaluation of Mathematical Model of Interaction of Electrochemically Activated Water Solutions (Anolyte and Catholyte) with Water, *European Reviews of Chemical Research*, 2 (4): 72-86.
- Ignatov, I., Mosin, O. V. (2016) Results of Bioinfluence of Dimitar Risimanski with Biophysical Model Systems, *Journal of Medicine, Physiology and Biophysics*, 24: 5-17.
- Ignatov, I., Mosin, O.V. (2016) Mathematical Model of Kangen Water®. Biophysical and Biochemical Effects of Catholyte, *Advances in Physics Theories and Applications*, 20: 33-55.
- Ignatov, I., Mosin, O. V. (2016) Biophysical Results of Bioinfluence of Dimitar Risimanski as Base of Medical Effects, *Journal of Medicine and Nursing*, 27: 24-35.
- Isaacs E.D., Shukla A., Platzman P.M, et al. (2000) Compton scattering evidence for covalency of the hydrogen bond in ice, *J. Phys. Chem. Solids*, 61, 403-406.
- Keutsch F. & Saykally R. (2011) Water Clusters: Untangling the Mysteries of the Liquid, One Molecule at a Time. *PNAS*, 98(19), 105330-10540.
- Krasnov, V.V. & Gordetsov, A.S. (2009) Infrared spectral analysis of blood serum as level of disturbances of metabolic processes in infusion children pathology. *Clinical Medicine*: 83-94 [in Russian].
- Lis, G., Wassenaar, L.I. & Hendry, M.J. (2008) High-precision laser spectroscopy D/H and  $^{18}\text{O}/^{16}\text{O}$  Measurements of microliter natural water samples. *Anal. Chem.*, 80(1): 287-293.
- Liu K., Cruzan J.D. & Saykally R.J. (1996) Water Clusters. *Science Magazine*, 271(5251), 929-933.
- Loboda O. & Goncharuk V. (2010) Theoretical Study on Icosahedral Water Clusters. *Chemical Physics Letters*, 484(4-6), 144-147.
- Lis, G., Wassenaar, L.I. & Hendry, M.J. (2008) High-precision Laser Spectroscopy D/H and  $^{18}\text{O}/^{16}\text{O}$  Measurements of Microliter Natural Water Samples. *Anal. Chem.*, 80(1): 287-293.
- Lv.J., Wang, W., Krafft, T., Li, Y., Zhang, F. & Yuan, F. (2011) Effects of Several Environmental Factors on Longevity and Health of the Human Population of Zhongxiang, Hubei, China, *Biol. Trace Elem. Res.*, 143 (2):702-716.
- Luck W., Schiöberg D. & Ulrich S. (1980) Infrared Investigation of Water Structure in Desalination Membranes. *J. Chem. Soc. Faraday Trans.*, 2(76), 136-147.
- Machlin, L. J., Bendich, A. (1988) Free Radical Tissue Damage: Protective Role of Antioxidant Nutrients, *The FACEB journal*, 1(6): 441-445.
- Maheshwary S., Patel N., Sathyamurthy N., Kulkarni A.D. & Gadre S.R. (2001) Structure and Stability of Water Clusters  $(\text{H}_2\text{O})_n$ ,  $n = 8-20$ : An Ab Initio Investigation. *J. Phys. Chem.*, 105, 10525-10537.
- Mariani, E. et al. (2006) Antioxidant Enzyme Activities in Healthy Old Subjects: Influence of Age, Gender and Zinc Status: Results from the Zincage Project, *Biogerontology*, 7 (5-6): 391-398.
- Malhotra, A., & Dhawan, D. K. (2008) Zinc Improves Antioxidative Enzymes in Red Blood Cells and Hematology in Lithium-Treated rats, *Nutr. Res.*, 28(1):43-50
- Michaelides A. & Morgenstern K. (2007) Ice Nanoclusters at Hydrophobic Metal Surfaces. *Nat. Mat.*, 6, 597-599.
- Mocchegiani, E. (2007) Zinc, Metallothioneins, and Longevity- Effect of Zinc Supplementation: Zincage Study, *Ann N. Y. Acad. Sci*, 1119 (129-146).
- Mosin, O.V. & Ignatov, I. (2012a) Isotope effects of deuterium in bacterial and microalgae cells at growth on heavy water ( $\text{D}_2\text{O}$ ). *Voda: Himia i Ecologija*, 3, 83-94 [in Russian].
- Mosin, O.V. & Ignatov I. (2012b) Separation of heavy isotopes deuterium (D), tritium (T) and oxygen ( $^{18}\text{O}$ ) in water treatment. *Clean Water: Problems and Decisions (Moscow)*. 2012. № 3-4. 69-78 [in Russian].
- Mosin, O.V. & Ignatov, I. (2013) The structure and composition of natural carbonaceous fullerene containing mineral shungite, *International Journal of Advanced Scientific and Technical Research*, 6(11-12): 9-21.
- Pasichnyk I. Everaers R. & Maggs A.C. (2008) Simulating van der Waals-interactions in water/hydrocarbon-based complex fluids. *J. Phys. Chem. B*, 112(6), 1761-1764.



- Pauling L. (ed.) (1960) *The Nature of the Chemical Bond and the Structure of Molecules and Crystals*. New York: Cornell University Press.
- Pimentel G.C. & McClellan A.L. (1960) *The hydrogen bond* (L. Pauling, Ed). New York: Reinhold Publishing Co.
- Pocock, S.J, Shaper, A.G. & Packham, R.F. (1981) Studies of Water Quality and Cardiovascular Disease in the United Kingdom, *Sci. Total Environ.*, 18: 25–34.
- Orgel, L. (1963) The maintenance of the accuracy of protein synthesis and its relevance to aging, *Biochemistry*, 49: 517–521.
- Saykally, R. (2005) Unified description of temperature-dependent hydrogen bond rearrangements in liquid water. *PNAS*, 102(40): 14171–14174.
- Simon, M. et al. (2006) How Much Calcium Is in Your Drinking Water? A Survey of Calcium Concentrations in Bottled and Tap Water and Their Significance for Medical Treatment and Drug Administration, *HSS Journal*, 2(2): 130–135.
- Sykes M. (2007) Simulations of RNA Base Pairs in a Nanodroplet Reveal Solvation-Dependent Stability. *PNAS*, 104(30), 12336–12340.
- Tokmachev A.M., Tchougreeff A.L. & Dronskowski R. (2010) Hydrogen-Bond Networks in Water Clusters (H<sub>2</sub>O)<sub>20</sub>: An Exhaustive Quantum-Chemical. *European Journal of Chemical Physics and Physical Chemistry*, 11(2), 384–388.
- Tsai C.J. & Jordan K.D. (1993) Theoretical Study of the (H<sub>2</sub>O)<sub>6</sub> Cluster. *Chem. Phys. Letters*, 213, 181–188.
- Wang F & Jordan K.D. (2003) A Parallel Tempering Monte Carlo Investigation of (H<sub>2</sub>O)<sub>6</sub>. *J. Chem. Phys.*, 119, 11645–11653.
- Woodhead, R. (1984) *Molecular Biology of Aging*. NY, Basic Life Science, 35, pp. 34–37.
- Yuan, Y.&Shao, Y. (2002) Systematic Investigation of Alkali Metal Ion transfer Across the Micro-and-nano-water/1,2-dichloroethane interfaces facilitated by dibenzo-18-crown-6, 106 (32): 7809–7814