The influence of microwave radiation from the geocosmos on the state of a living organism

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Abstract. The cardinal problem of biophysics is insufficient understanding of the microwave radiation influence on a living organism. Microwave fluxes enter the biosphere from the earth's ionosphere during solar flares and geomagnetic storms, and also from the anthropogenic background. The task of the work was to present quantum-mechanical estimates of the ionosphere influence on the biosphere. Estimates for aqueous media of an organism are made within the framework of a new concept which describes the processes of formation of polyatomic Rydberg molecules built from their parent molecules by adding a proton, which is possible due to their high affinity for protons. The resulting ions are neutralized by capturing an electron into the Rydberg orbital, which is confirmed in experiments for the gases and liquids. The enhancement of the associative properties of highly diluted biologically active solutions under the influence of microwave flows is also investigated. One of the best partners in the mechanism of increasing formation of associates with the participation of microwave fluxes are water molecules (with its high proton affinity). When the number of water molecules grows with superdilution, an increasing number of microwave quanta are involved in the associative formation of water-containing biocomponents. An interpretation of the phenomenon of sporadic "non-reproducibility" of bioexperiments and contribution of geocosmic factors to the arthritis and viral pathology are presented.

1. Introduction

Life on the Earth is adapted practically to the entire spectrum of electromagnetic waves penetrating into the biosphere. In the process of evolution the adaptation of the body functions to the coming significant changes in the environment was developed. Among such changes are permanent variations of various cosmic factors, due to the cyclical nature of solar-geomagnetic activity. The authors propose to consider the microwave radiation of the terrestrial ionosphere (long recorded by ground observatories), perturbed precisely during periods of maximum solar activity — flares and geomagnetic storms, as the most important factor of impact on living organisms. The fact is that during these events almost all of the additional emerging fluxes do not reach the biosphere, being absorbed by the ionosphere itself [1], but they excite microwave emission, up to the level of $10^{-11} \text{ W/cm}^2$ and, possibly, up to $10^{-10} \text{ W/cm}^2$. In addition, in the past decades, the anthropogenic component in the microwave range (EHF-UHF-UHF) has increased dramatically in the environment (up to an order of magnitude every 15 years [2]), primarily due to the work of cellular transmitters and consumer electronics. However, until now there was no understanding of how interaction between
these electromagnetic waves and liquid media of an organism works. This was named one of the cardinal problems of modern biophysics more than 60 years ago [3].

The purpose of our research was to consider the physical processes causing the effects of ionosphere microwave emission on the formation of associates in aquatic biological solutions with taking into account the space weather variations. Presented research results contribute to fundamental physical understanding of the reaction of biological systems on the microwaves radiations of natural (ionospheric) and artificial origin. They are based on the conclusions made in [4] and confirmed by optical experiments [5], both in the gas and in the liquid [6] phases, that proton transfer is capable of providing the appearance of stable Rydberg states of polyatomic hydrogen-containing molecules [5], including the participation of water. The task of the work was to present quantum-mechanical estimates of the influence of the ionosphere on the biosphere. In our study, we used the mechanisms of quantum-electron-proton interactions known from the physics of the interaction of electromagnetic (microwave) radiation with matter and atomic-molecular collisions.

Assessments of possible role of energy transfer in liquid media of an organism are made within the framework of a novel concept - supramolecular physics. Supramolecular physics [1, 7] describes processes developing outside the molecule in whose evolution to the complex forms (over-molecular structures - associates) microwave radiation of external origin absorbed by exited Rydberg components of this molecular complex takes part. Suggesting a new term we use the analogy with the well known supramolecular chemistry [8]. Taking into account very high rates of proton transfer made it possible to speak [8] about molecular protonics. So, "the transfer of protons is of fundamental importance in the bioenergetics of a living organism, directing transport processes and the synthesis of ATP - adenosine triphosphoric acid - a supplier of chemical energy for biochemical and physiological processes in the body [8]". It is also the first step of hydrogen bonding in the environment, including the processes of cloud formation, which are most important for the energy sector, as a key factor in the radiation balance of the Earth as a planet [7].

We have drawn attention to the fact that in such situations the probability of association processes into a stable complex is determined, according to [9], by the value of the orbital angular momentum ($l$) of the Rydberg electron, namely, it decreases at small values of $l$ and, conversely, is large at large values ($l > 2 - 3$). This circumstance is associated with such a change in the shape of the electron orbit that at large $l$ it ceases to penetrate into the ionic core, which increases the stability of the associate. Moreover, in [10], p. 206, it was determined, when comparing the valence and Rydberg states for molecules consisting of such atoms important for biology as C, N and O, that the lowest Rydberg states begin already with small principal quantum numbers $n = 3$. Consequently, during periods of an increase in the magnitude of external microwaves fluxes, apparently, first of all, from the ionosphere, when they are absorbed by a Rydberg electron in allowed electric dipole transitions with an increase in the orbital angular momentum ($l$) per unit, one should expect a decrease in the rate of breakup of clusters (up to the order of magnitude [11]) that is strengthening of associate formation.

It is obvious that external microwave radiation, in the absence of control over primarily microwaves from the disturbed ionosphere, can be the main factor responsible for many years of observations of the effects of "non-reproducibility" in a number of biophysical experiments [12]. Note that sporadic "non-reproducibility" is meant. Thus, we follow the approach [12], p. 531: "Irreproducibility does not mean the unreality of the object, irreproducibility makes sense only in relation to the time interval of the study." In the presence of many generally recognized factors of non-reproducibility, its nature for non-thermal effects has not yet been investigated, see [12], p. 578. Although the above referred to small effects in magnetobiology, it is also important in the interpretation of the phenomena of low doses [13] and especially in the study of high and ultrahigh dilutions of aqueous biological solutions [14-17].

2. Some observational data and model assessments
The explanation of the observed situation in studies on the physicochemistry of a living organism is proposed to be associated with the permanent influence on all objects of the biosphere of the
microwave emission of the terrestrial ionosphere, perturbed by the ionizing fluxes of the shortwave radiation of the Sun and corpuscular precipitations (mainly of keV electrons) from the radiation belts of the Earth and directly from geomagnetsosphere. Such emission was experimentally detected in various ground-based observatories. The physical mechanism of its generation was proposed in our works [9, 18]. It consists in the excitation of the Rydberg states of atoms and molecules of all upper-atmospheric gases due to the impact of fast electrons of ionization (photo-, Auger- and secondary ionospheric electrons). Therefore, the level of microwave emission from the ionosphere makes it possible to adequately describe the current level of solar-geomagnetic activity and its influence on the physics of solar-terrestrial links. These microwave ionospheric fluxes in almost the entire range from 1 mm to 10 dm, freely (except for some narrow absorption bands) penetrate to the earth's surface and the biosphere. Variations in the magnitude of such fluxes can be (according to our estimates) from four to five orders of magnitude depending on the time of day. The maximum flux is observed as a rule during the period of the global magnetic storm and its main phase. The altitude of the microwave emission generation region usually exceeds 100–200 km[18, 19], and hence the radiation from this ionospheric source penetrates distances along the earth’s surface, up to 2000 - 4000 km, from the oval of auroras, down to middle and low latitudes of 40° and even lower. Thus, at moderate latitudes, in the absence of a global magnetic storm, the main flux of microwaves comes from the high-latitude (auroral) zone, and strong radiation appears from the zenith only during periods of storm corpuscular precipitation (mainly electrons) from the radiation belts, see for example [20].

Registration of microwaves from the terrestrial ionosphere at ground observatories was carried out repeatedly both in the zone of auroras and at midlatitudes, including periods of solar flares. However, with the increase in electromagnetic smog in recent decades (the level of which increases 10 times every fifteen years), field experiments are becoming more complex and less informative, which makes the results already completed and published from 1947 to 1981 almost exclusive [20-25].

Already in [22] conducted a detailed consideration of the source of ionospheric microwave radiation at a wavelength of 10 cm (3 GHz), registered on the night of January 24 to 25, 1949, by a radar receiver in northern Canada and associated with intense aurora. It was concluded that the most likely source of this radiation is a plasma oscillation of the ionized volume associated with the auroral display. If this is so, the electron density in at least localized regions must be of the order of 10¹¹ cm⁻³. This, of course, should be considered very problematic, see also [26], where the differences in highly excited (with principal quantum number ≥10) Rydberg states of atoms and molecules were not taken into account; for the latter, the energies of Rydberg levels practically lie in the range of energies of vibrational-rotational excitation [27].

In [23], an important conclusion for the physics of solar-terrestrial connections is made that there is a positive correlation between the intensity of ionospheric microwave radiation with wavelength of 10 cm and the intensity of both auroral displays and sunspot activity. Thus the registration of this microwave flux in 1951-1952 was unsuccessful, which was explained by the fall in these years of solar and auroral activity by two to three times compared with the observation period in [24].

In 2002, the decisive role of the Rydberg excitation in mechanism of generation of microwaves by a disturbed upper atmosphere was for the first time experimentally confirmed at the Russian ionosphere heating stand “Sura” – analogue HAARP, Alaska, USA, (with absorption of radio waves at altitudes of 200-300 km at frequencies of 4.7-6.8 MHz) [28]. Possible mechanisms of the emission excitation were discussed and the physical interpretation of the observed phenomenon [28] was completely based on our works [18, 19, 29] given as a result of microwave emission at a frequency of 600 MHz with all the upper-atmospheric gas components excited by the impact of accelerated ionospheric electrons to highly excited (Rydberg) states with a principal quantum number of more than ≥ 10. For example, the radio emission of the oxygen atom (the main component of the atmosphere at altitudes of the upper atmosphere over 180 km) lies in the cm-range with a decrease in n by 1 in the interval n = 10-20. When n changes by more than 1, the mm-range is emitted. Decimeter radiation appears in the case of transitions without changing n for n = 20-40.
The excitation rate increases with the growth of geomagnetic and solar activities in particular during the solar flares (up to 10 times and more) and during the principal magnetic storms (up to 100 times and more). Unlike the auroral zone, where the excitation rate as a rule shows only one main maximum at the altitude about 100 km [19], during the solar flare there are usually two maxima [18]. The first maximum, connected with EUV solar radiation, occurs at the altitude near 200 km and its value increases during a flare by several tens per cents. The second maximum at the altitude above 100 km becomes the main one the large flare. Its increase comes up to ten times and resulted from the X-ray solar radiation. During the quiet Sun the excitation rate of sum of the Rydberg states exceeds the value 10 cm$^{-3}$s$^{-1}$ for atoms and molecules of oxygen and 100 cm$^{-3}$s$^{-1}$ for molecules of nitrogen. During solar flare 2B the integral intensity in vertical column is $10^9$ photons cm$^{-2}$ s$^{-1}$, and in the main phase of a strong magnetic storm (at maximum auroras) it reaches $10^{12}$ photons cm$^{-2}$ s$^{-1}$.

In [30] it was clearly shown that although the sun is a powerful source of radiation with its radio bursts, however, even more intensive and variable source is the microwave flux from terrestrial ionosphere. In the periods of solar flares, in particular in the X-ray range, the ionospheric microwave fluxes grow up very sharply, by about an order of magnitude or more [31-34]. The magnitude of ionosphere emission rises up to 1000 times in the periods of principal magnetic storms, especially in the zones of polar aurora [19], as well as at the moderate latitudes. Results of the ground-based measurements of the microwave fluxes from ionosphere, performed in the period of solar flares [30] show that the emission signal of the ionosphere exceeded the intensity of the radioflux from the quiet Sun by a factor of 2 – 40 at the wavelength equal to 50 cm. The width of the surge reached 1 GHz. This flux [30] in the period of a solar flare is equal to $\sim 3 - 70 \cdot 10^{-16}$ W/ cm$^2$, that is orders of magnitude greater than the sensitivity threshold of biological objects to microwaves [35]. During the period of magnetic storm this value grows up to $10^{11} - 10^{12}$ W/cm$^2$.

3. Our main model assumptions
In the case of molecules with large proton affinity (including water) the process of associate formation by means of capture of electron to the Rydberg orbital is known [4, 5]. In [4] this idea was formulated as follows: “Polyatomic Rydberg molecules are known... These polyatomic molecules have in common that they can be thought of... by adding a proton, which is possible because of their high proton affinity. These ions are then neutralized by capturing an electron in a Rydberg orbital [5].”

In these situations, the probability for association is determined by the value of orbital momentum $l$ of Rydberg electron: it decreases at small $l$ and, on the contrary, it grows at bigger $l$ ($l>2$) because the electron more seldom penetrates into the ion core.

Consequently, in the process of absorption of the microwave radiation by electron on Rydberg orbital, decay of associates decreases. In this case, at addition of proton to the parent water molecule its own electron from hydrogen atom neutralizes arising positive charge being captured to the hydrogen-like Rydberg levels, beginning with highest principal quantum number $n$.

This process can be written as:

$$\text{AS(Hn) + p' + (OH)} \rightarrow \text{AS (Hn + p' + e_{Ry} + OH)*} \rightarrow \text{AS(Hn)H}_2\text{O},$$

(1)

where AS(Hn) – is the neutral complex molecule (molecular cluster-associate), with large proton (p') affinity, contenting several (n) hydrogen atoms ((H), p' + (OH)) - is the molecule of water near this molecular complex with large proton affinity, $e_{Ry}$ – is the electron from Rydberg orbital, which neutralized the charge of attached proton, AS(Hn + p' + e_{Ry} + OH)* - is a neutral excited Rydberg molecular complex which absorbs a microwave quantum with increasing orbital momentum ($l$) of Rydberg electron, AS(Hn)H$_2$O – is the molecular complex (cluster-associate) after attachment of a new water molecule [1, 7]. This process is fully consistent with the conclusion [36], where it is stated that the greatest contribution to the formation of Rydberg states with $n \geq 10$ for plasma conditions (and this exactly corresponds to a condensed medium - a water-containing biological solution of a living organism) is made by the processes of recombination of ions with an electron.
The formation of associates for biological applications including origin of life were noted previously [37, 38]. The activity of the ancient Sun was much higher, which dramatically increased the flux of microwaves from the ionosphere. This could contribute to the birth of organic life, taking into account the fact that the basic molecules of the ancient terrestrial atmosphere: water, ammonia and methane, have according to [5, 6] a high proton affinity.

In [39], pp. 251-253, and also [40], pp. 175/176, it was confirmed that Rydberg states were registered in absorption and in emission spectra for water vapors and for condensed species (liquid water and ice). In these three species the cross sections of absorption processes are practically equal.

Of course, the contribution of collisions with nonradiative quenching of Rydberg states is possible in a liquid. The situation with the cross sections for quenching Rydberg states is not easy. The question of the interaction of the Rydberg atom as a whole particle (with a size greater than ~ 100 times the diameter of an ordinary atom / molecule and therefore practically “transparent”) with a collisional component of the medium (usually it is neutral, as in our case atomic /molecular component) was considered in [42], p.165. The interaction between the electron and the neutral atom / molecule occurs at shorter distances than the Coulomb one. Consequently, a highly excited electron interacts with a neutral only when they are very close and this collision is much shorter in time than in the interaction of charged particles. Since the ion core is far from the Rydberg electron and its presence is insignificant in electron-neutral collisions [42]. It can be assumed that the quenching effect of such a collision — a passage through a very bloated atom which is in the Rydberg state — is small, despite its large geometric cross section proportional to $n^2$, where $n$ is the main quantum number. In [35], p.210, the time between successive collisions with molecules in an aqueous solution was estimated to be about $10^{-11}$ seconds. In our case, the average time of the charge neutralization process for a molecular particle, including associates, after the proton attachment is an order of magnitude shorter (in the estimates made earlier in [1, 7], it is $\sim 10^{-12}$ s), so collision quenching can be neglected.

In [40], pp. 395-397, attention had been paid to the experimental evidence for existence of Rydberg excitation of biological molecules and it was pointed out that “theory ignores the Rydberg excitation”. The table presented in [40] contains such important biological materials as DNA, red blood cells, oligopeptides, glycopeptides, chloroplasts etc. It should be taken into account that a non-radiative transfer of potential energy from water-containing associates to those biomolecular components via “inelastic impacts” is also possible.

**4. On the possible role of induced emission**

The microwave radiation absorbed by the organism stimulates the growth of number and sizes of associates containing water molecules and can simultaneously lead to induced emission of the same wavelength and direction [43]. This induced radiation is emitted at interaction of microwave quanta with Rydberg states even with higher probability than that for emission in spontaneous transitions [4, 44]. This means that in the process of associate formation the induced microwave emission (which constitutes up to one half of the total flux of external microwave radiation participating in associate formation) can take part in further acts of association.

So, it can be stated that the bioenergetics of a bioobject increases in comparison with all previous estimates that did not take into account the process of induced emission.

**5. Assessments and illustrative examples**

The assessment of the possible contribution of the absorption of microwaves to the process of association, including water-containing complexes, in a living organism was carried out as in the case of tropospheric condensation-cluster (droplet) haze [7], for the main phase of the world magnetic storm, when the flux of quanta of ionospheric microwave radiation $F = 10^{22}$ quanta / cm$^2$ s. The absorption cross section of a microwave quantum ($S$), with an increase in the orbital angular momentum $J$ by unity, is in $n^6$ ($n$ is the principal quantum number) times greater than the gas kinetic ($a_0$)$^2$, proportional to $\lambda^2$ [45], where $\lambda$ is the wavelength. Since $\lambda \sim c \times n'$ (where $c = 137$ is the speed of light in atomic units), the value of the induced absorption cross section is $S = 0.25 \times c^2 \times n'^2$.
As a result, we obtain that \( S = 1.2 \times n^6 \times 10^{12} \text{ cm}^2 \) [45]. In fact, it will be smaller, since there is Lorentz-collisional broadening. Then the probability of the formation of associates stabilized by the absorption of the microwave flux by an electron in the Rydberg orbital with an increase in the value of \( I \) by one will be \( p = S \times F \times r \), where \( r = 10^{-12} \text{ s} \) is the average value of the duration of the association process of a complex molecule through the neutralization of a positive the charge of the atomic-molecular complex ion (formed with the participation of the \( \text{H}_2\text{O} \) molecule due to the high affinity for the proton), which has attached the proton to the water molecule. It was found that the probability of the formation of associates stabilized by the absorption of the microwave flux by an electron in the Rydberg orbital in an aqueous medium (including in the human body) can reach up to 26% inside the skin layer (up to 16 cm thick in the decimeter range). The estimated evaluation was made according to the given formula for \( n = 100 \). The value \( n = 100 \) was chosen based on an estimate of the probable size of a "coat" of water molecules \( \sim 1 \mu \text{m} \), clinging to biopolymers, because this is the diameter of the Rydberg (Bohr) orbit with a given \( n \). It is probably clear that the assessments carried out led to the upper level of the expected reaction of the degree of association in a water-containing biological solution of a living organism, which is, apparently, inherent mainly in situations with some medical pathologies during the main world magnetic storms.

We estimated in [45] that there is no sense to take into account \( n > 100 \) because of collision neutralization of such states in surroundings (especially in thick liquids). Real values of \( n \) are substantially lower, starting from \( n \approx 10 \), thus in fact we obtained the upper estimation of the contribution of magnetic storm to the formation of water associates in a skin layer. The matter of fact is that, within the frame over of supramolecular physics, the electron passes through all Rydberg states, beginning with \( n = \infty \). Thus its excitation to a higher sublevel of thin structure by a flux of microwaves always reduces the probability for electron to penetrate deep into atom-molecular core, and, consequently sharply reduces the probability for dissociation of the formed associates.

6. Associate formation in the field of microwave emission of the ionosphere

Model representations for describing the nature of known in modern biophysics manifestations of enhancement of associative properties of strongly diluted biologically active solutions (see also [17] and the publications mentioned there) under the influence of microwave fluxes, primarily of ionospheric origin were created in [1].

In [17], it was determined that the main part of nano-associates in highly diluted solutions are water molecules. Note that the feature requiring interpretation namely enhanced associate formation, concerns only cases of very low concentrations of biomolecules - less than \( 10^{-7} - 10^{-10} \text{ M} \), and up to \( 10^{-18} - 10^{-20} \text{ M} \). Indeed in [17] no significant difference was observed in the rate of associate formation in aqueous solutions of all 60 studied bioactive substances at concentrations from \( M \) to \( \sim 10^{-7} \text{ M} \), both in the presence and in the absence of electromagnetic shielding. We proposed the following interpretation of the nature of this phenomenon taking into account the effect of microwave radiation from the ionosphere on the probability of associate formation. In the framework of supramolecular physics, one of the best partners in the mechanism for increasing the rate of associate formation with the participation of microwave flux quanta are water molecules (because of its high affinity for a proton). When the number of water molecules grows with super-dilutions, more and more quanta of microwaves, including induced emitted, participate in associate formation of the water-containing components. So the disappearance of the associative effect under the Permalloy shielding of the geomagnetic field can be considered as a confirmation of our hypothetical explanation, since any microwave fluxes are drastically weakened under the metallic shield.

Consequently, it can be assumed that an increased total microwave flux consisting of external and induced radiation is able to affect the state of electronic Rydberg excitation of biomolecules. The participation of such excited biomolecules in turn can affect the energy and kinetics of all biochemical reactions, including association.

\[ \times (a_0)^2, \text{ where } (a_0)^2 = 0.25 \times 10^{16} \text{ cm}^2. \]
7. On the issue of manifestations of heliobiology in medical pathologies

Taking into account the effect of the formation of water associates, it is possible to explain the known data on rheumatoid arthritis during magnetic storms: the deterioration of the clinical course [46] and the onset of new cases of rheumatoid arthritis (with its generalization [47], i.e. with the involvement of new groups of joints in the pathological process) at the time of extremes 11-year cycle of solar activity, when the number of solar flares and magnetic storms has maxima [31]. It is during these periods, when the microwave flux from the ionosphere is higher, that the “coat” of water associates becomes more powerful, which prevents phagocytes from penetrating cell membranes and recognizing the effects of arthritis in the synovial fluid.

In 1985, at the absolute peak, in the last hundreds of years, of the main - short-wave activity of the Sun [48], Luc Montagnier, deciphered the genome of the AIDS virus, and then, while searching for vaccines for HIV-infected, they unexpectedly discovered [49] that after fragmentation and filtration, such a virus is capable of self-reproduction. In this case, the process of "building" its DNA from the remaining small fragments takes place, and the missing fragments are synthesized according to some internal program, but as a result, the virus itself or some of its new mutants was always reproduced. The recorded phenomenon was observed only in the absence of metal (magnetic) shielding, mainly at high and ultra-high water dilutions (with a maximum at concentrations of $10^{-13}$-$10^{-18}$ M), in filtrates from cultures of various microorganisms - not only viruses, but also some bacteria, in this case, associated radio emission of the ultra-low-frequency (ULF) range usually occurred at frequencies of 500 - 3000 Hz. The authors of [49] came to a controversial assumption about the connection between the problems of obtaining a vaccine against the AIDS virus with the ability of certain DNA sequences of viruses to emit ULF radio waves, which was also found in influenza and hepatitis C viruses, hence, having a very low viral load in their plasma.

Our study shows that all the conclusions about the "unexpected behavior" of DNA viruses are quite explainable within the framework of the known processes of the physics of the interaction of electromagnetic (microwave) radiation with the water-containing environment of a living organism, already quantitatively considered taking into account Rydberg excitation in a number of biophysical applications [1, 7].

We explain the phenomenon of virus DNA synthesis with concomitant radiation in the range of 500-3000 Hz [49] by the fact that it can be supported by the stimulating effect of external microwave irradiation on the association of water molecules and biopolymers. The very process of generating additional ULF radiation is associated with manifestations of the well-known dynamic (so-called "ac") Stark shift [44] and, apparently, the subsequent process of interaction of two harmonic oscillations with close microwave frequencies: an external signal and a new one. In general, the Stark shift is specific for all temperature sources of the environment - personnel and thermal conditions in the laboratory, since the magnitude of the frequency shift is proportional to $T^{\frac{1}{2}}$ [44]. In connection with the declared insufficient sensitivity of the equipment in this part of the experiment [49], its authors propose to consider the values of the published frequencies of ULF signals not quite definite, which so far limits their classification.

Our study allows us to assert that electromagnetic energy from the environment in the microwave range is capable of causing all the observed effects in experiments [49]. Indeed, quantum-mechanical estimates [1, 7] quantitatively confirmed the contribution of absorption of microwaves from the ionosphere inside the skin layer (from fractions of a mm to 16 cm) up to 26% to the process of associate formation in biological solutions, including in the human body, at the maximum of a magnetic storm. This effect, determined by the high affinity for a proton in water molecules, under conditions of ultra-high aqueous dilutions (up to concentrations of $10^{-15}$-$10^{-18}$ M), enhances the biochemical activity of the dissolved biocomponent due to the collisional transfer of potential energy from the Rydberg-excited water-containing associate to Rydberg associates. (obviously high-energy) levels of biomaterials, including DNA, which also affects the kinetics of all biochemical reactions, including associate formation [17]. As a result, more and more associates appear in the biological solution, irradiated by microwaves, and fewer individual water molecules remain, which are just
capable, according to [50], p. 631, penetrating the double helix of DNA, contribute to its decay.

8. Conclusions

Thus in the present work:

1). A new approach to the physics of microwave radiation influence on the living organism liquids is proposed and substantiated. For this purpose the concept of supramolecular physics which concerns formation of over-molecular structures from water molecules in liquid media is used. This approach is based upon consideration of the processes of electron-proton-molecular interactions with taking into account formation of associates from water molecules by adding a proton (due to their high proton affinity) and subsequent capture of a neutralizing electron to a highly excited (Rydberg) level.

2). These processes are considered in conditions that microwave emission from ionosphere is present. In ionosphere the microwave emission rises sharply due to electron precipitation from radiation belts during magnetic storm and under the influence of short-wave radiation from solar flare.

3). The suggested mechanism of microwave influence (originating primarily from the ionosphere) on the biosphere including human beings is important methodologically as it emphasizes the necessity to take this influence into account in all researches on helio-geo-biocorrelations and electromagnetobiology. This is fully consistent with the conclusions [51]: “The main physical factor explaining all changes in physicochemical systems and indicators of organisms during shielding, is mainly due to their isolation from alternating fields - the electromagnetic background (background of radio waves) in a wide frequency range [highlighted in the original].”

4). A hypothesis is shortly discussed that the processes of induced emission and non-radiation energy transfer of acquired potential energy are possible in a living organism:

- the exposure to the microwave radiation results in formation of associates and also leads to the induced emission of the same frequency and direction. This means that the microwave radiation of excited Rydberg associates, induced in a liquid medium by external microwave radiation, then acts together with external radiation, stimulating further acts of induced radiation, which leads to the formation of associates with the inclusion of new water molecules (as well as to a deeper penetration of microwaves into organism);

- the important biological materials and water associates have close Rydberg levels therefore non-radiative transfer of excitation among Rydberg molecules possible in organism.

5). Thus we introduce a previously unknown in biology factor - sporadic microwave radiation from the ionosphere, which allows a new approach:

- to the physics of solar-terrestrial - biosphere relations,
- to bioenergetics,
- to the account of the contribution of electromagnetic environment smog to the biophysics of liquid media of a living organism.

9. References

[1] Avakyan S V and Baranova I, A 2019 The influence of environmental electromagnetic radiation on associate formation in aqueous solutions Biophysics 64 7-13
[2] Stojarov A N 2007 Medical ecology: textbook (Minsk: Vish. Shkola) (in Russ)
[3] Szent-Györgyi A 1957 Bioenergetics (New-York: Academic Press Inc.)
[4] Gallas J A C, Leuchs G, Walther H and Figger H. 1985 Rydberg atoms: high-resolution spectroscopy and radiation interaction - Rydberg molecules Adv. Atom. Molec. Phys. 20 413-66
[5] Dabrowski I and Herzberg G 1980 The electronic emission spectrum of triatomic hydrogen. I. Canad. J. Phys. 58 1238-49
[6] Herzberg G 1987 Rydberg molecules Ann. Rev. Phys. Chem. 38 27-56
[7] Avakyan S V 2017 Environmental supramolecular physics: climatic and biophysical effects Herald Rus. Acad. Sci. 87 276-83
[8] Lehn J-M 1995 Supramolecular chemistry. Concepts and Perspectives, (Weinheim, New-York, Basel, Cambridge, Tokio : VCH Verlagsgesellschaft mbH)

[9] Avakyan S V 2008 Physics of the solar–terrestrial coupling: results, problems, and new approaches. Geomagn. Aeron. 48 417-24

[10] Lefebvre-Brion H, and Field R W 1986 Perturbations in the spectra of diatomic molecules (New York : Acad. Press)

[11] Tarr S M Schiavone J A and Freund R S 1981 Long-lived high-Rydberg molecules formed by electron impact: H₂, D₂, N₂ and CO J. Chem. Phys. 74 (5) 2869-78

[12] Binhi V N 2011 Principles of Electromagnetic Biophysics (Moscow : FIZMATLIT) (in Russ)

[13] Gall' L N 2014 Physical principles of the functioning of the matter of a living organism (Saint. Petersburg : Publishing house of the Politechnical University) (in Russ)

[14] Davenas E and et al. 1988 Human basophil degranulation triggered by very dilute antiserum against IgE. Nature 333 816-8

[15] Maddox J, Randi J and Stewart W W 1988 “High-dilution” experiments a delusion Nature 334 287-90

[16] Benveniste J 1988 Reply Nature 334 p 291

[17] Konovalov A I 2013 Formation of nanoscale molecular ensembles in high diluted water solutions Herald Rus. Acad. Sci. 83 136-41

[18] Avakyan S V, Serova A E and Voronin N A 1997 The role of Rydberg atoms and molecules in the upper atmosphere. Geomagn. Aeron. 37 331-5

[19] Avakyan S V 2005 Microwave radiation of the ionosphere as a factor in the way of solar flares and geomagnetic storms act on biosystems. J. Opt. Technol. OSA 72 p 608-14

[20] Burein A N, Klimenko V V, Osipov N K and Chernov A A 1981 SHF radio emission of auroral ionosphere and the oval of aurora Geomagn. Aeron. 21 367-9

[21] Covington A E 1947 Microwave sky noise Terr. Magnet. Atmos. Electr. 52 339-41

[22] Forsyth P A, Petrie W and Currie B W 1949 Auroral radiation in the 3000-megacycle region Nature 164 453

[23] Chapman R P and Currie B W 1953 Radio noise from aurora J. Geophys Res. 58 363-7

[24] Ellyett C D 1969 Radio noise of auroral origin. J. Atmos. Terrestr. Phys. 31 671-82

[25] Gerasimov V I, Zherebtchov GA and Kurilov V A 1970 SHF radiation of polar atmosphere. Geomagn. Aeron. 10 921-2

[26] Forsyth P A, Petrie W and Currie B W 1950 On the origin of ten centimeter radiation from the polar aurora Canad. J. Res. 28A 324-35

[27] Freund R S 1983 High-Rydberg molecules. Rydberg states of atoms and molecules (eds. R F Stebbings and F B Dunning) (Cambridge : Un. Press) 355-92

[28] Grach S M, Fridman, V M, Lifshits L M, Podstrigach T S, Sergeev E N and Snegirev S D 2002 UHF electromagnetic emission stimulated by HF pumping of the ionosphere Ann. Geophys. 20 1687-91

[29] Avakyan S V 1996 New possible mechanism of sporadic ionospheric radioemissions Abstr. papers present. at the 25-th Gen. assem. URSI, Aug.-Sept France, G1: Ionospheric models and indices p 136

[30] Troitskii V S, Starodubtseva A, Bondar L, Zelinskaya M, Strezhneva K, Kitay M and Sergeeva A 1973Search for sporadic radio emission from cosmic space at centimetres and decimetres wavelengths Radiophys. Quant. Electron. 16 239-52

[31] Avakyan S V, Vdovin A I and Pustarnakov V F 1994 Near-Earth space ionization and penetration radiations Handbook (Saint-Petersburg : Gidrometeoizdat) p 501

[32] Avakyan S V 2006 Space solar patrol: absolute measurements of ionizing solar radiation Adv. Space Res. 37 297-302

[33] Schmidtke, G et al. 2015 Where goes the Thermospheric Ionospheric GEospheric Research (TIGER) Program go? Adv. Space Res. 56 1547-77
[34] Avakyan S V, Kovalenok V V, Savinykh V P, Ivanchenkov A S, Voronin N A, Trchounian and Baranova L A 2015 The role of a space patrol of solar X-ray radiation in the provisioning of the safety of orbital and interplanetary manned space flights Acta Astron. 109 194-202

[35] Binhi V N 2002 Magnitobiology: underlying physical problems (San Diego : Academic Press)

[36] Golubkov G V and Ivanov G K 1991 High-excite states of the molecules N₂, NO, O₂ and elementary processes with their participation. Results of science and Technology, ser. Kinetics and Catalysis 24 82-130

[37] Eigen M and De Maeyer L 1958 Self-dissociation and protonic charge transport in water and ice Proc. Royal Soc., ser. Matem. and Phys. Sci. 247 505-33

[38] Eigen M 1971 Self organization of matter and the evolution of biological macromolecules (Berlin and New-York : Springer-Verlag)

[39] Robin M B 1974 Higher excited states of polyatomic molecules I (New-York and London : Academic Press)

[40] Robin M B 1985 Higher excited states of polyatomic molecules III (Orlando : Academic Press, Inc)

[41] Gallagher T F 1988 Rydberg atoms Rep. Progr. Phys. 51 143-88

[42] Takayanagi K Collision processes involving highly-excited atoms. Comm. Atom. Molec. Phys. N5/6 177-88

[43] Avakyan S V and Baranova L A 2020 Microwave radiations in oncology: about possibility of inhibition of malignant mitosis Russ. J. Biol. Phys. and Chem. 5(4) pp 680-8 (in Russ)

[44] Haroche S and Raimond J M 1985 Radiative properties of Rydberg states in resonant cavities Adv. At. Mol. Phys. 20 347-411

[45] Avakyan S V and Devdariani A Z 2016 Role of Rydberg states and microwave radiation in tropospheric water-vapor cluster formation J. Opt. Technol. 83 327-8

[46] Khalfieva G M, Khalfiev N G and Tagirov I S 1988 Dependence of dynamics of clinic-biochemical reactions of the patients with the rheumatoid arthritis of the geophysical disturbances Influence of solar activity, climate and weather on the human’s health and problems of meteo-prophylactic. Abstr. Republican scien.-pract. Conf. (eds Khamitov Kh S and Gimadeev N M, Kazan : Kazan Medical Institute) 1 111-2

[47] Popov V V, Nutrikhina N N, Korovkina L V and Palkhanova L V 1988 Influence of solar activity on the rheumatoid arthritis occurrence Influence of solar activity, climate and weather on the human’s health and problems of meteo-prophylactic”. Abstr. Republican scien.-pract. Conf. ) eds Khamitov, Kh S and Gimadeev N M (Kazan : Kazan Medical Institute) 1 p 117-8

[48] Lockwood M and Frohlich C 2007 Recent oppositely directed trends in solar climate forcings and the global mean surface air temperature Proc. Royal Society A 463 2447

[49] Montagnier L Aissa J, Del Giudice E, Lavallee C, Tedeschi A and Vitiello G 2011 DNA waves and water J. Phys.Confer. Ser. 306 p 012007

[50] Slesarev V I 2015 Chemistry: The foundation of the living chemistry: Textbook for Univ. (Saint-Petersburg : Chemizdat) (in Russian)

[51] Temuryants N A and Vladimirsky B M 2017 Problems of electromagnetic shielding in biology (Simferopol : The Crimea Univ) p 171 (in Russian)