www.jcimcr.org

JCIMCR OPEN ACCESS Journal of Clinical Images and Medical Case Reports

ISSN 2766-7820

Short Commentary

Open Access, Volume 3

Microwave radiations of environment: On the possibility of inhibition of malignant mitosis

SV Avakyan[1]; LA Baranova[2]*

[1]All Russian Scientific Center "State Optical Institute named after S.I. Vavilov, Birzhevaya line 10, St. Petersburg, 199034, Russia.

[2]Physico Technical Institute after A.F. Ioffe of Russian Academy of Sciences, Politekhnicheskaya st., 26, St. Petersburg, 194021, Russia.

***Corresponding Author: LA Baranova**

Physico Technical Institute after A.F. Ioffe of Russian Academy of Sciences, Politekhnicheskaya st., 26, St. Petersburg, 194021, Russia.

Email: l.baranova@mail.ioffe.ru

Received: Jul 27, 2022

Accepted: Aug 17, 2022

Published: Aug 24, 2022

Archived: www.jcimcr.org

Copyright: © Baranova LA (2022).

DOI: www.doi.org/10.52768/2766-7820/2013

Abstract

From the standpoint of fundamental physical optics, clinical images and medical cases of a number of human viral diseases are considered under the influence of the environment on a sick organism, namely: Solar-geomagnetic disturbances and modern anthropogenic background. Microwave emission of the terrestrial ionosphere disturbed by flares on the Sun and during periods of magnetic storms was determined to be the agent of such an impact, and the anthropogenic influence is associated with the continuously increasing radiation of the microwave flux during the development of mobile cellular communications. Separately, new experimental results on the effect of weightlessness on the mitosis of cancer cells, including those created artificially are being studied. A unified interpretation of these results within the framework of supramolecular physics of the generation of supramolecular structures (water-containing associates) in a living organism is presented.

Proposals for the medical application of irradiation of tumors with a stream of microwaves with spatiotemporal modulation, at an ecologically safe, nature-like level, are discussed for the purpose of possible inhibition of malignant mitosis, taking into account proton transfer, the appearance of highly excited (Rydberg) molecules in the biological media, and the appearance, with induced radiation, of a directed biofield.

Keywords: Microwave emission of the ionosphere; Mobile cellular communications; Viral diseases; Association formation in biological media; Stimulated radiation; Inhibition of malignant mitosis.

Introduction

In [1] a positive experience of predicting the end of the acute stage of covid19 is described based on an analysis of the situation in the current level of microwave radiation of the terrestrial ionosphere according to data on the type of modern sunspot activity. According to [2], p.344, "*during 2020, more than 34 thousand scientific articles were published on the structure, distribution, pathogenesis and possible approaches to the treatment of infection caused by the new SARS-Cov-2 coronavirus. However, no definitive answers to these questions have yet been received…*" In a series of our works since 2016, we rely on the interpretation of the known temporal irreproducibility of biophysical experiments [3], the existence of which was discussed in [4]. This interpretation of the relationship of diseases: Rheumatoid [5,6] and other viral diseases, including HIV [7,8], influenza and covid [1], with the presence of increased microwave fluxes in acute periods after a solar flare and, especially, a magnetic storm from the terrestrial ionosphere. It is important

that the same approach has already been tested in the framework of taking into account the effects of cellular microwave telephony [1], and before that, it actually received experimental verification in applications to the interpretation of weather and climate effects, including the role of the last secular maximum (with the imposition of quasi-centennial, quasi-bicentennial, and possibly quasi-four-hundred-year cycles of solar activity) at the end of the 20th – beginning of the 21st centuries, at the present stage of global warming [5].

In connection with the above, the purpose of this study is to present a possible approach to the analysis of the special role of microwave radiation of ionospheric and anthropogenic origin in clinical oncology. Proposals are given on the ways of inhibition of malignant mitosis based on the use of known experience in the use of irradiation by modulated microwave sources in medical practice. The aim of the work was to explain the results of observations of the impact of the weightlessness effect on the death of cancer cells, described in [9]). These phenomena are briefly discussed in the framework of the supramolecular physics of water-containing associates in biological objects.

It is known that one of the cardinal problems of modern medical biophysics is the lack of sufficient understanding of the bioenergetics of a living organism [10,7,1,3,5]. First of all, this concerns the mechanisms of the influence of external electromagnetic fields on the aquatic environment of organisms. So it is still relevant to consider the assumption of Albert Szent-Györgyi, the Nobel laureate in physiology, formulated 60 years ago that *"interactions between molecules can occur without direct material contact, either through energy bonds or through an electromagnetic field, which, in this way, , is represented by a matrix of biological reactions"* [10]. Today, this issue, in the face of greatly increasing electromagnetic pollution of the environment due to progress in consumer electronics and communications, is even more relevant. The solution for this problem in a wide range of microwaves (in the wavelength range from 1 mm to 10 dm, i.e. in the frequency range from 300 to 0.3 GHz of the electromagnetic spectrum: EHF-UHF-UHF) is presented in [5-8,3], where the mechanism proposed in the framework of the newly developed supramolecular physics, named by analogy with the well-known supramolecular chemistry, is used - chemistry outside the molecule that studies organized ensembles of a higher level of complexity, such as associates of two (or more) molecules held by intermolecular forces [11]. Thus, supramolecular physics is the physics of supramolecular structures outside the molecule, in the evolution of which microwave radiation of external origin participates in the associate clusters, absorbed by the Rydberg excited components of the molecular complex with an increase in its stability. In [6-8,12], the adequacy of the concepts developed by us with quantum mechanical estimates was verified by comparison with the experimental data obtained earlier for tropospheric water-containing clusters [13]. In [14], it was proposed to consider the mechanism [1,2,4,5] as the primary act of hydrogen bonding in chemistry. Thus, we believe that, in fact, it was possible to propose a physical solution to the problem raised in [10] on taking into account the influence of electromagnetic fields on the aquatic environment of a living organism. Our approach involves both body water and the electromagnetic (microwave) field of the environment [1,3,5,6-8], primarily of the ionospheric-cosmic nature. The basis of our approach was the results of [15-17], where a mechanism for the formation of polyatomic Rydberg molecules, including from a water molecule, was proposed, taking into account the experiments in the field of physical optics carried out in [16]. At the same time, it was emphasized in [18] that the studies were carried out both in the gas and in the liquid phases, and more details about the registration of Rydberg excited molecules in the liquid phase, including water, in publications of 1974–2004, were discussed in [19,6]. According to [15], p. 457, in the case of association are known the polyatomic Rydberg molecules: *"… have in common that they can be thought of as being built up from their parent molecules … by adding a proton, which is possible because of their high proton affinity".* The resulting positive ions are neutralized by the capture of an electron into a Rydberg orbital with high values of the principal quantum number n. In these situations, the probability of association processes is determined by the value of the orbital moment (l) of the Rydberg electron: it decreases for small values of l and, conversely, is large for large values of l > 2, while, according to the selection rules, an increase in l per unit occurs with each absorption microwave range quantum from any external source. The point is that, at increased values of l, the electron orbit rarely passes into the ionic core, which reduces the probability of the breakup of the formed associate [17,15]. Thus, under the influence of the flow of microwaves of ionospheric or anthropogenic origin, including, apparently, mobile communications and consumer electronics, there is an increase in association formation in aqueous solutions of living organisms. These publications are used in this work to achieve the goal stated in the title - to present proposals for the possible inhibition of the division of malignant cells in a living organism. The task of the study was to determine the prerequisites for such a possibility and the main details of the scheme of actions. We draw attention to the interdependence between the formation of the microwave *"biofield vector"* and the generation of supramolecular assemblies.

The concept of cellular biofields (inside and between cells) was involved in [20] in the context of the ability to set the direction in "shaping", i.e. in the regeneration of lost organs and the healing of wounds in a living organism, as well as in the division of cancer cells. It was supported by the results of optical-biophysical experiments by A.G. Gurvich [21], in which *"mitogenetic rays"* were discovered in a living organism at the beginning of the last century, i.e. radiation accompanied by the processes of cell growth and division. We can assume an important contribution to this phenomenon is precisely the processes we are considering with the participation of such physical mechanisms that were not taken into account earlier, such as the excitation of the Rydberg states of water and biomaterials, and spontaneous emission, in addition to the induced one, from these states, which, as is well known, lies in a very wide region of the electromagnetic spectrum, including range from UV to radio waves. It was in the UV, visible and IR spectral ranges that this phenomenon continued to be studied in detail, primarily in our country [22], p. 166.

A possible general model description of the physical nature of the phenomenon of *"mitogenetic rays"* is proposed below. At the same time, the authors do not claim to fully consider the details of this phenomenon, but consider it necessary, first of all - at this first stage, to create an original¸ physically adequate

picture and offer a completely consistent step-by-step model representation based on the developed approach (within the framework of the supramolecular physics of associate formation in biological media with the participation of water molecules). To ensure physical consistency with the general meaning of the phenomenon, we state that our approach is entirely consistent, apparently, with the assumption of A.G. Gurvich [21] about the nature of effect carriers as "*…associations of chemically unbound molecules, the existence of which is maintained by a continuous supply of energy."* Indeed, we always involve an external source of "continuous supply of energy" to the studied samples of biological media. This is the flow of microwaves from the terrestrial ionosphere, which changes, firstly, with the change in the time of day from day to night, and secondly, and most importantly, it sharply increases sporadically (up to thousands of times in a global magnetic storm) during solar-geomagnetic disturbances. In addition, this is the microwave (primarily millimeter) part of the thermal background radiation flux in the laboratory at 300 K [23], obviously with the contribution of temperature radiation from the personnel. According to the data of [24], the magnitude of such microwave radiation can be of the same order as our estimates of the flux from the ionosphere give under strong disturbances. It should be recalled that according to [20], pp.188/190, the *"stimulating effect of mitogenetic rays"* is extremely important ... at the stage ... of *"preparation for mitosis and the mitosis cycle itself, which, as we know, can be characterized as the most striking manifestation of "structured processes""*. Therefore, structuring, including association formation, is the determining process in the phenomenon of A.G. Gurvich.

So, the scheme of phenomena of A.G. Gurvich is proposed to be described as a set of the following successive events involving the mechanism of absorption of electromagnetic (microwave) radiation in the substance of a living organism containing water molecules, i.e. aquatic biological media:

1). Proton transfer between water molecules [15,16] with the appearance of an excited electron, which is always captured on a highly excited Rydberg orbital in the process of neutralizing the positive charge of a newly formed aggregate with a proton.

2). Absorption of a quantum of microwaves from a stream of external origin, leading to the transition of a Rydberg electron to a level with an increased value of the orbital quantum number l by one, which ensures an increase in the probability of formation of a stable associate.

3). The emergence of induced radiation (emission) of quanta of the same frequency and in the same direction, which had microwave radiation of external origin.

4). Spontaneous emission of UV, visible and IR quanta in electric dipole transitions from Rydberg states with an intensity maximum arising from changes from nl to the state n'=l, l'=l – 1 [25], p.183.

Recall that the probability of spontaneous transitions is much lower than the probability of induced ones, but it always takes place [15,23]. In general, according to [26], p. 424/5, the probabilities of radiative transitions are usually greater in cases where n and l change in the same direction (this is just our case). In addition, for large l, the transition probability is higher for $\Delta n = 1$ than for $\Delta n \geq 2$. But it should also be taken into account that, due to the quadratic dependence on the transition frequency, they have relatively large values for transitions between far-spaced levels.

We assume that the microwave component of the biofield is formed inside the body as *a stream during the induced emission of quanta of the same frequency, in the same direction as the radiation of external origin.* This is due to the fact [15,23] that the microwave frequency quanta between the Rydberg states already in the mm range (and even more so in the long wavelength: cm and dm spectral intervals) almost completely fall into the radiation region, where the matrix elements *are very large electric dipole transitions between neighboring levels* (due to their extremely close location). And simultaneously observed in a series of experiments like [20,21] broadband optical (in the UV, visible and IR range) [22], p. 165, is generated in our opinion in spontaneous electric dipole transitions (in accordance with the known Einstein's equation (1916), see, for example, [26], p. 394) from Rydberg states with a maximum intensity when changing: from nl to the state n'=l, l'=l – 1 [25]. Thus, *"mitogenetic rays"* can apparently also be attributed to a large extent to spontaneous emission [23]. Recall that the probability of spontaneous transitions for a given n strongly depends [27] on l. For small l, the radiative lifetime is proportional to n^3, and for high l, it is proportionally narrower than n^5, i.e. for small l, the lifetime is much shorter than for large ones. In the first approximation, this means that (with other similar conditions) the emission of UV quanta occurs n^5/n^3 times more often than IR quanta, i.e., for example, already at n ~ 10, the output of UV quanta will be two order higher than the IR quanta. It was found in [20] that UV radiation constitutes the main part of *"mitogenetic rays"*. It is important that these *"mitogenetic rays"* were attributed to participation in "shaping", i.e. in the regeneration of lost organs and wound healing in a living organism, as well as in the division of cancer cells [20,21]. According to [28], p. 380, *"the task of shaping is the main problem of biology in the 21st century."*

Associate formation in aqueous biosolutions under microwave exposure

In the proposed approach to the biophysics of aqueous biosolutions [5-9], taking into account the known quantum-electron-molecular processes:

- both body water and the electromagnetic field of the environment are involved;

- introduced the mechanisms of induced emission of electromagnetic (microwave: EHF-UHF-UHF) radiation and collisional nonradiative transfer of excitation energy from water associates to biomaterial molecules, including DNA, in a liquid medium [6].

The proposed physical mechanisms have been developed in detail since 2004–2007. in S.I. Vavilov State Optical Institute as part of the research program in the field of physics of solar-terrestrial relations, taking into account a new factor of influence - microwave radiation of the earth's ionosphere, including during periods of manifestations of solar flare activity and during geomagnetic storms [19,29].

Why was it necessary to take into account the microwave fluxes from the ionosphere? The fact is that in numerous space experiments, by now, the efforts of world science have determined the variations of all energy flows associated with solar and geomagnetic activity [30,31]. The results obtained indicate that these flows do not reach the lower atmosphere and, therefore, the direct impact of the effects of solar flares and magnetic storms on the biosphere and the lower layers of the atmosphere (the troposphere and its weather and climate char-

acteristics) is impossible. At the same time, dozens of domestic and foreign radiophysical measurements at ground-based observatories revealed microwave radiation of the terrestrial ionosphere during periods of solar flares and magnetic storms (auroras) (for example, [32,33]), but its nature was undetermined. We proposed [34], as a model mechanism for the generation of this radiation, to take into account the well-known, as the most effective, channel for excitation of Rydberg states of atoms and molecules for gases in the upper atmosphere - electron impact by fast electrons. They arise when the ionosphere is ionized by the flux of X-ray and extreme UV radiation from solar flares [34] and (during periods of magnetic storms) by electron fluxes precipitating from the Earth's radiation belts and directly from the geomagnetosphere. Microwave emission radiation is generated in allowed electric dipole transitions between sublevels of the fine structure of highly excited - Rydberg levels at $n \geq \sim 10$ with a change (decrease) in the orbital quantum number (l) by one, as well as in transitions with a slight decrease in n [29].

Ground-based measurements in the USSR [33] showed that during solar flares, the signal from the microwave radiation flux of the terrestrial ionosphere exceeded the intensity of the microwave flux from the quiet Sun by a factor of 2–40 (at a wavelength of 50 cm). The burst width reached 1 GHz. Then the flux of ionospheric microwave radiation at a wavelength of 50 cm during a solar flare is, according to measurements [33], ~ $3\text{-}70 \bullet 10^{-16}$ W/cm^2. During magnetic storms, such observations were made in the aurora zone [32]. During a magnetic storm, the flux can increase up to $10^{-11} – 10^{-12}$ W/cm^2 [35]. This is orders of magnitude higher than the threshold of sensitivity of biological objects to microwaves [36], p. 142. The sources of sporadic enhancement of the microwave flux from the ionosphere are mainly associated with auroral disturbances. It is known to be strongest in the region of the aurora oval (~67^0 geomagnetic latitude), where auroras are observed almost constantly [37], varying in intensity by 4 orders of magnitude. During global magnetic storms, a second maximum occurs at middle latitudes (associated with precipitation of electrons from radiation belts), which has been reliably recorded in long-term manned space flights [37]. This fact is confirmed by direct ground-based measurements of the ionospheric microwave radiation flux [38]. Important in taking into account the source of microwaves in the ionosphere for the physics of solar-terrestrial relations in application to biophysical problems are two circumstances:

1) the flux of microwave ionospheric radiation is proportional in terms of energy to both the flare power and the strength of the storm, that is, it well reflects the degree of current solar-geomagnetic activity;

2) the entire spectrum of microwave radiation of solar and ionospheric origin almost freely (with the exception of five narrow absorption bands) penetrates to the earth's surface, including the biosphere.

At the same time, our new approach made it possible to take into account the role of water molecules in solving the most important problems of modern physics of solar-terrestrial relations: - the influence of global magnetic storms on the state of liquid media in the human body and - contribution to the current global climate warming of the greenhouse effect on optically thin (warming up the air of the surface layers of the troposphere) clouds. Indeed, both the global increase in surface air recorded in recent decades [39], and numerous factual data on the role of solar flares and geomagnetic storms in the deterioration of the well-being of the human body, weakened by various diseases, are the subject of increased attention of physicists, biophysicists, and physicians. However, before our work, there were no real results on how to account for a greenhouse effect on water vapor in the troposphere, and the assessment of quantitative effects on the contribution of the structuring of the aquatic environment in a living organism, although it is water molecules that are the main greenhouse gas in the troposphere, and in the human body liquid water is 70% or more by volume and more than 90% by volume the number of molecules.

Possible role of the ionospheric-space microwave flow in the evolution of earth life

We proposed to consider the origin of terrestrial life from the time of its origin and its entire further evolution taking into account microwave radiation of an ionospheric-cosmic nature [40]. This is substantiated by the results of the analysis carried out in [40], which takes into account known approaches to model descriptions of the origin and evolution of life both directly on the early Earth and when it is introduced from space (in the atmospheres and nuclei of comets, on asteroids, and in meteorites). Microwave radiation of the earth's ionosphere always affects - both in calm conditions and in any periods of increasing fluxes of that ionizing radiation from space, which is absorbed in the earth's upper atmosphere, while it can affect the concentration of complex supramolecular structures. This is due to the indispensable excitation of highly excited (Rydberg) states of the electron captured by the Coulomb field when the positive charge of the resulting associate is neutralized. Therefore, such an electron is able to absorb quanta of the external field of microwaves: from the environment, first of all, coming from the ionosphere, as well as, for example, microwave solar radiation. At the same time, a set of experiments already performed confirms that microwave radiation, especially of the lowest intensity and with amplitude modulation at frequencies of a few and tens of Hz, causes consistently observed association effects in the synthesis of organic matter, as well as bioeffects in living media: from stimulating the growth of cyanobacteria (according to apparently the first living beings on the ancient Earth), prokaryotic and eukaryotic photosynthetic organisms [41]. For the purposes of our work, it is important that the early ("young") Sun emitted a flux of soft X-ray and extreme UV radiation about hundreds to a thousand times stronger [42] (compared to the current Sun)). Such streams produce ionospheric disturbances in the degree of ionization of the medium by several tens of times, and, according to our estimates [40], in the degree of optical and microwave (Rydberg) excitation of the ionosphere, up to 500 times. However, in the life of the Sun, as well as other stars of this type, no serious cataclysms are known, but a gradual evolution takes place. Therefore, it is very important that if ionizing and penetrating radiation usually leads to the destruction of organisms in the biosphere, then microwave radiation is capable of generating life through the stimulation of the formation of complex from simpler ones. The analysis presented in [40] leads to conclusions that are very important for determining the possibilities of controlling the inhibition of cell division in malignant and benign mitosis under the influence of microwave fluxes of a nature-like level:

1). The era of the appearance and evolution of terrestrial life corresponded to a reduced intensity of the Calactic Cosmic Rays - GCR, the main natural factor responsible for the optimal intensity of the formation of significant mutations in cells under modern conditions. Therefore, the obviously low values of microwave fluxes that are planned to be used in the proposed

therapy allow us to expect that non-malignant, healthy cells will not respond at the same level, given their acquired adaptability to changes in environmental stimuli, including disturbances in the earth's ionosphere, developed in the process of evolution.

2). Life on Earth has always been affected by the microwave flux from the ionosphere, on an absolute level and with magnitudes of variation no less (and usually greater) than at present. The high level of microwave flux from the early Sun and, especially, from the ionosphere, the presence of almost the highest values of proton affinity for the main components (water molecules, ammonia and methane) of the hypothetical atmosphere on the ancient Earth, allow us to suggest the possibility of physical and chemical self-organization in its atmosphere and reservoirs according to the scenarios of supramolecular chemistry, physics and biophysics [14]. By the way, the upper layers of water of any open reservoirs are under permanent irradiation with microwaves of ionospheric-cosmic nature at depths of at least fractions of a mm to one and a half tens of cm (in positive dependence on the value of the radio wave length).

Inhibition of malignant mitosis microwave irradiation

In [43], p. 4, the paradox of modern oncology is formulated as follows: *"three active levers for reducing mortality (prevention, early diagnosis and adequate effective treatment) do not work or are ineffective, despite enormous intellectual and financial efforts…".* As a result, the authors substantiate the need for the prevention of metastatic disease already at the earliest stages of treatment. But in most cases, an oncologist determines the presence of a tumor in the 7–10th year of asymptomatic, latent growth up to a size of ~1 cm^3, which is dictated by the real possibilities of modern diagnostics [43]. At the same time, surgical trauma during removal of the primary tumor may be accompanied by the activation of dormant ("dormant") tumor cells [43]. Therefore, in our opinion, it is the development of new non-invasive methods of effective treatment, including methods for inhibiting the process of cancer cell division by microwave irradiation, that is most relevant. We propose to try to slow down the process of malignant cell division by irradiation with microwaves, when the value of the orbital quantum number l increases. This, as shown in [1,3,4,5-8], leads to an increase in the yield of associates. Microwave irradiation simultaneously increases cohesion - adhesion, attraction of molecules in a biological medium, due to the intermolecular interaction of highly excited Rydberg atomic-molecular particles, which have a high polarizability [44]. So, microwave irradiation, firstly, accelerates the process of association formation in aqueous biosolutions, and secondly, increases their cohesion. *"Cancer cells have a lower degree of organization, and at the same time, a lower degree of water structure"* [45], p. 148, they also have low cohesion, since it "…is typical for the active state (intense fission), while high cohesion is for the state of rest" [46]. It is important that the author of [10,45,46], Albert Szent-Györgyi, actually foresaw our approach within the framework of supramolecular physics (i.e., with the inclusion of the proton transfer and capture of an electron in the associate formation process, which neutralizes the positive charge arising from the appearance of a proton, to a high-lying Rydberg orbit): *"The notion of charge transfer brings into play excited levels that were previously considered inaccessible, because usually the energy required to raise an electron to an excited level of the molecule to which it belongs is too high"* [46] while discussing the possibility that *"the massiveness of the reacting molecules favors charge transfer."* Within the framework of supramolecular physics, a Rydberg electron actually appears immediately at an energy level of ~> 10 eV, and the Rydberg molecule of both a water associate and biomaterials is relatively large.

Microwave therapy experiments with low frequency modulation

Microwave radiation has long been used in physiotherapy, and it has been shown that:

1). More efficient pulsed microwave radiation. One of the first works in this direction was [47], where the radiation of a microwave source with a frequency of 30–300 GHz of low intensity (from 50 μW) could be modulated in a wide range of low frequencies from 1 to 1000 Hz. Treatment with pulsed EMF shows a therapeutic effect of 77-85% (with the restoration of connective tissue) [48]. However, the most widely studied application is in bone repair and acceleration of healing of fresh fractures, delayed and non-union, bone grafts, osteoporosis and osteonecrosis, as well as restoration of cartilage and soft fibrous tissues. In all of these experimental systems and clinical applications, acceleration of extracellular matrix synthesis and tissue healing was observed. In [49], it was confirmed in experiments that the stimulating effect of modulation at frequencies less than 100 Hz during microwave irradiation on the development of pathological effects. A recent study by Global Quantech [51] confirms that irradiation with low-intensity EMR causes inhibition of tumor growth and suppression of the viability of cancer cells by more than 1.5 times due to molecular structuring of the aqueous medium of a living organism;

2). Important, as it follows from our concept, is the geometric direction of the microwave action, which determines the effect of the given direction in the stimulated emission of a microwave flux in a living environment. In this regard, the details of recent experiments on the effect of artificial weightlessness on the death of up to 90% of cancer cells are of interest [52]. The author of these studies, Dr. Joshua Chou (University of Technology Sydney) believes that they violate the commonality - the communication of cells with each other: *"...it stops them communicating with each other.",* see also review [53] with his participation. In [54], the results of the study of the mechanisms of cellular gravisensitivity are presented. These laboratory models for experiments with cultured cells usually always include [54], p. 39, unidirectional or multidirectional rotation of the object under study around one or more axes: fast (90 rpm), and slow (6 -10 rpm). Under the conditions of orbital space flights, i.e. also in the absence of gravity, experiments were repeatedly carried out to determine the effect of weightlessness on cancer cells, but the decrease in their viability did not much exceed 10 -15%. Such quantitative differences between the results of ground-based [52] and orbital experiments are apparently associated, in accordance with the concept of supramolecular physics, with the prevailing role of irradiation by directed microwave beams. To use these experimental facts in the present work to substantiate specific proposals on the possibility of inhibition of malignant cell division, more detailed information on the degree of shielding from the flow of ionospheric microwaves is required. The presence or absence of a metal container in the first case and the location of the experimental samples on board the space station relative to windows that are transparent to the ionospheric microwave flux in the second case are important, since orbital flights always take place within the earth's ionosphere. Inside the International Space Station, its own total variably directed microwave flow is also formed from computers, functional, scientific and household appliances, and micro-

wave communications. This microwave (primarily millimeter) part of the thermal background radiation flux in the laboratory compartment with the contribution of temperature radiation from personnel. In the latter case, according to the data of [24], the magnitude of such microwave radiation can be of the same order (~10^{-11} W/cm^2•GHz), which is also given by our estimates [5,35] of the flux from the ionosphere during geophysical disturbances (up to ~10^{-10} W/cm^2). All these are ecologically safe, nature-like levels, in addition, the condition of proximity of the flux intensities is satisfied, which is necessary for the possible participation of the phenomenon of stochastic resonance in enhancing the effect of irradiation in a narrow band from an anthropogenically caused source of microwaves due to the collection of energy of natural electromagnetic emission (microwave) radiation of the disturbed terrestrial ionosphere [55,4].

Conclusion

1. Within the framework of the modern interpretation of *heliobiology,* a science developed a century ago by the great Russian scientist A.L. Tchijevsky, proposed a new agent of solar-terrestrial relations: microwave radiation of the terrestrial ionosphere. It exists almost constantly, sporadically increasing during periods of increased solar-geomagnetic activity, especially during magnetic storms and solar flares. For more than two decades, we have been conducting research on the introduction of this agent of solar-terrestrial physics to take into account its role in the association formation of water molecules when solving the most pressing problems of modern physics of solar-terrestrial relations: the effect of global magnetic storms and solar flares on the state of liquid media in the human body, and on the formation of optically thin (and always warming up the air in the surface layers of the troposphere) cloudiness, which makes an important contribution to modern global warming.

2. Prior to our work, there were no practical results both on taking into account the greenhouse effect on water vapor in the troposphere, and on a quantitative assessment of the contribution of structuring the aquatic environment in a living organism [3,5,6], although it is water molecules that are the main greenhouse gas in the troposphere, and in more than 70% liquid water in the human body. The article presents an approach to biophysical problems based on known quantum-electron-molecular processes from physical optics [1,3,5-9]. At the same time, both the water of the body and the electromagnetic (microwave) field of the environment are considered, and for the first time the mechanisms are introduced into biophysics: induced emission of strictly directed electromagnetic (microwave: EHF-UHF-UHF) radiation in the liquid medium of a living organism, as well as the processes of collisional nonradiative transmission potential energy of Rydberg excitation from water associates to molecules of biomaterials, including DNA [3,7,8].

3. The research carried out in the article on a number of experimental results published in recent decades, as well as taking into account the original approach to biophysical mechanisms during electromagnetic irradiation of water-containing biological media of a living organism, led us to the conclusion that it is promising to set up work to determine effective modulation frequencies and amplitudes for nature-like, intensity-corresponding to ionospheric levels of microwave exposure, which may be able to inhibit the mitosis of malignant cells in each organ [9]. The deliberately low fluxes used in such treatment allow us to expect that non-malignant, healthy cells will not respond to an abnormal proliferation regime, given their adaptability to changes in environmental stimuli, developed in the process of evolution against the background of a relatively low natural mutational effect created by GCR on ancient Earth. Therefore, according to our concept (within the framework of supramolecular physics), a cancer cell, apparently, will be more susceptible to microwave therapy with effective modulation frequencies and amplitudes than a healthy one. The effects of accelerating the synthesis of the extracellular matrix and tissue healing, registered in [47,48] in experimental systems and clinical applications, also make it possible to expect that microwave irradiation in an effective therapeutic regimen will reduce the levels of those tumor inflammations that often hamper anticancer therapy [43]. In addition, since surgical trauma during removal of the primary tumor may be accompanied by the activation of dormant ("dormant") tumor cells, it seems that the most relevant is the development of non-invasive methods of effective treatment, including, in our opinion, the proposed methods for inhibiting the division process. cancer cells by irradiation with a stream of microwaves with spatiotemporal modulation.

References

1. Avakyan SV, Baranova LA. Microwave emissions and the problem of modern viral diseases. Herald Rus. Acad. Sci. 2022; 92: 177-187.
2. Efimenko AYu, Kalinina NI, Rubina KA, Sumina EV, Sysoeva VYu, et al. The secret of multipotent mesenchymal stromal cells as a promising tool for the treatment and rehabilitation of patients with a new coronavirus infection. Herald Rus. Acad. Sci. 2021; 91: 344-350.
3. Avakyan SV, Baranova LA. The influence of microwave radiation from the geocosmos on the state of a living organism // IOP Conf. Ser.: Earth Environ. Sci. 2021; 853: 012003.
4. Binhi VN. The principles of electromagnetic biophysics. Moscow, Fizmatlit. 2011 (In Russ).
5. Avakyan SV. Environmental supramolecular physics: Climatic and- biophysical effects. Herald Rus. Acad. Sci. 2017; 87: 276-283.
6. Avakyan SV, Baranova LA. The influence of environmental electromagnetic radiation on associate formation in aqueous solutions. Biophysics. 2019; 64: 7-13.
7. Avakyan SV. Supramolecular physics of the ionosphere - biosphere links. In: Proc. of the 11th International School and Conference "Problems of Geocosmos" (Oct. 03-07, 2016, St. Petersburg, Russia). Eds. by VS Semenov, MV Kholeva, SV Apatenkov, NYu Bobrov, AA Kosterov, AA Samsonov, NA Smirnova, TB Yanovskaya. SPbSU. Saint Petersburg. VVM Publ. 2017; 180-186.
8. Avakyan SV, Baranova LA. How does the geocosmos control the biosphere? 1. Formation of associates in high delited water biosolutions under the influence of the microwave flux from the ionosphere. 2. DNA, ionospheric microwaves and water. In Books of Abstracts. 12th Int. Conf. and School "Problems of Geocosmos". (Oct. 8-12, 2018. St. Petersburg, Russia). Eds. by VS Semenov, SV Apatenkov, et al. SPbSU. Saint Petersburg. VVM Publ., 2018; 135-136.
9. Avakyan SV, Baranova LA. Microwave radiations in oncology: About possibility of inhibition of malignant mitosis. Actual.Vopr. Biol., Fiz. i Khim. 2020; 5: 680-688. (In Russ).
10. Szent Györgyi A, Bioenergetics NY. Acad. Press Inc. 1957.
11. Lehn JM. Supramolecular chemistry. Concepts and Perspectives. Weinheim NY, Basel, Cambridge, Tokio, VCH Verlagsgesllschaft mbH. 1995.
12. Avakyan SV, Devdariani AZ. The role of the Rydberg states and

microwave radiation in the tropospheric clusterization of a water vapor. J. Optical Technology. 2016; 83: 327-328.

13. Ivlev LS. Aerozol impact at the climate processes. Optics of the atmosphere and ocean. 2011; 24: 392-410. (In Russ).

14. Avakyan SV, Baranova LA. Molecular protonics and supramolecular chemistry, physics and biophysics. Invited Lecture. Book of Abstracts of XXI Mendeleev Congress on general and applied chemistry, Symp. of UNESCO "Self-Assembly and Supramolecular Organization". Saint Petersburg. 2019; 6: 216.

15. Gallas JAC, Leuchs G, Wallher H, Figger H. Rydberg atoms: High-resolution spectroscopy and radiation interaction-Rydberg molecules. Adv. At. Mol. Phys. 1985; 20: 413-466.

16. Dabrowski I, Herzberg G. The electronic emission spectrum of triatomic hydrogen. 1. Can. J. Phys., 1980; 58: 1238-1249.

17. Bates D.R. Electron-ion recombination in an ambient molecular gas. J. Phys. B. At. Mol. Phys. 1981; 14: 3525-3534.

18. Herzberg G. Rydberg molecules. Annu. Rev. Phys. Chem. 1987; 38: 27-56.

19. Avakyan SV, Physics of the solar–terrestrial coupling: Results, problems, and new approaches. Geomagn. Aeron., 2008; 48: 417-424.

20. Gurwitsch AG. The principles of the analytic biology and the theory of cellar fields. Moscow, Nauka. 1991 (In Russ).

21. Gurwitsch AA. The problem of mitogenetic emission as aspect molecular biology. L Medicine. 1968 (In Russ).

22. Samoilov VO. Medical biophysics. Textbook for the Universities. 3rd edition. Saint Petersburg, Spets Lit. 2013 (In Russ).

23. Haroche S, Raimond JM, Radiative properties of Rydberg states in resonant cavities. Adv. At. Mol. Phys., 1985; 20: 347- 411.

24. Gulyaev Yu. V. The physical fields and radiation of human: new methods medical diagnostics. Science and culture: The elect lectures. Saint Petersburg, BAS, 2009; 171-207. (In Russ).

25. Smirnov BM. Exited atoms. Moscow. Energoizdat. 1982 (In Russ).

26. Frish SE. Optical spectra of atoms. Fizmatgiz, Moscow-Leningrad. 1963 (In Russ).

27. Kleppner D. An introduction to Rydberg atoms. Atoms in unusual situations (Ed. J.P. Briand). NATO ASI. ser. B. 1986; 143: 57-76.

28. Gall' LN. Physical principles at the functioning of the substance for living organism. Saint Petersburg, Publishing-house of SPbPU, 2014 (In Russ).

29. Avakyan SV. New possible mechanism of sporadic ionospheric radioemissions. Abstracts of papers presented at the 25-th General assembly of URSI. August-Sept. 1996. France. G1. Ionospheric models and indices,1996, p. 136.

30. Avakyan SV, Vdovin AI, Pustarnakov VF. Near-Earth space ionization and penetration radiations. Handbook. Saint Petersburg, Gidrometeoizdat, 1994; 501. (In Russ).

31. Schmidtke G, Avakyan SV, Berdermann J, Bothmer V, Cessateur G, et al. Where goes the Termospheric Ionospheric GEospheric Research (TIGER) Program do? Adv. Space Res., 2015; 56: 1547-1577.

32. Forsyth PA, Petrie W, Currie BW. On the origin of ten centimeter radiation from the polar aurora. Can. J. Res. 1950; 28: 324-325.

33. Troitskii VS, Starodubtsev AM, Bondar' LN, Zelinskaya MR. Strezhneva KM, et al. Search for sporadic radio emission from cosmic space at centimetere and decimetere wavelengths. Radiophys. Quant.Electron. 1973; 16: 323-341.

34. Avakyan SV, Serova AE, Voronin NA. The role of Rydberg atoms and molecules in the upper atmosphere. Geomagn. Aeron. 1997; 37: 331-335.

35. Avakyan SV, Voronin NA. Possible mechanisms for the influence of heliogeophysical activity on the biosphere and the weather. J. Opt. Technol., 2006; 73: 281-285.

36. Binhi VN. The magnitobiology. Experiments and models. Moscow, MILTA.2002. (In Russ).

37. Avakyan SV, Evlashin LS, Kovalenok VV, Lazarev AI, Titov VG. The observations of aurora from space. L., Gidrometeoizdat. 1991 (In Russ).

38. Burenin AN, Klimenko VV, Osipov NK, Chernov AA. SHF radio emission of auroral ionosphere and the oval of aurora. Geomagn. Aeron. 1981; 21: 367-369.

39. Avakyan SV. The Role of solar activity in global warming. Herald of the Russian Academy of Sciences, 2013; 83; 275-285.

40. Avakyan SV. Metodology of VI. Vernasdsky, historiometricity and heliobiology of A.L. Tchijevsky, ethnogenes of L. N. Gumilev and the modern solar-terrestrial physics. In Proc. V.I. Vernadsky and noospheric paradigm of the development of the society, science, culture, edication and economics at XXI century: collective monography. Scientific Eds. by A. I. Subetto and V.A. Shamahov. 2013; 2: 245-256. Saint Petersburg. Asterion (In Russ).

41. Tambiev AH, Kirikova NN, Betsky OV, Gulyaev YuV. Millimeter waves and photosynthesis organisms. Eds. Gulyaev Yu V, Tambiev AH, Moscow, Radiotehnics. 2003 (In Russ).

42. Tehrany MG, Lammer H, Selsis F, et al. The particle and radiation environment of the early Sun. The 10th European Solar Physics Meeting, 9 - 14 Sept. 2002. Prague. Czech Republic. Ed. A. Wilson. ESA SP-506. Noordwijk. ESA Publications Division. 2002; 1: 209 - 212.

43. Ashrafyan LA. Kiselev VI. Modern oncology, molecular biology and the perspectives of effective therapy. Moscow, Molodaya gvardiya, 2015 (In Russ).

44. Gallagher T. Rydberg atoms. Rep. Prog. Phys.1988; 51: 143-188.

45. Szent Gyorgyi A. Bioelectronics. A study in cellular regulations, defense, and canser. NY, L. Academic Press Inc. 1968.

46. Szent Gyorgyi A. Introduction to a molecular biology. NYL. Academic Press Inc. 1964

47. Avakyan RS. Gabrielyan GG, Madosyan LV, Melikyan RL, Taube AL, et al. Device "Artchah" for microwave resonance therapy. Electronic industry. 1990; 12: 30-31. (In Russ).

48. Aaron RK, McK Ciombor D, Therapeutic effects of electromagnetic fields in the stimulation of connective tissue repair. J. Cell Biochem. 1993; 52: 42-46.

49. Pakhomov AG, Murphy MB. Comprehensive review of the research on biological effects of pulsed radiofrequency radiation in Russia and the former Soviet Union. In: Advances in Electromagnetic Fields in Living System, V.3 (J. C. Lin, ed.), Kluwer Academic/Plenum Publishers, New York. 2000; 265-290.

50. Bandara P, Carpenter DO. Causes of cancer: Perceptions vs. the scientific evidence // European J. of cancer. 2020; 124: 214-216. Doi.org/10,.1016 j.ejea.2018.03.029

51. Smirnov I. The effect of low intensity electromagnetic fields on water molecular structure and its medical applications. Book of Abst. of Third Int. confer. Physics – to sciences about life. 2019,

SPb., Ioffe Inst. 2019; 113.

52. Space the new frontier in the battle against cancer. 2019; ABC News.

53. Bradbury P, Wu H, Choi JU, Rowan AE, Zhang H, Poole K, et al. Modeling the Impact of Microgravity at the Cellular Level: Implications for Human Disease. //Front. Cell and Developmental Biol. (21.02.2020) 8: 96.

54. The mechanisms of the cellular gravisensitivity. Ed. by L.B. Buravkova). Moscow. GNTCH RF IMBP RAS. 2018 (In Russ).

55. Makeev VM. Stochastic resonance and its possible role at live nature. Biophysics. 1993; 38: 194-201.