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From the researcher's notebook

Microwave Emissions and the Problem of Modern Viral Diseases

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Abstract—The results of a study on the mechanisms of the influence of an increased level of microwave radiation on the growth of infectious, primarily viral, diseases in the environment are presented. This is the radiation of the earth's ionosphere, which reached its maximum in the late 1980s–early 2000s, following an increase in the level of solar activity since the 17th century. Over the past 30 years, the anthropogenic electromagnetic background has increased 100 times due to the development of cellular mobile communications and computerization. The predicted interaction of natural and anthropogenic sources of microwaves sharply increases their negative impact on the ecological situation. Of particular concern is the active spread in recent years of the new 5G communication standard; in the future, it is the development of the most dangerous millimeter range in our country.

Energy from the environment in the microwave range can cause "unexpected behavior" in the DNA of viruses. Clarifications to the recommendations of experts on the protection of the population with the help of electromagnetic shielding, obtained in the framework of supramolecular physics of the environment, are proposed.

Keywords: microwave radiation of the ionosphere, cellular communication systems, flu viruses, AIDS, Covid infections, protection of the population

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The main sources of microwave radiation are the increasing anthropogenic electromagnetic background, mainly due to the operation of cellular radio networks in the microwave range; microwave EHF, SHF, and UHF radiation of the earth's ionosphere at frequencies of 300–0.3 GHz (wavelengths from 1 mm to 10 dm), disturbed during periods of increased solar–geomagnetic activity, including during solar flares and magnetic storms. Such radiation in the period 1985–2003 reached peak values, which was associated with the cumulative secular maximum (with the superposition of quasi-centenary, quasi-bicentennial, and, apparently, about four hundred-year cycles) of solar–geomagnetic activity [1–3].

During 2020, more than 34000 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, definitive answers to these questions have not yet been obtained. Real manifestations of viral pandemics (epidemics of grippe, influenza, and "Spanish flu"), which can be associated with the impact of radio waves, were observed already in the second decade of the 20th century with a peak in 1918–1920 [4, 5]. Based on our hypothesis, this could have been facilitated not only by the rapid development of radio communications themselves but also by the increase in the number of large geomagnetic storms recorded by magnetic observatories after 1912 (even at the minima of the solar eleven-year cycle). From that time until 2009, no years were recorded on the Earth with an absence of global magnetic storms. This means that the Earth's ionosphere has been regularly invaded by flows of corpuscles, mainly electrons from the radiation belts and directly from the geomagnetosphere, for a century. Real geomagnetic activity, primarily in terms of the number of global magnetic storms, has been constantly increasing, reaching an annual maximum in 2003 of more than 70 large storms. An analysis of data on the known sunspot manifestations of solar activity and the appearance of the results of first episodic and then patrol space experiments made it possible to establish the presence of long quasi-centenary, quasi-bicentennial, and about four hundred-year cycles. The cumulative maximum of the overlap of these cycles probably determined the appearance of the absolute solar activity

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peak in 1985–1987. We emphasize that it is true solar activity that is meant, when the absolute value of the total radiation flux from the entire solar disk increases, ionizing the earth's upper atmosphere in the extreme UV and soft X-ray ranges under background conditions and, especially, during periods of flares, the number and power of which also increase. Spot activity indices are completely ineffective here and only confuse the situation. It suffices to point out the behavior of 11-year maxima in the number of sunspots in the last 100 years, when the absolute peak in the number of sunspots occurred in 1958, and the peak of true solar activity was recorded by spacecraft 27–29 years later [1–3].

The impossibility of measuring the true parameters of the electromagnetic and corpuscular activity of the Sun before the beginning of the era of rocket and space experiments (since 1946) did not allow A.L. Chizhevskii, an active researcher into the influence of electromagnetic disturbances of the environment on the occurrence of epidemics [4], to compare solar–geomagnetic activity and specific pandemics directly. The works [4, 5] provide direct indications of the existence of such a relationship both in the case of the influenza virus and for a number of other epidemic diseases. The duration of the influenza epidemic in each eleven-year solar period is, on average, four years, and the peaks within this cycle fall both at the maximum and at the minimum of sunspot activity. This corresponds to modern data [1] on the same distribution of the main source of microwaves from the ionosphere—global magnetic storms. It was also assumed that centimeter and millimeter radio waves can be agents of influence [4, p. 206].

Geocosmos and mechanisms of solar–biospheric relations. Despite the world-famous studies on the role of the environment in physiology by brilliant Russian scientists (I.M. Sechenov, V.I. Vernadsky, and A.L. Chizhevskii), as well as similar foreign works, until recently, neither the main heliogeophysical factors nor the main physical mechanisms of the impact of the geocosmos on living organisms, including humans, were clear. Sechenov generally included the concept of the environment in the concept of the organism, believing that the organism is inseparable from the external environment.

Vernadsky stated, "In science, as in life (in the history of mankind and an individual), one cannot break away from the "environment," which, in fact, is the recognition of the causal connection of all phenomena; there is a reduction of phenomena to a single one; there is a unity of reality" [6, pp. 45, 46]. Academician L.A. Orbeli formulated the problem this way [7, p. 61]:

> The organism and the environment are something inseparable and are in unity and in interaction. If we remember this and take into account the fact that the entire course of development of certain functional relations proceeded in a certain environment, eternally changing, eternally influencing living organisms, then it becomes clear that not a single function could take shape and undergo certain changes otherwise, both under the influence of and depending on those influences of the environment to which it was constantly exposed.... We have to reckon with both internal factors, emanating from the organism itself in the form of the interaction of its individual parts, and external factors.

Accounting for the environment and its effects on organisms, organs, and cells is the key direction of research in natural science according to Vernadsky and Orbeli. This is what lies at the basis of Chizhevskii's scientific discoveries in heliobiology [4], which is fully consistent with the paradigm of modern physics of solar–terrestrial relations. So the study of cosmophysical influences has deep historical roots and is traditional for classical Russian physiology [7, 8]. For example, a positive correlation (up to 80%) of electroencephalography (EEG) data with geomagnetic activity was found. Changes in the homeostasis system turned out to be the more significant, the more intense the magnetic storm. A negative correlation was observed for some local indicators of EEG synchrony with various indices of solar activity. In this case, the correlation was much weaker, but the microwave flux from the ionosphere during flares (the highest manifestation of solar activity) is 10–100 times less than during a magnetic storm. The weak correlation of effects with solar activity is also understandable, since the experimentally recorded values of microwave fluxes from the ionosphere in such periods are already at a level close to the threshold of sensitivity of biological objects to microwaves.

Until recently, there was no clear understanding of bioenergetics: what is the mechanism of the impact of external electromagnetic fields on the body? Therefore, it is still relevant to consider the assumption formulated 60 years ago by Albert von Szent-Györgyi, a Nobel laureate in physiology, that "interactions [between molecules] can take place without such bodily contact, either through energy bands or through the electromagnetic field, which thus appears with water and its structures as the matrix of biological reactions" [9, p. 150].

In our country, the study and development of the bioenergetic approaches considered in [9] have been actively conducted for several decades [8, 10]. In a series of our works [11–17], the details of such an atomic–molecular approach are described using the known mechanisms of physical optics, under the influence of electromagnetic radiation on water, and the processes of collisional nonradiative transfer of potential energy from excited aqueous molecular complexes to biopolymers. In [18, pp. 27, 28] it is noted,

> The author [15] theoretically proved the presence of microwave radiation in the ionosphere

and upper atmosphere of the Earth, which is generated in quantum transitions between highly excited Rydberg states of all atomic and molecular components of the upper atmospheric plasma and is strictly characteristic. An increase in the intensity of millimeter radiation (a significant excess over the background) directly correlates with both solar activity and geomagnetic storms. Moreover, all this radiation (beginning with the wavelength of 0.8 mm or more) practically freely penetrates into the atmosphere down to the earth's surface.

This energy agent, which was not taken into account before in the physics of solar–terrestrial relations, has allowed us to propose a solution to a paradoxical situation in the field of heliobiology. Indeed, all the main factors of the impact of true heliogeomagnetic disturbances on the lower atmosphere and biosphere (the flux of extreme UV and soft X-ray radiation from the Sun, including during flares, fluxes of corpuscles, mainly electrons, from the Earth's radiation belts and directly from the geomagnetosphere, precipitating in the zone of polar auroras, and during global magnetic storms, and at moderate latitudes) do not penetrate either to the lower atmosphere or to the biosphere, completely dissipating in energy in the Earth's ionosphere (at altitudes from ~60 to 300–400 km). This, in fact, creates the ionospheric plasma, simultaneously causing the emission of microwave (Rydberg) radiation from almost all gaseous components of the upper atmosphere. The proposed consideration of the emission ionospheric flux determines the cosmophysical foundation of heliobiology.

The publications from 1994 to 2008 [14–16] noted the importance of the mechanism of Rydberg excitation of the ionosphere for the physics of solar–terrestrial relations with the performance of model calculations of microwave radiation fluxes during periods of solar flares and geomagnetic storms. This was preceded by systematic work at the Vavilov State Optical Institute in the period 1974–1994. As a result, in the interests of solving the problems of solar–terrestrial relations, three previously unaccounted for processes from the physics of atomic–molecular collisions were successively introduced into the ionospheric model: the Auger effect (1974), double photoionization (1978–1979), and excitation of highly excited electronic (Rydberg) states upon the impact of photoelectrons, as well as secondary and Auger electrons (1989–1994) [19]. This led to an understanding of the nature of the repeatedly measured microwave emission of the ionosphere during periods of solar flares and geomagnetic storms (polar auroras), emitted during allowed electric dipole transitions from these states by upper atmospheric gases. In such situations, the probability of association processes in a stable complex is determined, according to [16, 20, 21], by the value of the orbital moment (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 connected with a change in the shape of the electron orbit when at large l values it ceases to penetrate into the ionic core, increasing the stability of the associate. Therefore, during periods of increased values of external microwave fluxes, primarily 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) by unity, one should expect a decrease in the cluster breakup rate (up to an order of magnitude [15]), that is, enhancing the association of biosolutions.

We emphasize that the proposed new factor in the physics of solar–terrestrial relations (by considering processes in the lower atmosphere and biophysics, taking into account microwave fluxes of ionospheric origin) is probably the most effective agent of the influence of solar–geomagnetic activity on weather–climatic characteristics and the biosphere. Indeed, in addition to microwave radiation, only cosmic rays that actually participate in the ionization of the environment reach the heights of the lower atmosphere and the earth's surface. The ionization threshold is ~10 eV. The energy of the quantum of the microwave flux, which controls the decrease in the probability of the associate (cluster) breaking up through its absorption by a Rydberg electron, which leads to an increase in the orbital quantum moment, is $\sim 5 \times 10^{-5}$ eV, that is, 2×10^5 times less. The fluxes of cosmic rays at the entrance to the lower layers of the atmosphere reach $\sim 7 \times 10^{-10}$ W/cm^2 for galactic cosmic rays (GCRs) and $\sim 2 \times 10^{-7}$ W/cm^2 for solar cosmic rays (SCRs) [1], and the microwave flux from the ionosphere to the main phase of the global magnetic storm reaches $\sim 10^{-11}$ W/cm^2 [16]. Hence, it follows that the efficiency of the impact of the flow of microwave quanta from the ionosphere to the environment exceeds the impact of GCR by about $\geq 10^3$ times and SCR by ≥ 10 times. The frequency of SCR arrivals at tropospheric altitudes is low: up to one event per quarter. For comparison, the number of large solar flares and global geomagnetic storms (reasons for a sporadic increase in the microwave flux from the ionosphere) averages one event every week [1]. In this regard, one can also consider the recent publication [22] on the dependence of the manifestation of viral epidemics on sunspot activity through the mechanism of cosmic ray action. Leaving aside assumptions about the mechanism of the solar–biospheric connection, the results of these studies should be considered an important confirmation of the ideas of helioepidemiology [4, 5].

Microwave radiation of the environment and physiology. Orbeli emphasized that physiology should provide "practical assistance to the population of our homeland and the population of the entire globe in protecting against a number of harmful factors that occur in nature, which are artificially generated by us, and the use of which is expanding" [7, p. 67]. We have been

discussing the presence of such a factor in nature since 1994 [14–16]. We are talking about sporadic microwave emissions of the earth's ionosphere that are especially strong in a magnetic storm and during periods of flares on the Sun. Orbeli's concept was developed on the basis of the original supramolecular physics of generation in natural and anthropogenic microwave fields of supramolecular structures in a living organism with the participation of water [11–13, 15–17]. In this case, the unique property of the water molecule, the high affinity for the proton, was taken into account, which makes it possible to obtain an intermediate highly excited electronic, Rydberg, state in which the transitions between levels lie in the microwave range during the implementation of a hydrogen bond in the associate formation. The absorption of a microwave quantum leads to an increase in the probability of associate formation up to ten times [15]. This basically contributes to the implementation of not an energy but an information channel of the effects of weak microwave fluxes on the organism in the framework of quantum biophysics, bioelectronics, and bioenergetics [9, 23]. Szent-Györgyi actually foresaw our approach within the framework of supramolecular physics (that is, with the inclusion in the process of associate formation of the transfer of a proton and the capture of an electron, which neutralizes the positive charge arising from the appearance of a proton into a high-lying Rydberg orbit). The concept of charge transfer introduces excited levels, previously considered inaccessible, because usually the energy required to lift an electron to the excited level of the molecule to which it belongs is too high [23]. The possibility that the massiveness of reacting molecules favors charge transfer was also discussed [23]. Within supramolecular physics, the Rydberg electron actually appears immediately at the energy level of ≥10 eV and the Rydberg molecule of both the water associate and biomaterials is relatively large.

Sources of microwave fluxes in the environment. Now it has become obvious that the most effective impact among cosmic factors on the state of the environment and the biosphere as a whole is exerted by ionospheric microwave radiation. The Sun delivers a fairly insignificant and relatively invariable flux of microwaves to the Earth's orbit, since even during periods of solar radio bursts it increases only several times [1, pp. 24–27].

Ground-based measurements have shown that, during solar flares, the signal from the microwave radiation flux of the Earth's ionosphere exceeds the intensity of the microwave flux from the quiet Sun up to 40 times (at a wavelength of 50 cm) or more; then the equipment goes off the scale [24]. The burst width reached 1 GHz. During magnetic storms, such observations were made dozens of times in the aurora zone [25]. During a magnetic storm, the flux can increase up to 10^{-11}–10^{-12} W/cm^2 [16], and during the main phase of the storm, up to 10^{-10} W/cm^2. This is orders of magnitude higher than the threshold of sensitivity of biological objects to microwaves. So, the fluxes during geomagnetic disturbances can be much higher than those considered in [26, p. 99]. Finally, the results of observations in Norilsk [27] allow us to state that if, during small and moderate magnetic storms, the source of the ionospheric microwave flux is located at high latitudes (in the auroral zone), then during a sufficiently strong magnetic storm, the fluxes are radiated from the near-zenith direction even at middle latitudes. This is confirmed by numerous observations by cosmonauts of strong auroras directly in the zone of orbital flights, that is, at latitudes less than 51.6° [28]. Since the height of the region of the ionosphere (both auroral and mid-latitude) emitting a microwave flux exceeds 100 km and reaches 300–350 km, almost the entire terrestrial biosphere is exposed to microwave radiation up to equatorial latitudes. During solar flares, the increase in the ionospheric microwave flux is 10–100 times less than during a strong magnetic storm. Such a significant microwave effect of magnetic storms is not associated with the magnitude of the induction of the natural geomagnetic field, since anthropogenic sources, for example, in the metro, recorded static fields that exceeded the Earth's field by several times, and not with geomagnetic storm variations (several percent, which is close to the effect of telephone tubes). According to the results of targeted research [29, p. 49], anthropogenic magnetic fields in electric transport can exceed the value of the natural geomagnetic field by 7–8 times. Therefore, the human body during a magnetic storm reacts to the microwave flux from the ionosphere (increasing thousands of times during the main phase) rather than to variations in the magnetic induction (from several percent to several times).

The fact is that the generation of microwave radiation in the ionosphere usually occurs under the influence of electron flows (mainly with an energy of ≥1 keV) coming from the magnetosphere, the intensity of which increases strongly just during storms [1, pp. 296–300; 28, pp. 66, 67]. The magnetosphere itself can be likened to a giant (with a diameter ten times greater than that of the Earth) focusing immersion (accelerating) lens [28, p. 51], which forms streams of corpuscular charged particles, primarily electrons, from solar wind particles. Then they invade the ionosphere in two ways: permanently directly into the auroral region within the auroral oval at geomagnetic latitudes of ~67° and during global magnetic storms in the form of precipitation from the outer radiation belt, where energetic electrons accumulate in the period between storms [1].

The maximum microwave fluxes from the ionosphere that occur sporadically during global magnetic storms are an important additional factor in the total effect of electromagnetic radiation on the biosphere, the intensity of which can reach ~10^{-10} W/cm^2, which exceeds, for example, the human body's own micro-

wave radiation (as it is considered of thermal origin). Therefore, the effect of the mm-component of the Planck radiation of the environment should be considered, at least in a laboratory room, or, for example, when conducting biophysical experiments inside the International Space Station [30]. The entire flow of microwaves from the ionosphere is modulated in the range of less than 100 Hz, where the Schumann and Alfvén frequencies are located, associated with resonant cavities between the ionosphere and the Earth's surface and the main part of the ionosphere and its upper boundary [11, 13]. The effect of stochastic resonance of the flow of ionospheric emission, continuous over the entire spectral interval, with anthropogenic microwave sources (electronics, cellular communications, positioning) at operating frequencies, as well as with sources of thermal radiation (in the millimeter range) of the environment and personnel is also predicted.

The flux of microwave emission radiation from the ionosphere was measured in dozens of experiments from ground-based radiophysical observatories, primarily during periods of solar flares and magnetic storms [11–17, 24, 25, 27]. It is important to emphasize that even in the main phase of the global magnetic storm, i.e., when observing the brightest auroras, the value of the flux reaching the biosphere is lower than $\sim 10^{-10}$ W/cm^2, which causes only weak, nonthermal forms of impact on living organisms.

Obviously, external microwave radiation, in the absence of control over microwave fluxes from the disturbed ionosphere, can be the main factor responsible for long-term observations of "irreproducibility" effects in a number of biophysical experiments [10, 17, 26, 30]. This refers to sporadic "irreproducibility." Thus, we take the following approach: "irreproducibility does not mean the unreality of the object; irreproducibility makes sense only in relation to the time interval of the study" [26, p. 531]. It was emphasized that "the problem of reduced reproducibility of nonthermal (that is, nonheating, not leading to an increase in the temperature of living tissue—*S.A. and L.B.*) effects is important; in the presence of many generally recognized irreproducibility factors, its nature has not yet been studied" [26, p. 578]. Although the foregoing referred to small effects in magnetobiology, this is also important in the interpretation of low-dose phenomena [8, 10], especially in the study of high and ultrahigh dilutions of aqueous biosolutions [11, 13, 31]. We propose [17] to attribute the source of the often implemented, but still not understood, problem of the nonrepeatability of biological experiments and tests (see the discussion in [32, 33]) to the external, uncontrolled in these experiments, electromagnetic (microwave) radiation from the ionosphere, which we proposed for accounting.

With the development of cellular telephony, the overall level of microwave background in the habitat is rapidly increasing. In connection with the new 5G communication standard, it is planned to use the mm-radiation range actively in our country in the near future. It is known that small base stations of modern cellular mobile communication systems also emit within the microwave frequency range (from 0.7×10^9 Hz to 3.5×10^9 Hz, with the prospect of using the 5G standard and the interval $(4.8–4.99) \times 10^9$ Hz, as well as the millimeter range). In the light of the ideas from the physics of the interaction of electromagnetic radiation with the environment, including according to the laws of thermal radiation, such an advance to the region of higher frequencies than in foreign countries (where the operating range is 3.4–3.8 GHz) seems dangerous to us. Anthropogenic radiation is becoming more intense, apparently being the main reason for the current increase in the level of electromagnetic background in the environment by an order of magnitude every 15 years [34]. According to the WHO [34, p. 15], 75% of annual deaths are due to environmental factors, and in oncology, 90%. This can be caused by a disproportionate increase in the ecologically significant level of the total flow of the anthropogenic electromagnetic background. The point is that, according to the results of our analysis [30] of the situation with a mm-radiation flux consisting of the most energetic photons in the entire microwave range, it can be especially aggravated in a limited space. Here it is necessary to consider background (thermal) sources that have a perceptible level of flow in the biologically important mm range [35]. A cumulative consideration of the impact of external microwave flows, taking into account the induced emission of microwave quanta in the biomedium itself, is presented by us in [30] when interpreting the concept of a biofield. This is the equilibrium radiation of the habitat at room temperature $T = 300$ K (27°C) and heat from personnel at 37°C [35, 36]. Therefore, it is the mm-range that is the main candidate for the phenomenon of *stochastic resonance*, which is constantly discussed by biophysicists [26], since the intensity of the flow of microwave sources worthy of attention is in a limited interval. This is already close to the condition for the implementation of such a resonance [26] when the effect of irradiation of a biological object in a narrow frequency band is enhanced, for example, from an anthropogenic source, due to the collection of energy of the emission microwave radiation from the disturbed earth's ionosphere in a wide spectral range. Thus, human radiation in the microwave range reaches $\sim 10^{-11}$ W/cm^2 GHz [36], and the equilibrium radiation flux (at 300 K) for the mm range reaches $\sim 10^{-10}$ to 10^{-12} W/cm^2 [35].

Academician V.A. Chereshnev noted that "since the 1970s, there has been an increase in the number of viral diseases, one of the reasons for this is antibiotic therapy, which causes the death of bacteria that counteract the spread of viruses in the intestine" [37, p. 754]. Since 1976 a change in the behavior of the average global temperature on the earth's surface has been

recorded with its transition to an almost continuous increase, as well as a similar behavior of the surface temperature of the World Ocean. These temperatures continue to rise and constitute just the phenomenon of modern global warming. In our papers [12, 16], based on a comparison of variations in global cloud cover recorded by the International Satellite Cloud Climatology Project (http://isccp.giss.nasa.gov/climanal7.html), we proved the relationship between the prevalence of total cloudiness and the intensity of the microwave radiation flux of the Earth's ionosphere, generated when it is disturbed by factors of increased solar–geomagnetic activity—an increased flux of short-wave (ionizing the upper atmosphere) solar radiation and quasi-periodic intrusions into the ionosphere of corpuscular flows (mainly electrons of keV energies) from radiation belts and directly from the geomagnetosphere. Anthropogenic electromagnetic pollution of the environment over the past 30 years has increased in the microwave range by two orders of magnitude, mainly due to the rapid development of cellular mobile communications [34].

Recently, among the three important anthropogenic factors of modern environmental pressure, electromagnetic pollution of the environment has been named, which provokes the human immune system, creating inflammation in the intestines [38]. Previously, similar results have already been discussed [8, p. 368]:

> Under the action of microwave radiation in the region of several tens of GHz at a rather low intensity (up to 0.1 W/m^2), some bacteria (for example, *Escherichia coli*) synthesize a peculiar protein, colicin, which has antigenic properties for bacteria of other strains.... It is likely that microwave radiation can disrupt the normal sequence of nucleotides in messenger RNA, resulting in the production of macromolecules unusual for the cell, which are unable to provide the full administration of the corresponding functions.

The effect of inflammation in the intestine may be determined by the lack of the innate immune defense system, which, according to I.I. Mechnikov, is associated with the protective effect of phagocytes, discovered by him in 1883 and predicting the relationship of phagocytosis with inflammation. In 1894, Mechnikov, in response "to a remark by the famous German microbiologist J.R. Petri, who compared the phagocytic theory with an Asian fairy tale, noted that scientists should not phagocytize, not devour each other, but help and cooperate, just as phagocytes and antibodies do" [39, pp. 780, 781]. How can I not mention the words of J.W. Goethe when writing his treatise "The Theory of Colors" in 1810: "Oh, this evil world of science!"

It can be assumed that more than a decade of worldwide rejection, in fact, suppression [10], of the unique scientific results of the work of a group of researchers headed by Nobel laureate in biology and medicine (2008) Luc Montagnier from the World Foundation for AIDS Research and Prevention (UNESCO) to develop a vaccine against HIV infection could have led to the Covid pandemic. By the way, already on April 20, 2020, that is, at the beginning of the COVID-19 epidemic, this scientist expressed the opinion that the Covid virus was the result of manipulation with the AIDS virus. Indeed, back in 1985, just in the year of the absolute peak of the main short-wave activity of the Sun over the past centuries, Montagnier himself deciphered the genome of the AIDS virus, and then, while searching for vaccines for HIV-infected people, his scientific group unexpectedly discovered that, after fragmentation and filtration, this virus was capable of self-reproduction [10, 40]. At the same time, the process of building its DNA from the remaining fragments of a small size takes place (in laboratory experiments, fragmentation was at least 20 nm), and the missing fragments are synthesized according to some internal program. As a result, the virus itself or its new mutant was reproduced. Naturally, this phenomenon, the participants of the work believed, did not make it possible to obtain a vaccine against AIDS. This was observed only in the absence of metal shielding, mainly at high and ultra-high water dilutions, in filtrates from cultures of various microorganisms, not only viruses but also a number of bacteria, and associated ultra-low-frequency (ULF) radio emission usually occurred at frequencies of 500–3000 Hz. In [40], a controversial assumption was put forward about the connection between the problems of obtaining a vaccine against the AIDS virus and the ability of some viral DNA sequences to emit ULF radio waves, which was also found in influenza and hepatitis C viruses. HIV-infected people also had ULF radiation while receiving antiretroviral therapy (hence, their plasma viral load was very low).

Our study showed [13] that all conclusions about the "unexpected behavior" of virus DNA are quite explicable within the known processes of interaction of electromagnetic (microwave) radiation with the water-containing medium of a living organism, which have already been quantitatively considered taking into account Rydberg excitation in a number of biophysical applications. We explain the phenomenon of viral DNA synthesis [40] by the fact that it can be supported by the stimulating effect of microwave irradiation on the association of water molecules and biopolymers. Energy from the environment in the microwave range can cause all the effects observed in experiments [40]. Indeed, quantum mechanical estimates [11, 12] quantitatively confirmed the contribution of the absorption of microwave fluxes from the ionosphere inside the skin layer (thickness from fractions of a mm to 16 cm) to 26% in the process of associate formation in biosolutions at the maximum of a magnetic storm, including in the human body. This effect, determined by the high proton affinity of water

molecules, under conditions of ultrahigh water dilutions (up to concentrations of 10^{-15} to 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 obviously high-energy levels of biomaterials, including DNA, which also affects the kinetics of all chemical reactions, including associate formation [11]. As a result, more and more associates appear in the biosolution irradiated with microwaves and fewer individual water molecules remain, which, penetrating into the DNA double helix, can contribute to its disintegration [41, p. 631].

The present pandemic, variations in solar–geomagnetic activity, and the problem of 5G cellular communications. The study of the influence of heliogeophysical activity and ionospheric disturbance on the environment is an interdisciplinary task. Let us give an example that is directly related to viral pandemics. Almost 60 years ago, biophysicist A.M. Molchanov from the Pushchino Research Center of the USSR Academy of Sciences put forward a hypothesis about the resonant structure of the solar system [42], which is most strongly manifested precisely in the annual variability of solar activity (in the number of powerful flares). It follows from this hypothesis that such a nonlinear oscillatory system as the Sun and its planets, in the process of long-term dynamic evolution, tends to reach a synchronous regime in which the frequencies of individual processes (whether, for example, the flare activity of the Sun or a change in various parameters of the planetary system) are in simple multiple relations with each other. Thus, although seemingly insignificant due to the smallness of the energy of the gravitational interaction of the planetary system and the Sun in comparison with the energy of solar activity, the influence of the periodic motion of the planets on flares on the Sun has a deep physical reason. The resonant directions determined by Molchanov in the Solar System correspond to the anisotropy of solar flares found by statistical processing of long-term data [43].

In any phase of the solar activity cycle, the number of recorded flares has relative maxima in February–March, August–September, May–June, and November–December. For large flares, the position of the maxima somewhat shifts (toward July for the May–June interval and to October for the August–September interval). These conclusions are consistent with the data obtained at the national orbital scientific station Salyut-6 on a noticeable increase in the emission glow of the ionosphere and auroras from July to October 1978 [28, p. 46] and later confirmed by the results of direct spectral recording by photometers of the Abastumani Astrophysical Observatory of the Academy of Sciences of the Georgian SSR [44].

Recently, when determining the role of solar flares and geomagnetic storms in variations of the main meteorological parameters (temperature and atmospheric pressure at the high-mountain station Solnechnaya, St. Petersburg State University, at the altitude of 2100 m), it was found that the effects were 1.5–2 times more frequent in June–July and September–October (respectively, about 25 and more than 30%) with an average annual probability of an event over a period of two months equal to 16.7%. This conclusion is comparable with the results of a statistical analysis of data on the absorption of cosmic radio noise for more than 1000 cases of solar cosmic ray protons reaching the Earth [43], where, along with March, June–July and September–October were also registered as the periods of their predominant appearance. It is these periods that are mentioned as waves in the modern Covid pandemic in discussions on the pages of the weekly *Argumenty Nedeli* (November 2020, February and August 2021) with the participation of leading Russian epidemiologists Professor I.A. Gundarov and Academician A.G. Chuchalin: March–April, end of September–October, November–January. Gundarov cites the case of American aircraft carriers when, while sailing offline for six months, outbreaks of infection of 600–800 people suddenly occurred. Gundarov, using the example of outbreaks of an increase in the number of infected people in Moscow on June 18–19 and 24–26, 2021, actually confirmed the direct connection between COVID-19 and geomagnetic storms, since powerful magnetic storms were recorded on June 17 and 25. At the All-Russia Conference "Solar and Solar–Terrestrial Physics" at the Pulkovo Observatory of the Russian Academy of Sciences in 2021, a report [46] drew attention to an unusually high asymmetry in the excess of the total area and number of sunspot groups in one of the solar hemispheres (see Fig. 1): first, 100% from August 2018 and almost until the end of 2019 in the northern hemisphere, and then a sharp transition from the end of 2019 (close to 100% in May–July 2021) to the southern hemisphere up to the greater part of the first quarter of 2021. With the participation of the head of the synoptic program of the US National Solar Observatory, Dr. A.A. Pevtsov, we interpreted the results of the analysis of coronal hole observations from the data of the Atmospheric Imager Assembly of the Solar Dynamics Observatory (SDO) spacecraft [46]. Since the Earth's magnetic field is directed from south to north, taking into account the prevalence of polar coronal holes in the southern hemisphere of the Sun, this caused an increase in geomagnetic activity with the appearance of powerful magnetic storms in June 2021.

It is noteworthy that 100 years ago, during the Spanish flu pandemic, according to the site https://www.bis.sids.be/silso, a northern asymmetry was detected in the number of sunspots from the middle of the first half of 1913 to the middle of 1919, which was then replaced by a southern asymmetry for almost two years (from the middle of the second quarter of 1919 to the end of the first quarter of 1921). Thus, even

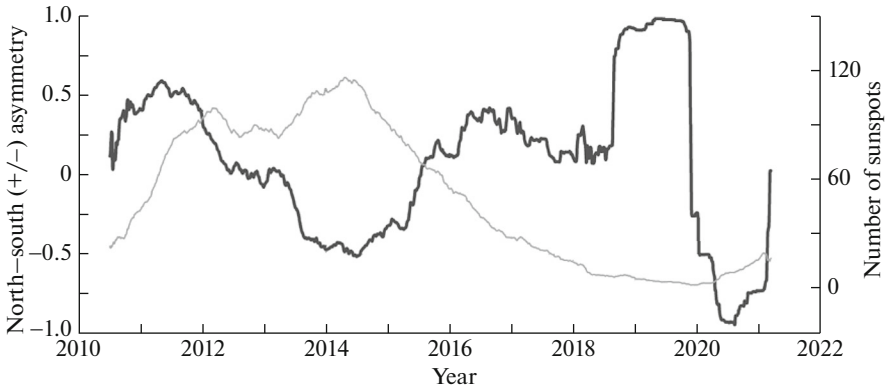

Fig. 1. Daily summaries smoothed over 13 months.
Profile of the north–south asymmetry N/S (+/–) for the total sunspot area (black curve) against the background of the sunspot number index (thin curve) from 2010 to early 2021 [46].

in those distant years, the outbreak of a viral pandemic (influenza) corresponded mainly to the southern location of solar spot activity, similarly to COVID-19, when there was a sharp, close to 100% level (in May–July 2020), transition to the southern hemisphere from the end of 2019, lasting most of the first quarter of 2021. The gradual weakening of the 1918–1920 influenza epidemic occurred with the superiority of sunspots in the northern hemisphere (from the middle of the second quarter of 1919 to the end of the first quarter of 1921). In the light of these comparisons, it can be expected that the phenomenon of the return of the excess of the total area and the number of sunspot groups at the end of the first quarter of 2021 to the northern solar hemisphere, already recorded with DSO (see Fig. 1), is, apparently, a sign of a weakening of the current helioepidemic Covid situation. In such a situation, the main electromagnetic pressure can be exerted by the anthropogenic microwave smog of the cellular communication system. On this occasion, Academician Chuchalin said: "Man has built the modern world, changed his entire environment..., and turned out to be very vulnerable to what he himself created. And first of all it concerns his immune system."

For our work, of interest are the conclusions of [47] on the prevalence of the role of environmental pollution by electromagnetic radiation and fields as the main factor affecting the incidence and mortality rate from COVID-19. They are based on data analysis of the testing and mass deployment of 5G networks, including the mm-range, in Europe in 2019–2020. At the same time, objects of the NATO communication structure with the headquarters in Belgium stand out, where there was a particularly high mortality rate from Covid by mid-2020 (more than 15%), an order of magnitude higher than in Belarus, Iceland, Malta, Russia, and Slovenia.

In a specially organized discussion [48, 49], domestic specialists—experts from relevant state commissions—spoke out against a simplified approach to the implementation of the 5G standard in Russia. It is emphasized that "electromagnetic fields of radio frequencies of nonthermal intensity are an irritant of the nervous system.... As for protection, this is only screening of the room.... It is the absorber that is important" [48]. "It should not be surprising that every year 300000 people of the working population die due to oncology. This is largely a consequence of such exposure.... The conversation should last no more than five minutes, and in a day, no more than half an hour" [49].

More than 200 million 5G mobile communication installations are already operating in the world, of which more than 60% are in China, that is, almost in the habitat of every third family. In Russia, by 2024, it is planned to deploy full-scale 5G networks using an increased frequency of 4.8–4.99 GHz, as well as an even more dangerous millimeter range.

The research results presented confirm that a periodic increase in the active viability of viruses can be described in terms of the physics of the interaction of microwave electromagnetic radiation with water-containing biosolutions and is associated with an increase in the microwave flux in the environment. Therefore, during a pandemic, it is desirable to protect patients at risk from exposure to microwave radiation by doing the following:

• treating external and internal walls of buildings (hospitals, maternity hospitals, kindergartens, schools, nursing homes), as well as nonmetallic roofs, with a microwave-reflecting/absorbing paint and coating windows with special films;

• wearing special two-layer clothing that has interference properties for the passage of an external microwave flow to the body;

• drastically reducing the amount of time you use your mobile phone, using only a headset, not surfing the Internet, and not allowing your battery to charge in your home.

These recommendations are fully consistent with the opinions of experts [48, 49] and, most importantly, with the conclusions of biophysicists: "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—electromagnetic background (background of radio waves) in a wide frequency range" [50]. When carrying out the attenuation of the total external background of microwaves in practice, it is important to create conditions for avoiding the possibility of the manifestation of stochastic resonance, separating the magnitudes of the fluxes of different sources due to the protection of the selected frequency filter quality.

* * *

So, we have considered the effect on a living organism of the sporadic microwave radiation of the ionosphere with a wavelength in the region from 1 mm to 10 dm (UHF–SHF–EHF), which has long been known from observations of radiophysical observatories. Since the main microwave fluxes are emitted from ionospheric heights of ~100–200 km or more, the effect of their appearance also reaches low latitudes, especially during magnetic storms. This is due to the fact that almost the entire microwave range practically freely penetrates into the lower layers of the atmosphere and into the biosphere (with the exception of five narrow absorption bands).

In order to reveal the role of natural and anthropogenic microwave background (associated with cellular communications) in the spread of viral diseases, the results of our studies on associate formation in aqueous biosolutions (including low concentrations) are analyzed taking into account the impact of external microwave fluxes and induced emission of microwave quanta in the biomedium itself. A solution to the problem in bioenergetics concerning the mechanism of the influence of electromagnetic radiation (including microwave radiation) on water in a living organism is proposed. In this case, the original supramolecular physics of the generation of supramolecular structures—clusters-associates of water molecules—under the influence of microwave radiation fluxes was used. Its absorption with the excitation of an electron neutralizing the positive charge of the complex ion to a Rydberg orbital with a higher orbital quantum number increases the number of associating particles, since the probability of penetration of the Rydberg orbit into the ion core decreases, and, consequently, the probability of decay of the resulting associate decreases.

All conclusions about the unexpected behavior of the DNA of viruses are quite understandable within the known processes of the physics of the interaction of electromagnetic (microwave) radiation with the water-containing medium of a living organism, taking into account the Rydberg excitation. We explain the phenomenon of viral DNA synthesis by the fact that it can be supported by the stimulating effect of microwave irradiation from the environment on the association of water molecules and biopolymers. Quantum-mechanical estimates have quantitatively confirmed the contribution of the absorption of microwave fluxes from the ionosphere inside the skin layer (thickness from fractions of a mm to 16 cm) to 26% in the process of associate formation in biosolutions at the maximum of a magnetic storm, including in the human body. This effect, determined by the high proton affinity of water molecules, under conditions of ultrahigh water dilutions (up to concentrations of 10^{-15} to 10^{-18} M) enhances the biochemical activity of the dissolved biocomponent due to the implementation of the collisional transfer of potential energy from the Rydberg excited water-containing associate to obviously high-energy levels of biomaterials, including DNA, which also affects the kinetics of all chemical reactions, including associate formation. As a result, more and more associates appear in the biosolution irradiated with microwaves and fewer individual water molecules remain that are able to penetrate the DNA double helix and stimulate its decay.

The effect of a permanent increase in microwave fluxes from the environment on the activation of viral pandemics is considered. This is not only the radiation of the earth's ionosphere but also the anthropogenic electromagnetic background, caused by an avalanche-like increase in microwave pollution of the habitat during the operation of mobile cellular telephony, household computer equipment, and digitalization systems. The predicted interaction of natural and anthropogenic sources of microwaves sharply increases their negative impact on the ecological situation. Therefore, efforts are needed to reduce drastically the amount of time spent using mobile phones and surfing the Internet among at-risk populations, including secondary school students. This wish of the authors is consistent with the concerns expressed recently by both teachers and parents of students, as well as with the opinion of the General Prosecutor's Office of the Russian Federation.

The proposed clarifications to the recommendations of experts on the protection of the population using electromagnetic shielding suggest the development of biophysical studies of the cumulative microwave impact both within heliobiology (at the present stage of the decline in the level of solar–geomagnetic activity) and taking into account the resonant mechanisms of increasing anthropogenic exposure at communication frequencies.

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CONFLICT OF INTEREST

The authors declare that they have no conflicts of interest.

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