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# An original theory regarding the correlations between the extremely high frequency electromagnetic waves of athermic intensities and their cellular effects

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## ABSTRACT

Lately it has been demonstrated that extremely low intensity millimeter therapy could represent an important new technological method, universal and effective in the treatment of diseases with various etiologies. In this way, millimeter waves have crystallized into a new branch of modern biophysics and cellular studies and are used extensively in medicine and biotechnology. Thus, in the present report, we will try to describe a new original theory regarding the interaction mechanism between extremely high frequency electromagnetic waves and their biological environment. This could be quite important since so far there has not been developed a general theory on the relations between extremely high frequency/extremely low intensity electromagnetic waves and the biological environment, at various levels of organization: submolecular, molecular, cellular, the organ level or the entire organism. In this way, the present paper was designed to contribute to the development and understanding of millimeter wave's interaction with the biological entities and to propose a new alternative biophysical and cellular mechanism to explain the biological effects inherent to the electromagnetic millimeter field.

## 1. INTRODUCTION

The extremely high frequency electromagnetic radiation of low intensity has gained lately an increased and special role in biology and clinical medicine for the diagnosis, prevention and treatment of various diseases. In this way, the extremely high frequency waves or millimeter waves are situated in frequency range from 30 to 300 GHz corresponding to the wavelength range of 1-10 mm [1].

Moreover, the problem regarding the interaction of the millimeter electromagnetic waves with biological activities has a fundamental importance. This is due to the fact that cosmic millimeter waves are absorbed by the Earth's atmosphere. In this way, at first glance sight it would seem that living matter has evolved without the 'participation' of millimeter electromagnetic waves. However, living organisms use all what is useful that comes from external factors, and the millimeter waves can convey and contribute to the processing of a very large volume of information, which is uncharacteristic for other wavelengths or frequencies. This has led to hypotheses according to which the living organisms themselves generate extremely high frequency waves [2].

One of the first researchers to propose a possible mechanism for the generation of millimeter waves by living organisms was the great physicist and Nobel Prize laureate, H. Fröhlich [3-5].

It has to be mentioned that experimental researches in this field have begun only in the late 1960s and early 1970 at the time when millimeter waves generators started to be produced (which until then were difficult to project from a technical point of view). In this way, experimental

investigations have shown a number of particularities fundamentally new in the process of interaction between the millimeter electromagnetic field and his biological manifestations. It was also found that the biological effects of millimeter waves coherent radiation can be detected at densities of the power flux density much lower than 10 mW/cm2 [6].

At such low intensities, the biological target object whole temperature increase does not exceed 0.1° C, due to the fact that the millimeter radiation quantum energy is less than the athermic energy $h\nu < kT$, where, $h$ , $\nu$ , $k$ and $T$ are the Plank's constant, the frequency of radiation, Boltzman's constant and the absolute temperature, respectively. In this case, the so-called athermic or informational biological effects occur, for which the character and intensity of the biological effects do not depend on the millimetre electromagnetic field intensity variation when exceeding a minimum threshold, but are mainly determined by the frequency, wavelength and polarization of incident radiation.

Also, the first millimeter waves generators were developed by the Institute of Radioelectronics of the Academy of Sciences, in the former Soviet Union, under the direction of the academician N. Deveatcov and Professor M Golant, and were initially used mainly for military purposes, such as radar or communication [6].

Moreover, the threshold character for the biological effect are depending on the density of the millimetre electromagnetic field power flux. In this way, the biological effect occurring at a certain value of it, reaches up to its saturation value, after which the increase the radiation intensity cease to lead to further increasing of the biological effect (Figure 1), while the resonance character of the biological effect depends on the external electromagnetic field frequency (Figure 2).

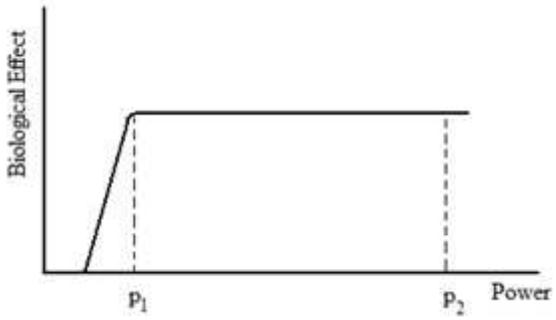


Figure 1. The biological effect occurring at a certain value of it, reaches up to its saturation value, after which the increase the radiation intensity cease to lead to further increasing of it.

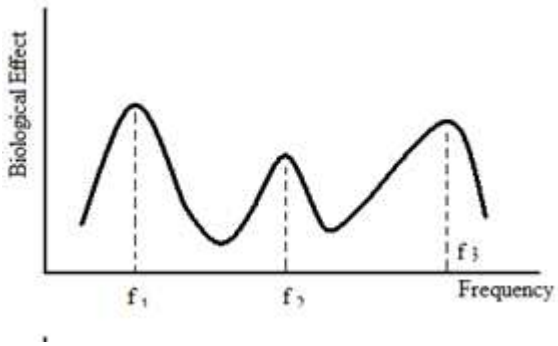


Figure 2. The resonance character of the biological effect dependence on external electromagnetic field frequency.

## 2. BIOLOGICAL AND CLINICAL RELEVANCE

In this way, after an impressive number of theoretical, experimental and applied scientific studies, that were and are conducted in Russia, Ukraine, the United States, Germany, Japan, France,

Italy, China and Romania related to the millimetre electromagnetic field effects on micro-organisms and laboratory animals, the massive use of millimeter waves has been initiated in clinical medicine. Currently, millimeter waves therapy is used extensively in the most prestigious scientific centers and medical clinics, for the treatment of more than 120 diseases, which we will discuss here shortly [2,7-10].

In this way, although so far the physical, biophysical, biological and biochemical mechanisms of the interaction of low-intensity millimeter waves with the human body have not been yet fully identified, millions of patients were successfully treated with the help of millimeter waves therapy. In this way, millimeter waves are used in virtually all the spectrum of pathologies, such as cardiology, neurology, oncology, gynaecology, urology, pneumatology, gastroenterology, surgery, pharmacology or paediatrics [2,7-10].

As it can be observed in the papers cited above, some authors have demonstrated clear bactericidal effects of low-intensity extremely high frequency electromagnetic field, in a comprehensive review regarding the possible mechanisms, targets and consequences of this phenomenon [10]. The same authors also showed that low-intensity electromagnetic field could be extremely relevant in understanding the role of bacteria in various environments, as well as studying their metabolic pathways, the antibiotic resistance manifestations and cell-to-cell interactions in bacterial populations. In addition, the low-intensity extremely high frequency electromagnetic field could exert serious membranar and genomic effects, such as altering DNA conformational changes or the membrane specific transportation [10].

Also, with increased relevance in this area of research are also the studies performed by the group of Whissell et al. [2], which demonstrated that very weak physiologically-patterned magnetic fields synergistically interact with specific drugs, in order to potentate the effects of some neurotransmitters, such as the opiate one, cholinergic, dopaminergic, serotonergic or the nitric oxide metabolic pathways. Moreover, the authors are suggesting that the combinations of the appropriately patterned magnetic fields and specific drugs can evoke changes that are several times larger than those evoked by the drugs alone [2]. This can be also correlated with the recent advances in the Neuroscience field that are suggesting various interactions between the central neurotransmitters are taking place in modulating superior functions such as memory, learning or sleeping [11-13].

Also, it seems that the millimeter waves can be implicated in the modulation of some fundamental enzymes for the process of apoptosis such as caspase-3, caspase-8, and MMP-13 expression. In this way, the group of Xia actually showed that millimeter wave treatment applied on caspase-3, caspase-8 and MMP-13 expression, in a rabbit surgically induced model of knee osteoarthritis, induced by anterior cruciate ligament transaction, can result in some significant effects in the field of Rheumatology. Thus, the aforementioned authors applied millimeter wave at 37.5 GHz frequency, 8 mm wavelength and 10 mW/cm2 power for 20 and 40 min, for 10 days, six weeks after transaction and obtained some encouraging results [2].

In addition, in a comprehensive review from 2011, lead by the group of Prof. ZhadobovA from Rennes, France, it was showed that electromagnetic, thermal and biological aspects are considered and analyzed for exposures in the 30-100 GHz range with a particular emphasis on the 60-GHz band, with further relevance for some biological studies on the human body [8].

## 3. AN ORIGINAL THEORY REGARDING THE EXTREMELY HIGH FREQUENCY ELECTROMAGNETIC WAVES OF ATHERMIC INTENSITIES AND THEIR CELLULAR EFFECTS

As mentioned above, right now there is not a unique and undisputed theory of the electromagnetic waves' action. However, there are a few concepts, as those described by the Deveatcov group or the aforementioned Fröhlich studies.

Another action mechanism of electromagnetic waves in biological media is based on the concept of stochastic resonance, in which a special role is played by millimeter radiation signal modulation with low frequency, which is characteristic forthe physiological rhythm of the body. In

this way, this will lead to changing regulatory processes of calcium in cell. Thus, rgarding these aspects, the Sitco group suggested the existence of the body's electromagnetic own casing. The action of millimeter electromagnetic field on biologically active points (BAPs) leads to the body's electromagnetic shell correction, influencing in this way the biochemical processes and metabolism normalization [14].

There also are other mechanisms trying to explain the phenomena occuring at electromagnetic millimeter waves interaction. In this way, our original hypothesis regarding the interaction mechanism of electromagnetic millimeter waves with biological objects is based on Fröhlich idea that bose-condensed phonons appear in the living objects due to metabolism. These phonons are characterized by macroscopic amplitude and have the same wave vector value, the same phase and polarization. The existence of the bose-condensed phonons results in the appearance of coherent millimeter wave or in other words the bose-condensed millimeter photons which are also characterized by the same parameters as the phonons.

Moreover, due to the interactions between bose condensed quasi-particles, it seems that periodical transformations of the phonons into photons and vice versa take place. If this interaction is strong, both photons and phonons can no longer be considered independent. In this way, these two excited states coupled constitute a mixture of phononi and photons called polaritons [15]. When the milimeter photons and phonons are in the bose-condensed state, the formed polaritons will be in the same state.

The polaritons dispersion curve contains two branches (as shown in Figure 3), with a polaritonic branch located above and another below the polaritons and forming branches of photons and phononi. When the living biological object is in normal non-pathological condition, the latter generates bose-condensed polaritons with macroscopic amplitude, with the same values of the wave vector, phase, polarization, frequency, amplitude of the radiation and absorption bands with a certain bandwidth, centered on the emission frequency. In fact, it represents a sharp peak, as shown in Figure 4.

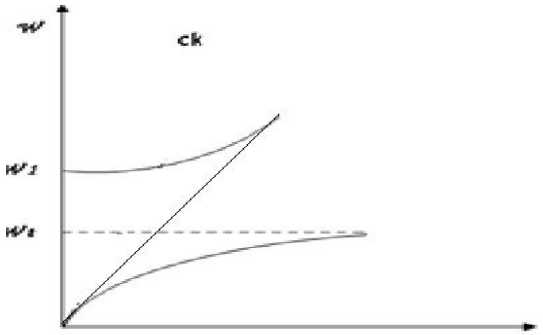


Figure 3. The polaritons dispersion curve.

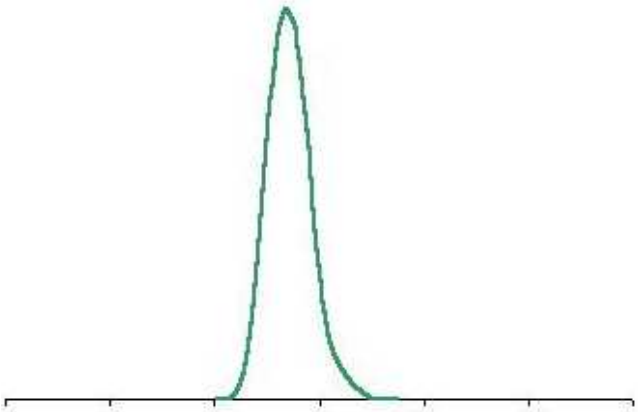

Figure 4. Amplitude of the radiation and absorption bands in living biological systems - in normal non-pathological condition.

Also, as it is well known, the living cells of biological objects are separated from the environment by a cell membrane. In this way, it is known that the membrane is as a double layered lipid. Membrane lipids consist of two distinct parts: the hydrophobic nonpolar 'tail', and hydrophilic polar 'head'. Membrane lipids form a double layer. Each layer is made up of complex lipids, and the double-layer structure consists of the internal non-polar and the external polar side.

Thus, according to our hypothesis, a living biological object in normal conditions has all the dipoles oriented in a single direction, and the internal bose-condensed polaritons have the same orientation of the wave vector (Figure 5).

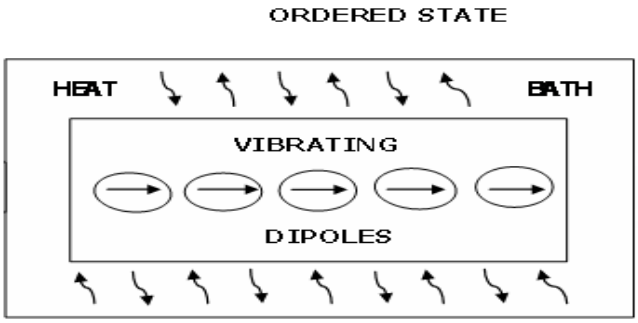


Figure 5. Living biological object in normal conditions – distribution of dipoles and internal bose-condensed polaritons.

In this case, the action of the external electromagnetic millimetre field does not generate biological effects because, figuratively speaking, external radiation has nothing left to orient, all the dipoles and polaritons wave vectors being already oriented, the latter being in a bose-condensed status. That is why the millimeter waves do not produce biological effects in healthy living organisms. In the case of illness or aging of the organism, dipole disorientation occurs, some dipoles changing their direction, while others preserve orientation (Figures 6 and 7).

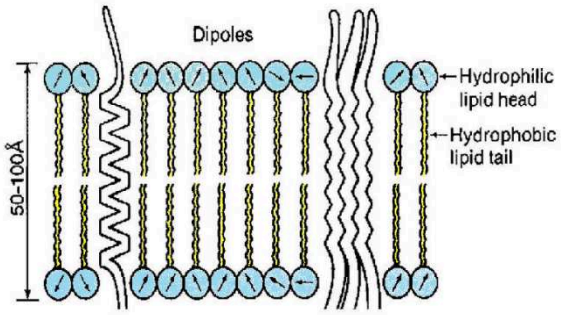


Figure 6. Distribution of dipoles in the possible case of illness or aging of the organism.

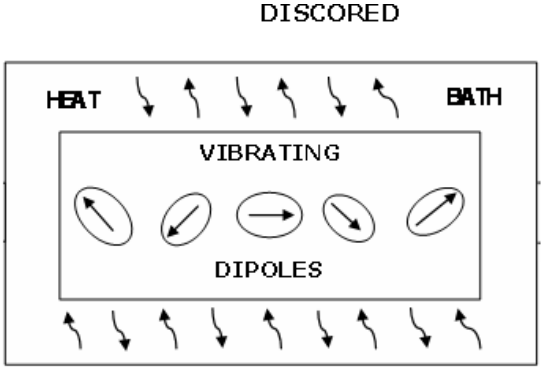


Figure 7. Distribution of dipoles and internal bose-condensed polaritons in the case of illness or aging of the organism.

At the same time, some polaritons leaving the bose-condensed state pass into a supercondensed state, in which the wave vectors are randomly oriented. In the case of pathological disturbances of various etiologies, and as a result of the disruption of the polaritons coherent state, the conformation of the electromagnetic millimetre field radiation bands fundamentally deforms, in direct dependence with the intensity of the pathology (as a result more irradiation peaks appear at different frequencies!) (Figure 8).

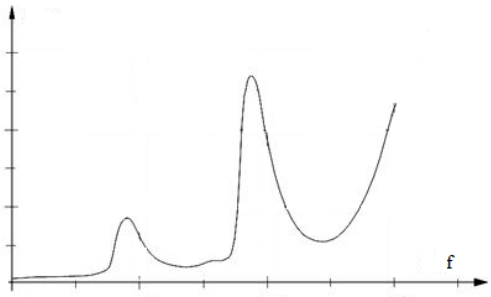


Figure 8. Changes in the the conformation of the electromagnetic millimetre field radiation as a result of various pathological disturbances.

Moreover, if the distortions do not exceed a certain critical and insignificant threshold, then the coherent bose-condensed internal field itself can restore the system to normality. Also, in the case of which the internal field cannot restore the coherence and normal condition of the biological object, then the external millimeter radiation field will be used. If the exterior field is coherent, its synchronic interaction with the internal polaritonic field results in the oscillations synchronization and the restoring of the system's bose-condensed state, the radiation absorption and emission bands, as well as frequency, amplitude, wave vectors (basically the returning to normality and the healing of the organism).

We have to mention that polaritons bose-condensation is induced in this case by the external coherent electromagnetic field, which differs from the spontaneous bose-condensation of Fröhlich. Polaritons induced bose-condensation leads to the decrease of the dispersion processes of the bose-condensed polaritons. A similar effect occurs in the case of the induced bose-condensation of excitons in condensed media. Additionally, as it has been demonstrated in some of our previous works, that bose-condensed phonons and photons may be described as a system of nonlinear differential equations in partial derivatives of Ginzburg-Landau-Keldysh type.

It has also been demonstrated that among the multiple solutions of the equations, there are nonlinear periodic solutions described by elliptic functions, soliton-type solutions ('solitary waves'), which during propagation retain an unchanged form, quasi-periodic and chaotic solutions generated by the so-called toruses and strange attractors (Figure 9).

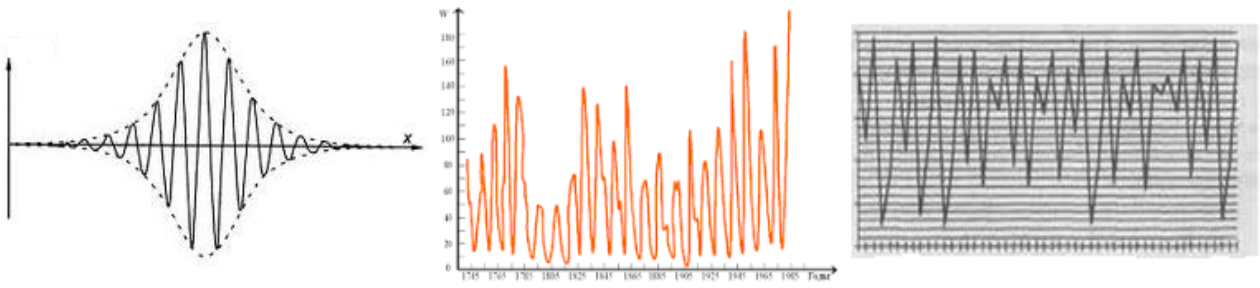


Figure 9. Nonlinear periodic solutions.

In this way, the soliton type polariton wave propagation explains the electromagnetic field action at remote distances compared to the electromagnetic field applying or generation position. Moreover, in the stationary cases it has been demonstrated the phenomenon of hysteresis in the dependence of the bose-condensed phonons number on the intensity of the internal and external electromagnetic millimeter fields. These phenomena can explain the biological effects related to the existence of plateaus in their dependence with the millimeter electromagnetic fields intensity and the biological object exposure time to the millimetrical electromagnetic radiation.

## 4. CONCLUSIONS

In conclusion, so far there has not been developed a general theory regarding the extremely high frequency and extremely low intensity electromagnetic waves and their interaction with the biological environment at different levels of organization: submolecular, molecular, cellular, the organ level or the whole organism. In this way, the present work was intended to contribute to the development of a new and original theory for the millimeter waves interaction with living biological entities and to propose a new alternative biophysical and cellular mechanism to explain the biological effects inherent to the electromagnetic millimeter field.

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