

# Interaction of the Extremely High Frequency and Low Intensity of Electromagnetic Radiation with Living Objects

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**Abstract — The usage of electromagnetic radiation in medicine in general and oncology in particular, including clinical oncology is constantly increasing. This is due to the fact that during their usage, the range of different exposure methods to electromagnetic radiation is increasing, leading to the reduction in treatment duration, decrease of allergic reactions, side effects on organs and tissues, incidence of drug disease and drug dependency. Of particular interest are the combined radiation effects of extremely high frequency, terahertz and infrared radiation on medical-biological objects.**

During the last 10-20 years electromagneto-biology with millimeter waves is considered to be one of the main new technologies that are utilized nowadays on a large scale in medicine, pharmaceutical biotechnology and modern agriculture.

Extremely high frequency and low intensity electromagnetic radiation has a specific role in clinical medicine, especially in diagnosis, prophylaxis and treatment of various diseases. Extremely high frequency waves or millimeter waves are situated in the frequency range between 30 and 300GHz, corresponding to the wavelength interval from 1 to 10 mm.

The problem of millimeter wave's and interaction with biological environments has a fundamental character. This is due to the fact that cosmic millimeter waves are absorbed by the Earth's atmosphere. At a first glance, it seems that the living matter evolved without the participation of electromagnetic millimeter waves. Living organisms use everything that is useful from external factors, and millimeter waves can conduct and contribute to processing of a high volume of information, fact that is not characteristic for other wavelengths (frequencies). This fact generated hypothesis according to which living organisms generate their own extremely high frequency waves.

One of the first researchers that proposed a possible mechanism of millimeter wave generation by living organisms was Nobel Prize Award winner, physicist, H. Fröhlich (1968). The generation of extremely high electromagnetic waves is also conditioned by the metabolic energy. These waves are coherent and therefore are characterized with the same frequency, phase, polarization and well determined wave vector.

The energy of vital processes in living cells is transformed in local dipole excited oscillations. Due to non-linear phenomena at the interaction of dipole oscillations and their link with elastic waves, takes place the transition of the system from a metastable state with a single type of oscillations to a fundamental state, and takes place the organizations of a collective giant dipole, that represents a coherent state of the biological object. This cooperative state conditions the creation in

biological systems of bose phonons – condensed in the frequency region of  $10^{11}$  Hz, far from the thermodynamic equilibrium zone.

The idea of bose phonon formation – condensed in biological systems is of a major importance for understanding of processes conditioned by the interaction of millimeter waves. It led to understanding of functional control mechanisms of the main systems (nervous, humoral) that assure the homeostasis of living organisms, including the human body, and also to explanation of diverse non-linear and cooperative phenomena that take place at the interaction of electromagnetic millimeter waves with biological objects. From the methodological point of view, Fröhlich's idea is in a close correlation with the model of soliton propagation in developed biological systems of A. Davydov (1973-1982) and developed cooperative phenomena developed by Moscalenco (1979-1980).

Experimental research in this domain began only in late 60's and early 70's of XX<sup>th</sup> century, when the millimeter wave generators were developed. Experimental investigations demonstrated a number of new peculiarities in the interaction processes of electromagnetic millimeter wave fields with biological environments. It was established that biological effects of millimeter wave coherent radiation is observed in densities of the power flux density lower than  $10 \text{ mW/cm}^2$  (N. Deveatcov, M. Golant 1991).

In such small densities, integral temperature growth of the targeted biological object doesn't exceed  $0,1 \text{ }^\circ\text{C}$  due to the fact that the quantum energy of millimetric wave radiation is lower than the athermic energy,  $h\nu < kT$ , where  $h$ ,  $\nu$ ,  $k$  and  $T$  are Plank's constant, radiation frequency, Boltzman's constant and absolute temperature. In such a case takes place the so called athermic or informational biological effect where character and intensity of biological effects do not depend on the variation of the millimetric electromagnetic field intensity and are determined predominantly by the frequency, wavelength and polarization of incident radiation.

First generators of millimeter waves were elaborated by the Institute of Radioelectronics of the Academy of Sciences of the former USSR under the administration of academician N. Deveatcov (1991) and prof. M Golant, and used in military purposes: radiolocation, communication etc.

Informational actions have a fundamental role in life existence. It was concluded that living objects not only generate electromagnetic waves but these assure the information transmission from one cell to another, contributing in such a way to cell communication in plants, microorganisms and animals.

We will mention that in the elaboration of various mechanisms regarding the processes that take place in alive biological objects and millimeter waves, it is necessary to separate electromagnetic fields: one electromagnetic field is external and generated by the respective generators and the other is internal, that we will call it Fröhlich field, generated by the alive biological media itself.

A special interest, represents the study of the interaction of external millimeter radiation with different hierarchical structures such as biomacromolecules, cells, tissues and finally the whole living organism. As a result of this action, in alive media take place diverse biological, physiological, genetic, biochemical and biophysical effects. Millimeter electromagnetic fields provoke biological effects at all organization levels of living matter.

An undeniable interest represents the experimental research regarding the action of millimeter waves on microorganisms and laboratory animals. After a series of investigations the following were concluded:

1. The resonance character of the biological effect dependence on the frequency of the external electromagnetic field.
2. Threshold character of the biological effect dependence on the density of the power flow of the millimetric electromagnetic field. The biological effect appears at a certain level, until it reaches the saturation level, after which radiation intensity increase doesn't lead to effect increase.
3. Dependence of the biological effect on the time of irradiation, after a time threshold the electromagnetic field doesn't lead to effect increase.
4. Dependence of the biological object on its initial state.

We will mention that the interaction of electromagnetic millimeter waves with alive organisms is an extremely complicated issue, conditioned first of all by the complexity of the biological objects and by the processes that take place in biological media.

The existence of internal electromagnetic and acoustic fields, generated by biological media itself and also external electromagnetic fields have a fundamental importance in explaining the electromagneto-biological effects of alive biological objects. Their confusion lead to wrong interpretation of the interaction mechanisms between external electromagnetic fields with studied biological media (irradiated). After an impressive number of fundamental, theoretical, experimental and applicative researches that took and take place in Russian Federation,

Ukraine, Italy, Japan, France, China, Romania regarding the action of millimeter electromagnetic fields on microorganisms and lab animals, app. 30 years ago began massive usage of millimeter waves in clinical medicine. Nowadays the millimeter wave therapy is widely used in the most famous clinics and scientific medical centers in the treatment of over 120 diseases.

Even if till now, wasn't identified the physical, biophysical, biological and biochemical interaction mechanism of low intensity millimeter waves with the human body, with the help of millimeter therapy were successfully treated millions of patients. Millimeter waves are used in almost all pathologies: cardiology, neurology, oncology, gynecology, urology, gastroenterology, surgery, pharmacology, pediatrics, etc.

In millimeter wave therapy are used generators with coherent and stochastic radiation of low and very low intensity that do not lead to the heating of the human tissue, an important difference between other physiotherapeutic devices. Experimental researches proved that no side-effects appear at the interaction of these electromagnetic fields with biological objects. After a series of investigations was concluded:

5. Cumulative character of the curative effect. Dependence of the curative effect on the surface, localization and used irradiation time.
6. Electromagnetic radiation propagation at substantial distances from the place of irradiation. Propagation of millimeter waves take place only in alive organisms, and their reception takes place only when the organism is ill.
7. Stimulation of non-specific body resistance by the millimeter radiation. Mobilization of the compensatory body reserves. The dependence of the therapeutic effect on the external electromagnetic millimeter field frequency. Development of therapeutic processes without toxic, allergic reactions or other side-effects. Complementation with other types of treatment: drugs, physiotherapeutic etc.
8. Possibility of millimeter waves utilization as monotherapy. Dependence of the therapeutic effect on the place of radiation application (biological active points, Zaharin-Ged zones). Millimeter therapy possesses anti-stress action, leads to the increase of body immunity, decrease of allergic reactions. Increase of the therapeutic effect in conditions of combined administration of millimeter, physio and chemotherapy.

Among the most common methods of cancer treatment are surgery, chemo- and radiotherapy. Combined treatment is commonly practiced, where surgery is supplemented by chemotherapy or radiation. Note that in general, these methods are not effective enough.

In oncological practice the microwave range of electromagnetic waves and laser therapy is widely used. Microwave treatment is applied in destruction of tumor cells as a result of local temperature increase of the tumor cells. The depth of the optimal heating is of approximately 4-5 cm. Chemotherapy is usually used for the treatment of disseminated cancer sites, when the body protective mechanisms are significantly reduced. Hyperthermia increases the damage of tumor tissues,

therefore it significantly increases the antitumor activity of chemotherapeutic drugs.

The laser therapy is used in the prevention and treatment of radiation injuries that usually appear during radiotherapy, for the treatment of various complications in the postoperative period, during rehabilitation and palliative care.

Low-intensity laser radiation is used in oncology to treat the complications of chemoradiotherapy, as an anti-inflammatory and immunomodulatory remedy, was proved to be effective in pain relief and increases the speed of wound healing.

Cancer treatment was proved to be more efficient when several physical factors are used during treatment, the effect of which achieves greater efficiency when combined. Lasers are also used in thermotherapy and its advantage, in this case, in comparison to other energy sources, is connected to the monochromatic and coherent properties of laser irradiation, thus providing a local irradiation with high energy and intensity, which leads to the death of cancer cells.

Given the continuous increase of cancer incidence and as a consequence an increase in mortality through oncological diseases, in recent decades were undertaken research, targeted to identify fundamentally new technologies in cancer treatment.

In the early 70s of the twentieth century on the initiative of the academician Devyatkov in a number of medical institutions of the USSR, was adopted a program of clinical testing using millimeter waves in the treatment of various diseases. This fundamentally new method, which at the initial stage was classified as secret, was first tested in more than 60 clinics, including such major medical centers as the All-Union Oncologic Scientific Center of the Russian Academy of Medical Sciences and Central Institute of Traumatology and Orthopedics.

As a result of the above mentioned researches was identified that millimeter wave therapy has a high efficiency in the treatment of many diseases: cardiovascular, neurological, urological, skin, gastrointestinal, dental, gynecological, oncology, etc.

Clinical trials of the millimeter wave therapy led to the conclusion that this method has no side-effects in medicine.

Millimeter wave therapy has no side effects and its specific features are:

- Can be used in the treatment of various diseases
- Non-invasive
- Can be used as monotherapy
- Anti-stress effect
- Analgesic effect
- Other

Currently, low-intensity millimeter radiation is widely used in medicine to treat more than one hundred diseases and has been successfully applied in various countries from Europe, Asia and North America

Note that the millimeter therapy has been widely used in the treatment of cancer.

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