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## **NONIONIZING ELECTROMAGNETIC RADIATION (EMF) AND THEIR INFLUENCE ON THE HEALTH OF LIVING ORGANISMS**

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**Abstract.** Although official statistics challenge the effect of electromagnetic fields on human health, it is often questioned because of the incontrovertible evidence of increased incidence of various cancers and skull tumor emergence and development. Exposure to radio frequency (RF), extremely low frequency (ELF) fields and microwave fields (MW) by using more often mobile (GSM) and wireless phones and exposure to electromagnetic fields created by communications antennas prove a causal link between exposure to electromagnetic fields and various forms of cancers developed. Study of the interaction of electromagnetic non-ionizing fields (EMF) and living matter and its possible biological and health effects is currently one of the topics most discussed and controversial, not only because of its purely scientific interest, but also with reference to its cultural, social and economic implications.

**Keywords:** Radiofrequency electromagnetic fields (RF), electromagnetic fields of extremely low frequency (ELF), nonionizing radiation, Biological effects of nonionizing radiation.

Since the '80s until now many studies signal and confirms that non-ionizing electromagnetic fields have biological effects on living organisms, other than thermal effects. Many artificial sources, imposed by the technological development of electronic devices are operating in a wide frequency range from static fields of extremely low frequency (ELF) to the radio (RF) and microwave (MW).

Communication systems, means of socializing, high voltage power lines, transmission and distribution of electrical energy, wireless mobile telephone systems, radio and television mainframe systems, communication systems of emergency services and military sphere all of them uses non-ionizing radiation (EM).

Yet numerous studies show that although do not interact like ionizing radiation, their interaction with living material and the produced functional changes in the context of the existence of electromagnetic fields, are proved by epidemiological studies and clinical case studies. Their effects occur before reaching thermal limits imposed and already recognized by the International

Community and the standards imposed by the International Commission on Non-Ionizing Radiation Protection.

Except that the limitation refers to electromagnetic fields induced changes, relative to 10 g of tissue for 6 minutes exposure time, thermal effects are considered to be "solved" by homeostatic mechanisms of living organisms, namely acquisition and dissipation of thermal energy by the blood flow, without taking into account that the 10 g of tissue exposed often are found in the brain tissue, and the homeostatic adjustment is not instantaneous, induced changes in living tissue could take place even on values 30 times lower of the field strength, than the limits arising from thermal effects.

World Health Organization (WHO) has made some initial standard to minimize the level of exposure awaited by the *Precaution Principle*, part of the European Union Agreement (Article 130. Of the Maastricht Treaty - February 7th. 1992) related to "chronic" exposure of the population (more than 4 hours per day) but it remained out of date. Following the *Precaution Principle*, the International Commission of Protection Against Nonionizing Radiation (ICNIRP) published in Health Physics the Guidelines for Limiting Exposure to Time-Varying Electric, Magnetic and Electromagnetic Fields (up to 300GHz) the European Recommendations 1999/519/in EU the limits are : 1.9 W/kg while in United States : 1.6 W / kg.

In 2007, a large group of international scientists published a comprehensive report entitled the "*BioInitiative Report*", citing numerous scientific studies that had been conducted showing the health dangers of electromagnetic radiation exposure. Now an updated version of the "*BioInitiative Report*" has been published. Consisting of 29 independent scientists and health experts from 10 different countries, the *BioInitiative Working Group 2012* assessed over 1800 new scientific studies involving power lines, cell and cordless phones, cell towers, smart meters Wi-Fi, laptops, routers, baby monitors and electrical wiring and appliances. They concluded that evidence for risks to health from electromagnetic radiation has substantially increased since 2007, and that we have far more evidence than necessary to require us to immediately take more precautionary action to protect ourselves and our children. Of special concern is the fact that the level of daily EMF exposure has become more intensive than ever. There is much greater involuntary exposure now, and it is nearly unavoidable - even for those who choose not to go wireless. Cell phone users, parents-to-be, young children and pregnant women are at particular risk [27], [29].

There is more evidence in this updated report that electromagnetic radiation damages DNA [30], [36], [37], interferes with DNA repair, and creates greater toxicity in the genes [40]. It also cites studies showing

pathological leakage of the blood-brain barrier [57] and altered immune function. Effects on memory and sleep disruptions [49], [53], [61], [73] (especially around Wi-Fi and cell towers) are further noted. There are also a dozen new studies linking cell phones on standby carried on a belt or in a pocket of men and wireless laptops to sperm damage: quality, motility & death, all affecting fertility and reproduction[14], [21], [28], [67].

Perhaps even more alarming is the evidence of increased incidence of child & adult brain tumor risks [40], especially glioma (a malignant brain tumor [44], [71], [34]), that is linked to electromagnetic radiation. Also increased is the incidence of acoustic neuroma with the use of mobile & cordless phones. EMF exposure has been further correlated with other cancers [33], such as child and adult leukemia and breast cancer [72] in both men and women. The report also cites studies showing a link between electromagnetic radiation and neurological diseases [3-5], such as Alzheimer's & ALS, miscarriage and a number of cardiovascular effects.

Information and population warnings related to the danger represented by the exposure to this invisible radiations and difficult to measure, is extremely low, and often there are no alternatives for communications (wire telephone), exposures to hotspots being made without the population consent and against their will, many situations being unavoidable.

### **How Electromagnetic field interact with cell dynamic?**

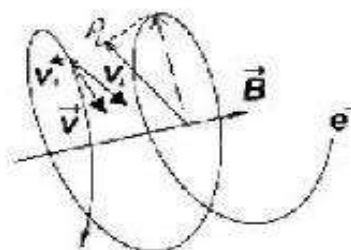
There are several approaches concerning the biological mechanisms that cause effects on living matter due to electromagnetic fields, including physics explanations related to nonlinear processes, chemistry of radical pairs and triplets transitional, cell biology translation signals or transient variation trans cellular flow of ionic species.

Yet seen from the point of view of quantum thermodynamic states of non-equilibrium and non-linear, there is scientific evidence of the surprising effect on living cells, of the combination of two magnetic fields of low intensity (static and alternative), parallel to each other, (intensity 30 times lower than the limits in force) and frequency lower than 100 Hz (experimental Liboff Blockman 1980).

These magnetic fields are in fact able to determine a transient flow variations across cell membranes of various ionic species, when the frequency of the oscillating magnetic field is equal to a well-defined value known as the "cyclotron frequency.

$$\omega_c = (1/6.28)(Q/m)B$$

This frequency is expressed, for a given ion, by: where  $Q$  and  $m$  are respectively the charge and mass of ionic species considered,  $B$  is the intensity of static magnetic field and can be seen as a rotation frequency characterizing ion circular motion in a plane perpendicular to the static magnetic field  $B$ .



Schematic representation of the process of cyclotron resonance.

In particular, applying to the cells along the earth's magnetic field, a weak magnetic field oscillating with frequency:  $\omega = 37.5$  Hz (equal to the cyclotron frequency of  $\text{Ca}^{2+}$  ion) there is a change in normal brain physiology established through a series of peaks deionized calcium influx into brain cells (1994, Russian scientists Zhadin and Novikov, verified experimentally same effect outside living organisms in a sample of glutamic acid). But how can a signal whose intensity is actually less than the thermal "noise" (kT) to overcome the energy barrier and energy transfer molecule? The answer, apparently paradoxical, is potentially provided by quantum physics, according to which, as is known, a particle or a quantum of energy can overcome this barrier by a mechanism known as "tunneling"

"Final" possible explanation is theory of quantum-coherence phenomena applied to biological systems Quantum Electrodynamics (QED) theory is universally accepted by the interaction of atomic and molecular components (nuclei and electrons) coupled through their tasks, electric and magnetic moments of the electromagnetic field.

As already shown (by Hepp and Liebe in the early 70's), for a given physical system and already since the 80's [58], [62], each system having the same density of atoms and molecules over a certain amount and temperature above than a certain value (which depends on the particular system) goes into a state that is totally different from that predicted by the generally accepted theory of condensed matter.

The nature of this state is similar to that of the atoms of a laser oscillating in phase, synchronized with an electromagnetic field that resonates at their frequency, generating coherent radiation in space and time.

Condensed matter and in particular the living (comparable to usual conditions) cannot be reduced to a sum of molecular components, but must be seen as a set of molecules oscillating in phase with a field electromagnetic (EMC) within the limited Coherence Domain (CD) whose size is inversely proportional to the energy jump suffered oscillating molecules. In particular, when a coherent fraction of matter, gets energy it:

a) may subtracting coherent layer molecules, destroying their consent with other phase oscillating molecules;

b) Can excite initial coherent state of matter, generating an excited state, which then in turn releases energy within the coherent state (no energy dispersion).

In particular, the second, enabling the formation of electron "almost free" characterized by energy very close to ionization energies, which can therefore be subtracted from the matter with extremely low energy consumption.

This coherent interaction mechanism underlying the formation and maintenance of homeostasis. Theory of quantum-coherence phenomena solves this problem, because within a consistent environment, molecules interact through their common coupling with the electromagnetic field (EMF) that oscillates in phase (and this is the means by which propagates interaction) and force intensity depends on the difference between their oscillation frequencies  $\omega_1$  and  $\omega_2$

$$F \sim \frac{1}{\omega_1 - \omega_2}$$

So that only molecules that have similar oscillation frequencies are strongly attracted and combining. Theory of quantum-coherence phenomena provides that collective motion of electrons almost free of coherent excited state of coherence domains that form along protein chain axis, are able to induce an electric current, and consequently, a magnetic field quantifiable.

This magnetization may occur, in turn, Josephson currents (a manifestation of the superconductivity) along the protein tube and capture potential ion dissolved in solution, forcing it to move along the circular orbits adjacent to the outer surface of the tube consisting of chain protein. In addition it follows that the magnetic flux variation between successive segments of the tube protein generates an electromagnetic field (EMF) whose frequencies are included in the 0.5 and 2.5 GHz microwave!

Theory of quantum-coherence phenomena is of fundamental importance in respect to understanding the influence of non-thermal exogenous magnetic fields of very low intensity and frequency, over cell process involving ion exchange through membrane, with potentially serious consequences for the functioning of the circadian rhythm and homeostasis.

Maintaining balance a living system is based on ion exchange cycle right through cell membranes due to daily and seasonal variations of the Earth geomagnetic field.

This means that the simultaneous action of a static magnetic field (such as due to the Earth and / or any artificial sources) and an alternating field of low intensity and frequency of artificial origin is able to control the system "ion pumps" present in the membranes cell, *causing them gain and attenuation and directly influencing their functioning* (e.g., acting directly by activating / deactivating the ionic gate) or indirectly (by changing the magnetic field generated by the endogenous neuro-vegetative system) on the right and normal ionic species flow.

### **Conclusions:**

The existing ICNIRP and FCC (Federal Communications Commission) limits for public and occupational exposure to ELF and RF are insufficiently protective of public health.

Research is needed (but should not delay) regulatory action for ELF and substantive *preventative action for RF proportionate to potential health and wellbeing risks from chronic exposure*.

A biologically-based exposure limit should reflect current scientific knowledge of bio effects and health effects, and impose new limits based on preventative action as defined by the Precautionary Principle (EEA (European Environment Agency), 2001).

Biologically-based exposure standards shall be protective against exposures levels of ELF and RF that affect or change normal biological functioning of organisms (humans). They shall not be based solely on energy absorption or thermal levels of energy input, or resulting tissue heating. They shall be protective against chronic exposure responses.

The existing standards are based on thermal (heating) limits, and do not address non-thermal (or low-intensity) exposures which are widely reported to cause bio effects, some likely leading to adverse health effects with chronic exposure.

Biological effects may include both potential adverse health effects and loss of homeostasis and well-being.

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