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# MAN IN THE OCEAN OF ELECTROMAGNETIC ENERGIES

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## ABSTRACT

**Man is a product of a long evolution of life in the ocean of external EM energies and the geomagnetic field. Humans also possess natural sensitivity to some of EM fields (for example the presence of the storm) or to small geomagnetic anomalies, which may trigger a weak muscular response. According to certain studies this could be the basis of understanding dowsing. There are also people, who are allergic, hypersensitive, to some frequencies of EM fields and similarly to people who are allergic to pollen. It is still unclear, what is the meaning of increasing EM pollution today. Various epidemiological studies still did not propose a final conclusion. Healthy people with a strong homeostasis are probably only partially disturbed by EM fields and the effects do not appear. However, especially susceptible people and people, who are additionally exposed to stress, are more prone to be influenced by the environmental EM fields; i.e. they are thrown out of equilibrium, which can lead to number of maladies. By this, there is no linear connection between power density and frequency of EM field and an exposure to it. Beside harmful, there are also beneficial effects of EM fields, especially for some diseases. In future, we can expect more consideration of EM fields either for their harmful or for their beneficial influence. It is possible that in more remote future the fields will help us to regenerate extremities or organs.**

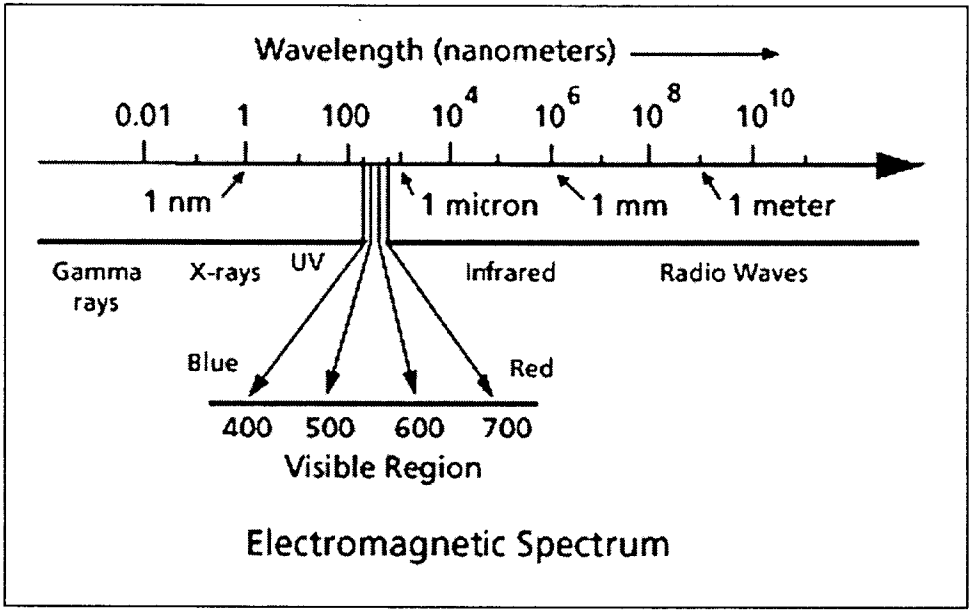
**KEY WORDS**: electromagnetic field, geomagnetism, nonionised radiation, human environment, coherent oscillations, electromagnetic pollution, safety standards, protection, epidemiological research, leukemia, cancer, hypersensitivity, mobile phones, healing with magnets, regeneration.

## INTRODUCTION

According to many new insights man has gained into the nature of life, a living system is not only a huge collection of molecules, but a highly sophisticated electrodynamic system as well (Del Giudice et al 1988, Vitiello, 2001). Seemingly, the origin of life did not depend only on delicate chemical conditions but also on electric fields and polar molecules (Jerman 1998). These intrinsic and endogenous electric and electromagnetic fields are in constant

communication with the external geomagnetic and electromagnetic (EM) fields. Along with other living beings, man as a sensitive and highly complex multi-level electrodynamic system is a product of a long evolution of life in the ocean of external EM energies. Of course, we do not have in mind ionised EM radiation or visible or infra-red waves, but only EM frequencies below the infra-red band like microwaves, ultra-short waves etc. until we have reached frequencies even below 1 Hz. (Graph 1). In many cultures humans used their natural sensitivity to EM fields or to small geomagnetic anomalies to gain some information about subterranean sources of water or about healthy places to live, at least through more sensitive and trained individuals (König 1975, 142-145; Katajainen & Knave 1995). Even the ancient urbanism and architecture may reflect man's use of sensitivity to EM clues within the territory of living. It seems that in our hi-tech western civilisation the sensitivity to the EM environment has been lost, but it is not the fact. Even in the most developed countries there are individuals who sense the fields, some of them using this ability to help others – but civilisation, seen from the standpoint of its standards, has really lost the EM sensitivity dimension, which may have many consequences. There is a possibility that the increasing EM pollution with its negative health effects will require re-considering EM fields in relation to humans.

There is therefore an EM aspect of anthropology that is perhaps insufficiently explored. In the present article we wish to make an introduction this, mostly neglected aspect of human life. We shall begin with a short presentation of endogeneous EM fields supposed to organize countless cellular biochemical interactions. In the next chapter we shall present a description of our EM environment including the natural and artificial sources of EM fields. Later on we shall speak about the health problems and about the

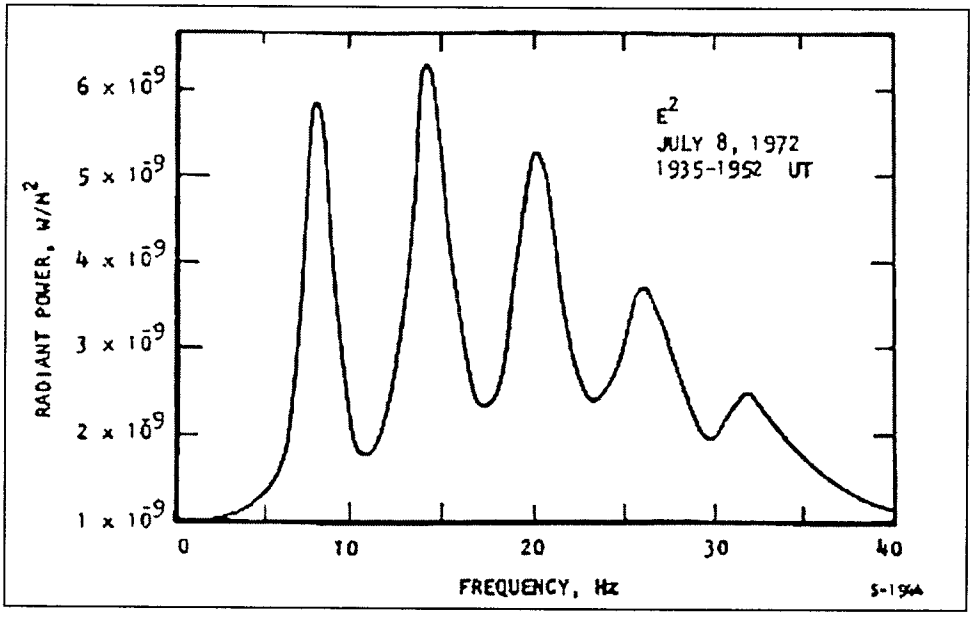



**Graph 1**. Specter of electromagnetic radiation.

application of the artificial EM fields. At the end we shall speculate about possible future changes of our civilisation due to a more in-depth study of the biological role of endogeneous and exogenous EM fields.

## ELECTROMAGNETIC NATURE OF LIFE

Organisms, including man, are not only passively exposed to environmental EM fields; according to certain theories and experimental findings they possess an active endogeneous EM field as well. The theory of this field stems from the British biophysicist Herbert Fröhlich. In short, on the basis of special electrical characteristics of the living cell, the theory presumes the existence of coherent oscillations (originating from the Bose condensation) of molecular dipoles which together with the endogenous EM field create a coherent EM field at a frequency of $10^{10}$ - $10^{11}$ Hz (Fröhlich, 1988). These oscillations are supposed to form a basis for the intramolecular as well as for the intercellular order. In a neoplasm such an order is broken and uncontrolled growth follows. Experimentally, this theory was verified in various ways, either through mycrodielectrophoresis (which showed somewhat lower frequencies) or erythrocyte rouleaux formation, and through interference and resonance effects with exogenous low intensity mm EM waves. A group of Czech scientists has recently found direct evidence for "Fröhlich's" radiation, even if at somewhat lower frequencies (Pokorny et al 2001). Fröhlich's theory was further elaborated, in terms of a quantum-field theory, by the Italian group around del Giudice (Vitiello 2001). According to this view, the endogenous bioelectromagnetic field is organized into tiny filaments, of a




**Graph 2.** Frequencies of Schumann resonances (for more details see text).

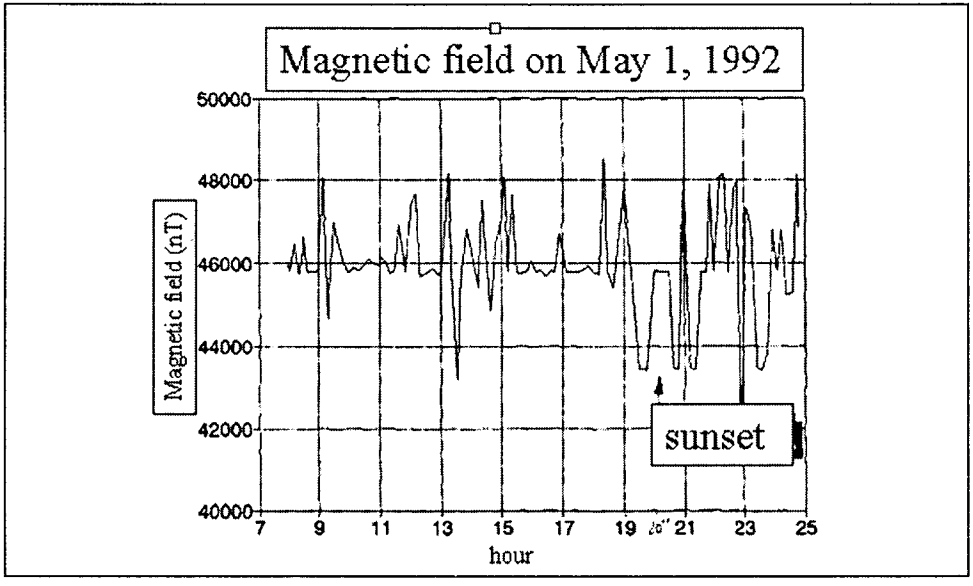
diameter similar to that of microtubules. The filamentous field is supposed to organize biochemical reactions through resonance induction. It should be mainly limited to the interior of the organism, leaking only a little - hence its radiation is ultraweak.

## SOURCES OF NON-IONISED ELECTROMAGNETIC RADIATION

Natural sources of electromagnetic radiation on Earth consist of the radiation originating from space and from the Earth itself. The latter is the consequence of the material properties and of the Earth's electromagnetic events in the atmosphere (few nT). Numerous storm flashes trigger agitation in the space between the Earth and the ionosphere; the latter acting as an empty resonator. In this way, standing waves with Schumman's resonance frequencies are produced (König 1975, 29-34; Graph 2.). These frequencies (7,8; 13,5; 19,1; 24,7... Hz) are also specific to some biological processes, for example, some of them are typical of the EEG waves (König 1975, 29-34; Aspden 1988; Kenny 1990).

The density of the natural static geomagnetic field is about 30-50 μT depending on the geographical latitude. It did not vary only in the course of history, when the field was reversed many times, but it varies also throughout the day. In our country the geomagnetic field density is around 46 ± 4 μT (Wiltschko 1995, 1-13; our own measurements (Grapah 3)).

Besides the geomagnetic field, we are also constantly exposed to highly variable electric fields that extend between the ionosphere and the Earth's surface. Most commonly, the clouds are electrically positive and the Earth is electrically negative. This difference in polarity produces a vertical electric field that all humans are exposed to. Its intensity




**Graph 3.** Local measurements of geomagnetic field densities (in μT) troughout the day (Ljubljana, May 01, 1992). The arrow shows the time of sundown..

**Table 1**. Magnetic flux densities at 60 Hz near various appliances in the USA (World Health Orgnization Geneva, 1987)

| Appliance | Magnetic flux density (μT) at distance z | | |
|---|---|---|---|
| | z = 3cm | z =30cm | z=1m |
| Can openers | 1000 - 2000 | 3.5 - 30 | 0.07 - 1 |
| Hair dryers | 6 - 2000 | < 0.01 - 7 | < 0.01 - 0.3 |
| Electric shavers | 15 - 1500 | 0.08 - 9 | < 0.01 - 0.3 |
| Sabre and circular saws | 250 - 1000 | 1 - 25 | 0.01 - 1 |
| Drills | 400 - 800 | 2 - 3.5 | 0.08 - 0.2 |
| Vacuum cleaners | 200 - 800 | 2 - 20 | 0.13 - 2 |
| Mixers | 60 - 700 | 0.6 - 10 | 0.02 - 0.25 |
| Fluorescent desk lamps | 40 - 400 | 0.5 - 2 | 0.02 - 0.25 |
| Garbage disposals | 80 - 250 | 1 - 2 | 0.03 - 0.1 |
| Microwave ovens | 75 - 200 | 4 - 8 | 0.25 - 0.6 |
| Fluorescent fixtures | 15 - 200 | 0.2 - 4 | 0.01 - 0.3 |
| Electric ranges | 6 - 200 | 0.35 - 4 | 0.01 - 0.1 |
| Portable heaters | 10 - 180 | 0.15 - 5 | 0.01 - 0.25 |
| Blenders | 25 - 130 | 0.6 - 2 | 0.03 - 0.12 |
| Television | 2.5 - 50 | 0.04 - 2 | 0.01 - 0.15 |
| Electric ovens | 1 - 50 | 15 - 0.5 | .01 - 0.04 |
| Clothes washers | 0.8 - 50 | 0.15 - 3 | 0.01 - 0.15 |
| Irons | 8 - 30 | 0.12 - 0.3 | 0.01 - 0.025 |
| Fans and blowers | 2 - 30 | 0.03 - 4 | 0.01 - 0.35 |
| Coffee makers | 1.8 do 25 | 0.08 do 0.15 | < 0.01 |
| Dishwashers | 3.5 do 20 | 0.6 do 3 | 0.07 do 0.3 |
| Toasters | 7 do 18 | 0.06 do 0.7 | < 0.01 |
| Crock pots | 1.5 do 8 | 0.08 do 0.15 | < 0.01 |
| Clothes dryers | 0.3 do 8 | 0.08 do 0.3 | 0.02 do 0.06 |
| Refrigerators | 0.5 do 1.7 | 0.01 do 0.25 | < 0.01 |

is around 100V/m. The intensities may change considerably when we are in the area of a storm.

Over the last 50 to 100 years, which represents just a brief moment in the geological and evolutionary time, a much higher number of EM sources with unnatural frequencies and magnetic field densities as well as unusual shapes of EM fields generated by human activities, have been added to the natural sources (König 1975, 58-114; Korpinen 1994). Consequently, man is exposed to the non-ionized EM radiation as a producer of the artificial radiation, which can have predominantly unknown effects, and as a receiver of the artificial and natural sources of EM radiation. The magnetic field densities of some artificial human sources are described in Table 1.

In the last 100 years the level of the non-ionized EM radiation has steeply increased. The electric grid is the most widely spread source of EM radiation. Here the electricity flows as an alternating current with a basic frequency (50Hz in Europe, 60Hz in America) and its higher harmonics which, together with the former, form the shape of the electric grid EM oscillations. The oscillations spread from electric wires into the environment as a very low-frequency EM radiation (ELF-EMFs). Moreover, the majority of the population (at least in more developed countries) are exposed daily to high-frequency EM radiation from TV sets and radio transmitters; today the mobile phone transmitters are rapidly joining them. Actually, there is no place left where we are not exposed to EM radiation from electrical devices such as computers, radios, TV sets, electric clocks, domestic appliances, cars with increasingly more electronics, and other means of transport as well as machinery and even satellites from space travelling around the Earth. We can safely speak about rapidly increasing electromagnetic pollution with unforeseeable consequences not only for humans but for the whole biosphere.

## EPIDEMIOLOGICAL RESEARCH

Not so long ago, hardly anyone considered the possibility of the harmful effects of using electricity without taking into consideration direct danger from electric shock due to electric contact or other similar causes. However, the situation changed in the late 70's. In 1979 two American scientists, Wertheimer and Leeper, published a study about a possible causal relationship between some child leukemia cases and the closeness of electric transmission lines. In the following years several organizations encouraged or financed researches in this field. One of the largest and most rigorous American researches about the causal relationship between cancer and ELF-EM fields lasted 8 years and was published in the New England Journal of Medicine in 1997. It included 1258 children and performed also measurements of EM fields in their environment. The scientists came to the conclusion that there was no statistically significant causal relationship between the fields in households and the child leukemia (Linet et al., 1997). On the other hand, it is also true that but little is known about the leukemia diseases in infants and adults. Several institutes, e.g. the National Institute of Health in the USA, are working intensively on research programs in this field to better understand possible causes for these diseases. In the year 2001 a German epidemiological study found only a weak causal relationship between leukemia cases and environmental ELF-EM fields. An interesting finding was that the effects were higher or

more statistically reliable when the studied persons were exposed to ELF-EM fields during the night, however, the authors did not reach any conclusions (Schüz et el., 2001).

After many similar researches the general opinion is that some connection between EM fields exposure and physiological effects on humans does exist, however, without a clear mechanistic explanation and more thorough studies on animals, the results only partially support hypotheses about the harmful effects of these fields. Although the ELF-EM fields are listed among carcinogens as a "possible carcinogen", according to some experts there is no experimental or theoretical basis for this statement (NIEHS report 1999). In its report NIEHS recommended decreasing the exposure, if, of course, this is not unreasonably expensive or dangerous. Similar advice was given for the exposure to TV or computer monitors that emit EM radiation with high frequencies. The safety of mobile phones is still a matter of discussion and there are still researches underway (Moulder et al., 1999).

## STANDARDS OF PROTECTION AGAINST HARMFUL EFFECTS OF NON-IONISED RADIATION

Since there is no plausible scientific proof of harmful effects of non-ionised radiation, safety values are mostly based on the levels of EM fields that produce thermal effects. Slovenia adopted even more rigorous standards for EM radiation in the natural and artificial environments (UL 70, 1996). According to these standards the general public should not be exposed to ELF-EM field intensities exceeding 500 V/m (electric field) and 0.01 mT (magnetic field, both at 50 Hz), which is even lower than in most European countries; however, the permitted density values are gradually decreasing throughout the world.

Unfortunately, all these standards are based on the linear understanding of the relationship between an EM field dose and human health risk, similarly as is known for the ionised radiation. According to the results of many research studies (including our own), it can be stated that weak EM fields affect physiological processes in a non-linear way. This means that a stronger field does not necessarily produce stronger effects, except at very high powers. When weak EM fields are tested, the so-called "window effect" appears, which means that the biological effects became visible only at certain EM field densities or frequencies, and even then only in certain physiological conditions or ontological phases of the tested organism. (Adey 1984; McLeod et al., 1992; Poponin, Winters, 1993; Walleczek, Budinger, 1992; Ružič et al., 1998a, b). It is therefore possible that some weak EM field density can have pronounced physiological effects, but a slightly higher density would only have a weaker effect or none at all.

A review of this research area reveals that the explanation of the physiological effects of non-ionised radiation rests on different physical mechanisms. Some of them have an excellent mathematical elaboration, the others only a weak one. The proposed mechanisms may be classified among the classical and quantum mechanical ones (cit. in: Bistolfi 1991, 13-143; Popp 1994, 33-80; Berg, Zhang, 1993). Of course, this means that our civilisation is still far from exerting intelligent control over its environment that abounds in artificial EM frequencies.

## HEALING EFFECTS

The discovered physiological effects of EM fields are not necessarily harmful. It has been known for some time that through the exposure to alternating EM fields of certain frequencies and intensities, the healing processes such as nerve and bone regeneration can be stimulated. Some researches have also revealed that the applied fields can counteract stress, for instance, weak sinusoidal EM fields can be used as a protection against heart attacks (Han et al. 1998). The results are encouraging, although the exact mechanisms of the healing process are not known. Usually, the best results are obtained with pulsed EM fields.

Since ancient times the healing influence of static magnets has been known and it is used even nowadays. For instance, in 1997 Vallbona et al. achieved a 75 percent healing rate when they treated 50 patients subject to the post-polio syndrome with weak static magnets fixed on places where the patients reported pain in the muscles and arthritis. In another study the neurologist M. Weintraub (1998) reported that 24 patients with painful legs felt relief when using static magnets. Dr. William Pawluk, the co-author of a review book that summarises 30 years of the East-European researches with magnets, states that every magnet has some physiological impact on the body, but the kind of the reaction depends on the type of the magnet used in treatment (Jarabek et al 1998). There are some theories on how static magnets can influence our physiological processes in a beneficial way, but here we are even in deeper darkness than with the dynamic EM fields. It can be understood therefore, why the EM fields are not used more extensively: doctors want to resort to something previously explained and well understood; and this almost always implies the use of pharmaceutical chemicals instead of fields.

In our country healing with electric fields and currents is thoroughly researched and applied for the healing of wounds (Cukjati et al. 2001); the studies are also directed towards the healing of tumors (Miklavčič et al. 1997).

In alternative medicine magnets are used much more frequently than in conventional medicine. Healers mostly recommend magnets for healing and alleviating arthritic pain, pain in the back, against headache and asthma. Magnets should also help against stress. Unfortunately, some studies do not confirm the analgesic effect of magnets (Cleary, 1995).

## EM WAVES AS A POSSIBLE SOURCE OF CHANGES IN HUMAN LIFE PATTERNS

Our civilisation is becoming more and more aware of the importance of EM fields for man. First, the fields may be harmful – the extent of which is yet to be established; second, their proper application can be very useful, especially for healing; and third, through knowledge of the intricacies of our own electrodynamic system, new possibilities that were only hoped for in the Human genome project, will open up for mankind. Which can be the changes caused by the first area? First of all, we will have to change the technology of most of our devices so that they will radiate only very small amounts of EM energies and within the intensity and frequency windows that have no physiological influence. The same principle will apply also to our electric grid and various broadcasting stations. Over time we may

also expect a decrease in the use of iron in our factories, business premises, houses and furniture, so that we will be exposed to the natural geomagnetic field again.

Through research involving the second and the third area we may expect revolutionary changes, deeply affecting our life. EM devices may arise that will have strong healing or alleviating effects on many illnesses, without patients taking pills with their side effects or only in very small amounts. This could prove devastating for the pharmaceutical industry, but will certainly ameliorate our lives. When we discover the body's EM language we will be able to provoke the dedifferentiation and the differentiation of tissues. A possibility of the regeneration of limbs and organs will be opened without the ethically questionable cloning of humans.

We may also reinvent the old ways of building houses and streets – something well known to ancient civilisations – so that they will be much better adapted to the magnetic and electromagnetic requirements of our bodies than the present ones. Of course, all this may still be waiting for us in a more distant future, but the past and present bioelectromagnetics researches provide a sound basis for such predictions.

## POVZETEK

*Človek se že od nekdaj nahaja v oceanu elektromagnentih energij in geomagnetnega polja. Marsikaj od tega lahko zaznava na ravni podzavesti, na primer bližino nevihte, nekateri ljudje lahko zaznavajo šibke anomalije geomagnetnega polja, kar jim lahko sproži šibke mišične odzive. Na tej osnovi naj bi po nekaterih raziskavah temeljilo bajaličarstvo. Poznamo tudi ljudi, ki so alergični, preobčutljivi, na nekatere frekvence EM polj in reagirajo podobno kot ljudje, ki so alergični na cvetni prah. Kaj pri vsem tem pomeni današnja naraščajoča EM polucija, je še nejasno. Različne epidemiološke raziskave še niso dale končnega zaključka. Zdrave ljudi z dovolj močno homeostazo umetna polja verjetno samo do neke mere obremenijo in se učinek ne pozna. Posebej občutljive ljudi in ljudi, ki so dodatno izpostavljeni stresu, pa okoliška EM polja lahko vržejo iz ravnovesja, kar lahko vodi v različna bolezenska stanja, pri čemer pa ni linearne povezave med jakostjo in frekvenco EM polj in ogroženostjo. Poleg škodljivih poznamo tudi koristne učinke EM polj, zlasti pri nekaterih boleznih. V bodočnosti lahko pričakujemo mnogo večje upoštevanje EM polj, tako glede njihovega škodljivega kot njihovega koristnega delovanja. Lahko da bodo omogočila celo posege v regeneracijo udov in organov.*

**KLJUČNE BESEDE:** elektromagnetno polje, geomagnetizem, neionizirajoča sevanja, človekovo okolje, koherentne oscilacije, elektromagnetno onesnaževanje, varnostni standardi, zaščita, epidemiološke raziskave, levkemija, rak, preobčutljivost, mobilni telefoni, zdravljenje z magneti, regeneracija.

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