

*Research*

## The Effects of Electromagnetic Fields on Health



**A survey by Dr. Otto Petrowicz**

So far a multiplicity of studies about „electrical smog“ have been carried out and published. In view of the abundant material it is not easy even for experts to keep an overview. A sifting of the published research reports and a critical discussion of the most important studies therefore proves to be essential.

Viewing the individual publications about the topic, a quite heterogeneous picture shows up. In principle each publication, which brings new research results to light, represents the current scientific status quo - at least in such a way, until it is obsolete or disproved by other investigations. The informative capability of the findings can be evaluated, however, only if one measures the underlying study according to clear, objective quality criteria. Among these criteria rank among others type and topicality of methodology, the number of cases, the biometric soundness as well as the plausibility and the reproducibility of the results. Of great importance are also the forums or the magazines, in which the work was presented or published, whose scientific level can be very different, and the fact whether the work is checked by independent consultants (distinguished scientists in this field) or not.

### Content

**RESEARCH**

The Effects of Electromagnetic Fields on Health **S. 1**

**ENVIRONMENT**

EEG Modifications and Sensitiveness to Changes in the Weather **S. 5**

**INFORMATION**

Use of Thermographic Methods For the Depiction of Absorbed HF-Energy on Surfaces **S. 6**

**FGF**

Seventh General Meeting of the FGF **S. 9**

**ELECTROMAGNETIC COMPATIBILITY**

Influence of Pulsed Electromagnetic Waves on the Electrical Activity of the Human Brain **S. 10**

**JURISDICTION**

Unified Jurisdiction **S. 12**

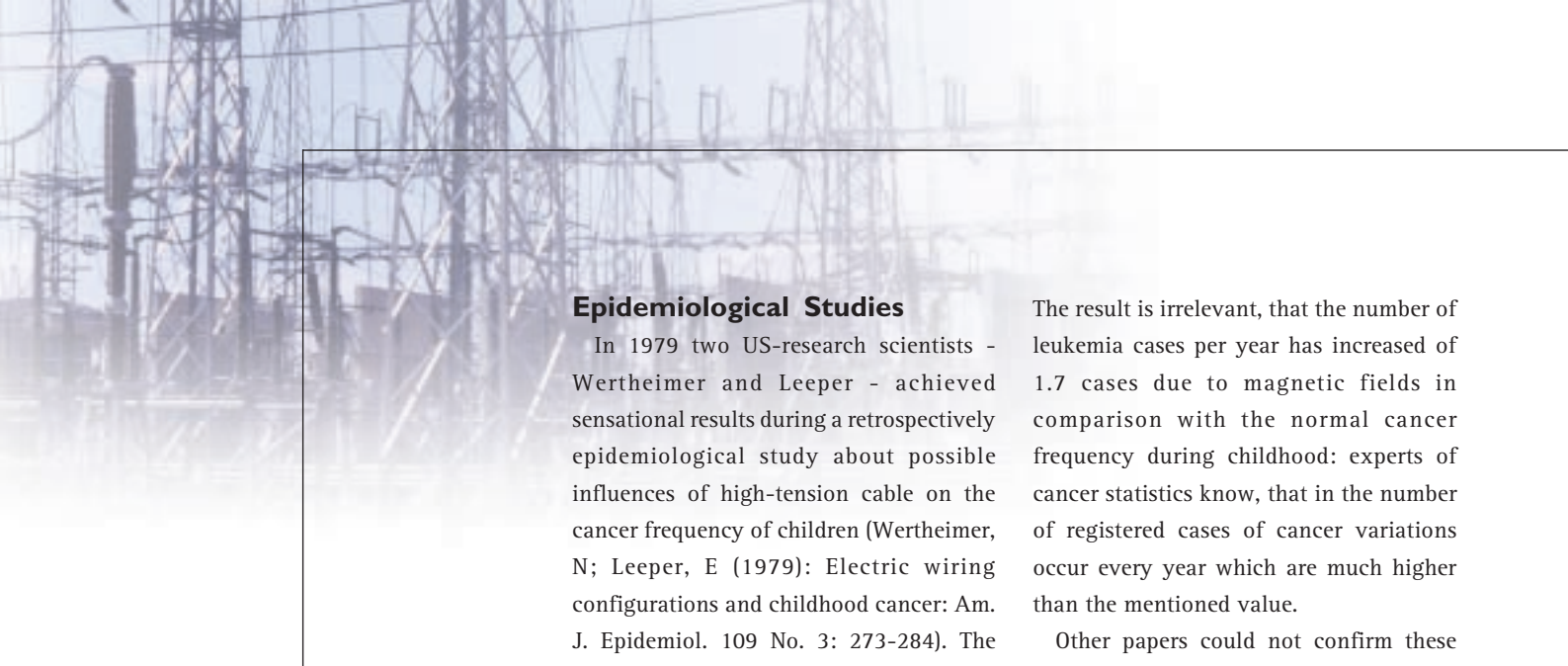
**NEWS**

**S. 16**

**IMPRINT**

**S. 16**





### Epidemiological Studies

In 1979 two US-research scientists - Wertheimer and Leeper - achieved sensational results during a retrospectively epidemiological study about possible influences of high-tension cable on the cancer frequency of children (Wertheimer, N; Leeper, E (1979): Electric wiring configurations and childhood cancer: Am. J. Epidemiol. 109 No. 3: 273-284). The investigation is based upon 344 deaths caused by cancer during the period from 1950 to 1973 in the area of Denver, Colorado.

Accordingly, adolescents had a 2 to 3 times higher risk factor to be affected by leukemia or tumors of the central nervous system. Nevertheless, at a closer look some deficiencies occur, arising questions about the validity of these conclusions. A general problem of these „older papers“ is the approximate evaluation of the exposition by means of the „wire code“. Besides the researchers only insufficiently considered other scopes of influence (co-factors) such as, e.g., the smoke habits of the parents, other radiation levels, for instance, X-rays which can favor a disease, social conditions, the traffic situation in the surroundings and the current cable conduction inside the habitations themselves.

The same topic was subject of a case-control-study which was presented by Feychting and Ahlboom in 1992 (Feychting, M; Ahlboom, A. (1992): Magnetic fields and cancer in people residing near Swedish high voltage power lines: IMM report 6/1992, Stockholm). The authors also came to the conclusion, that the cancer risk increases especially during childhood due to current-conducting cables. And again we find arguments herein, which make the theory of the scientists seem to be doubtful.

Hence it is, for instance, not evident, why children in single-family houses are more endangered - according to the investigation - than those living in apartment houses. Likewise the number of „cases“ is too low and therefore the possibility of an error respectively high.

The result is irrelevant, that the number of leukemia cases per year has increased of 1.7 cases due to magnetic fields in comparison with the normal cancer frequency during childhood: experts of cancer statistics know, that in the number of registered cases of cancer variations occur every year which are much higher than the mentioned value.

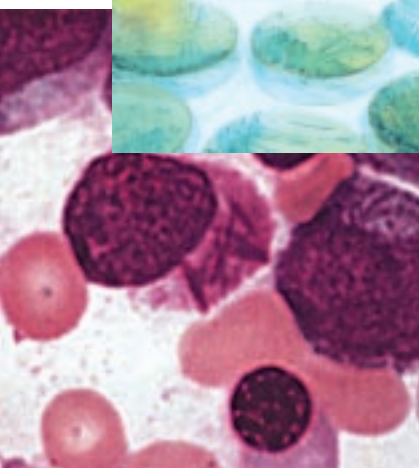
Other papers could not confirm these results. As a whole, large-scale epidemiological investigations refer only to vague correlations between EM-fields and cases of cancer, laying at the edge of significance. Apart from the mentioned weakness of the study other points of criticism are to be pointed out like the focusing on leukemia. Obviously, leukemia with its low latency and fast growth goes for a promising „nominee“ in the attempt to verify damaging environmental influences. Furthermore, it has not been taken into consideration, that „leukemia“ is a collective term for different symptoms which are quite different in their genesis and development. A separation into individual forms of leukemia has not or only insufficiently been made. The most important restriction is, however, the lack of knowledge about the exposition that was made in the past, which could only be roughly estimated and shows considerable mistakes.

### Melatonin

The effect of low-frequency fields on the human bio-rhythm has often been investigated. Thereby, a key role is assigned to the pineal gland in our brain. It produces the hormone melatonin, to which many functions, among others control functions of the day and night rhythm are attributed.

Some scientists fear that a decrease of the melatonin mirrors due to magnetic fields - especially at night - might lead to sleeplessness as well as immune weakness. Besides, it could nullify the protective function against cancer (radical scavenger) which is attributed to the hormone.

*Experimental investigations in cell cultures shall give further information about possible health effect of electromagnetic fields.*



*The fast growth of leukemia cells sometimes is put into a vague correlation with damaging environmental influences.*



*Possible health effects of high-tension cables had also been subject of a series of scientific investigations.*

In 1981 Wilson et al. had found a remarkable diminishing effect of electromagnetic fields on the melatonin production of male rats (Wilson, B.W.; Anderson, L.E.; Hilton, D.I. and Phillips, R.D. (1981): Chronic exposure to 60 Hz electric fields: Effects on pineal function in the rat. *Bioelectromagnetics* 2: 371-380). The results were rated as a weak chronic stimulation of the nervous system which influences the neuronal activity. Finally, the findings are, however, only relatively significant. A reason for that is the high individual variability of the melatonin concentration, which can make the results seem to be coincidental, since also malpractice in the use of biometric test procedures was recognized, which put the above mentioned significant differences into question.

Beyond, different investigations made in human medicine get contrasting results. Thus there is no evidence so far, for example, that humans are more sensitive to cancerous affection, if they are living against their bio rhythm.

In principle it should be noted that the extrapolation of findings from animal

experiments onto the human organism needs a detailed interpretation and is only permissible with considerable reservation.

### **EMF and Cancer**

The question after a possible cancer genesis or promotion due to electromagnetic fields is highly disputed in science. Beside the epidemiological studies also experimental investigations regularly deal with this subject. The investigations are made in vitro in cell cultures as well as in vivo in animal experiments - mainly on rats or other rodents.

A publication of Australian scientists from 1997 struck high waves (Repacholi, M.H.; Basten, A.; Gebski, V.; Noonan, D.; Finnie, J. and Harris, A.W. (1997): Lymphomas in E(-Pim 1 transgenic mice exposed to pulsed 900 MHz electromagnetic fields. *Rad. Res.* 147: 631-640). Michael Repacholi and colleagues had registered an increased Lymphoma-incidence with mice, which were exposed to high-frequency fields similar to mobile radio network for a longer time. However, the - quite essential - restriction has to be made, that the animals were genetically manipulated („transgene“)

and therefore had an enhanced predisposition for the development of spontaneous lymphoma anyway. At present several research institutions are trying to comprehend the experiments and to reproduce the results. It seems to be recommendable to wait for their results.

It is remarkable that short time later the same group made a similar study with 60 Hz magnetic field exposition, which did not show any differences between exposed animals and controls. This is an astonishing result, since effects could be rather expected at 60 Hz magnetic fields - if at all.

In 1993 Löscher et al. noticed symptoms of a causal connection between weak electromagnetic fields and the promotion of breast cancer (Löscher, W.; Mevissen, M.; Lehmacher, W. and Stamm, A. (1993): Tumor promotion in a breast cancer model by exposure to a weak alternating magnetic field. *Cancer Letters*, 71: 75-81). The scientists prescribed a breast cancer promoting carcinogens and then divided the animals into an exposition and control group. After several weeks of radiation with low magnetic field strengths, significant

differences appeared in number and size of the developed tumors.

The existence of a linear effect relation seems to be compelling if there were no contradictory findings. An element of uncertainty is at least the assessment of the tumor growth which has merely been determined by scanning. This appears to be the more important, as it was obviously no half-blind study. Therefore an important if not decisive influence on the findings has to be ascribed to the expectations of the experimentalist.

Considering the current discussion, it should be added that the results of the working group „Löscher“ are exposed to increased criticism of other teams being active in this area.

## EEG Modifications

Overwhelming resonance similar to the Feychting/Ahlbohm-study supplied an article of the medic Lebrecht von Klitzing from Lübeck (von Klitzing, L. (1993): In: Tagungsband (convention volume): Internationales Elektromog-Hearing (International Electromog Hearing), Niedersächsisches Umweltministerium (Ministry of the Environment of Lower Saxony)). Due to the long-term exposure to modulated mobile radio signals, the brain current diagram changed significantly with several test participants according to von Klitzing. The researcher assumes, that pulsed magnetic fields obviously led to a disturbance of the intracellular communication paths.

Among scientists, the results largely noticed by the public met an extremely

*Experimental setup and methodology are also decisive concerning the significance of research findings.*



divided echo. It was reproached to von Klitzing, that the signals generated by electromagnetic coils would not correspond to the GSM standards and a clear experimental description would be missing. Accordingly it was complicated or even impossible for other researchers to reproduce the presented findings.

Hence, for instance, Röschke and Mann (1997) could not verify the described effects. (No short-term effects of digital mobile radio telephone on the awake human electroencephalogram. Bioelectromagnetics 18: 172-176). In a placebo-controlled experiment the scientists could not verify an influence of GSM mobile telephones on the awake electroencephalogram. Here it has, however, to be considered that the probands were only exposed short time (3 ½ minutes) to radio waves - different to the case of the Klitzing-study.

Besides it has to be regarded that the EEG is very receptive even to weak exterior stimulation. Therefore it can only in a restricted sense serve as an indicator for a possible electromagnetic interference potential. If the measurement results reported by von Klitzing were really confirmed, the findings would most probably be bioeffects without any health relevance.

Again it should be added because of the current scientific discussion that two further studies, both published in 1998, dealing with EEG modifications by weak GSSM and DCS signals and likewise could not reconstruct the EEG modifications postulated by von Klitzing.

## Solid Evidences are Scarce

At a closer look almost all investigations suggesting a potential health risk due to EM-fields cannot convince in the end. There are often striking deficiencies of methodical, biometric or dosimetric type, which make the validity of the test results appear doubtful. It is true that the repetition of tests to achieve positive effects is not always easy. Nevertheless, they are absolutely necessary and again they indicate that even spectacular findings can not be reconstructed and

therefore have to be questioned. Unfortunately people often overestimate such findings as clear statements about a real health relevance or the results are only valid for the used model and its close packed conditions. It must absolutely be differentiated between biological effects without health consequences and such, which favor or cause the emergence of serious illnesses. Environmental attractions such as light, sound, warmth etc. cause biological effects and reactions in us, which are harmless below a threshold value, above a certain threshold level, however, they are impairing and even lethal. With low-frequency electric and magnetic fields and high-frequency electromagnetic radiation it is the same way. The existence of harmful athermal effects of such fields below or even far below such thresholds, respecting the relevant recommendations and regulations (limit values), have not been proved and are unlikely due to the present research findings. Obviously the accusing party makes it sometimes easy for itself to represent unwarranted risks by EM-fields as given in a doubtful manner. For objective researchers it is growing more difficult to treat the suspicion meanwhile deeply rooted in the population with strictly scientific arguments.

The task gets even more complicated by the fact, that scientists can only prove the harmfulness of a matter. A „zero-proof“ - i.e. the guaranty, that an agent under no circumstances produces detrimental effects - is, however, an unattainable ideal.

The presented survey is an extract from an extensive assessment of altogether 20 selected, much quoted scientific publications about the subject „Do electric, magnetic and electromagnetic fields have a health relevance?“ of March 1998.

The unabridged text can be seen or downloaded over the Internet supply of the Forschungsgemeinschaft Funk e.V. (Research Association for Radio Applications) under <http://www.fgf.de/Forum> of topics.

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# EEG Modifications And Sensitiveness to Changes in the Weather



**General indisposition, headache, phantom or scar pain - the range of weather-related („meteorotrop“) complaints could be extended at will. Indeed some people seem to be especially receptive to the caprioles of the weather. But what is it, that makes the affected persons react as a living „seismograph“?**

A possible solution could be supplied by the biometeorology, which in the weather forecast and its effects on the organism does not only consider visible quantities such as the cloud configuration, but also diverse physical phenomena. Revealing indicators for a forthcoming change in weather are the so-called Very Low Frequency (VLF-) Sferics - extremely short-lasting electromagnetic pulses which develop from lightning discharge.

Due to their expansion at speed of light, Sferics already announce a thunderstorm before it reaches the region concerned. Apart from their meteorological importance, Sferics have already been tested several times for their biological effectiveness.

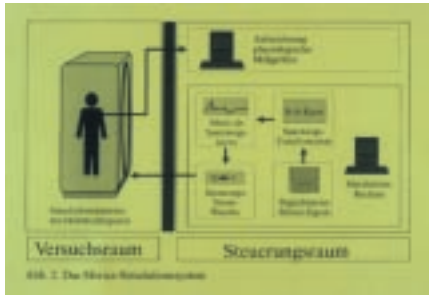
Numerous correlation studies suggest the connection of natural Sferics activity and physical complaints such as headaches and sudden hearing losses and in individual cases even heart and epileptic attacks. The previous studies could, however, not prove a direct causality.

As the discharges have the signal characteristics of a potential biotrop stimulus, their role as a possible cause of complaints about sensitiveness to changes in the weather was investigated within the scope of two double-blind studies. In the first experiment two groups similar of age and sex with comparable sensitiveness to changes in the weather were at first formed out of 20 female and male test persons.

After a baseline phase of ten minutes the researchers exposed the first test group to the pulses of an especially developed Sferics simulator for the same period of time. For this test the magnetic component of a representative pulse with an amplitude of 50 nT and a duration of 0.5 milliseconds was selected, which was generated during the exposition period with a randomized pulse frequency between 7 and 20 Hertz. To register longer lasting effects, the

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**C** pilot study had  
**U** already shown  
**R** modifications in  
**I** the alpha band of  
**R** the EEG as a  
**E** result of a  
**F** Sferics exposition,  
**F** this time the  
**S** researchers  
**S** have been  
**S** successful again.

# Use of The For



Schematic depiction of the Sferics-test setup



Data of the general sensitiveness of the test persons to changes in the weather had been recorded additionally to the EEG.

proband afterwards passed a 20 minute control phase without stimulus application. The second test group was not exposed to any stimulus.

After a previous pilot study had already shown modifications in the alpha band of the EEG as a result of a Sferics exposition, the researchers succeeded again this time. The brain current activity of the test group reacting with an increase of the alpha power differed from that of the non-stimulated control group which showed a „contrary reaction tendency“. Only near the end of the test the spectral power level of both groups approached each other again.

In a questionnaire the test participants had to specify from which meteorotrop complaints they usually suffered and how distinctive the correlative symptoms were. In a comparison with the results of measurements in the EEG it manifested, that the test persons sensitive to changes in the weather showed a stronger alpha power in certain parts of the brain under

the influence of Sferics than their less sensitive test fellows.

A second test series entered into the question whether the observed EEG modifications were a repeatable reaction pattern. For this study the scientists selected 32 women aged 19 to 76 years, who according to their own statements suffer regularly from migraine or tension headaches. The patients had in common, that they put down their complaints to the influence of meteorological factors. The most frequently mentioned causes were sudden changes of weather with 79 percent, changes of temperature with 48 percent and thunderstorms with 21 percent.

The test sequence as well as the results of measurement of the second experiment were otherwise identical to those of the first one: while the control group only showed minimal EEG modifications, the exposition group indicated an analogous increase of the alpha power. Physical complaints of the participants could, however, not be registered by the scientists. The experiments suggest, that the used Sferics exposition is a biologically effective stimulus which can release changes of the spectral composition of the spontaneous EEG. This means, that the human organism reacts more sensitive to low-amplitude magnetic fields in the low-frequency range than assumed so far. Whereas, in view of the results it is still unanswered whether Sferics can lead to marked changes in health in the sense of complaints about sensitiveness to changes in the weather. The scientists, however, do not exclude, that the observed EEG modifications might be a preliminary stage of a meteorotrop reaction. Further research is indispensable in any case.

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