The following reports are concerned with recent original scientific publications on the effects of high frequency fields posed by mobile communication systems. The author, Professor Dr. Roland Glaser, personally selected the publications to be discussed and has subjectively assessed the relevancy of each publication.

The Latest Scientic News

The epiphyse (the pineal-organ) produces melatonin, a time regulator for the body, and therefore it is still a major subject of discussions regarding field effects on humans, be it low or high frequency ranges.

For some time now, it has been known that in humans and in animals calcium deposits form in this organ, these deposits consist of hundreds of micrometer sized structures in the shape of mulberries and small 10-20 micrometer sized crystals, which look completely different. The latter have been for the first time crystal graphically analysed and identified as octagonal single crystals, whose characteristics can be ascribed as piezo-electric. Even though they cannot be compared to the magnets Krischvink described, the idea in this case that there **could be non-thermal mechanisms of high frequency fields, should be carefully considered.** This concept seems to be far-fetched, since there are many other piezo-electric structures all over the body and besides that the effects of weak HF-fields on melatonin production is highly unlikely (Baconnier, S.,Lang, S.B.; Polomska, M.; Hilczer, B.; Berkovic, G.; Meshulam, G.: Calcite micro crystals in the pineal gland of the human brain. First physical and chemical studies. Bioectromagnetics.: 23, 488-495. 2002)

Is the incidence of skin cancer (melanoma) dependent on the intensity of the surrounding FM transmitters? Örjan Hallberg und Olle Johansson, dermatologists at the Karolinska Institute in Stockholm believe they have found such a correlation. **They correlated an increase in the incidence of skin cancer with the number of surrounding transmitter masts and even with the transmission frequency.** They do, however, concede that in the former east-block countries which transmitted low FM-frequencies (70 MHz) had fewer problems since these frequencies were further away from the resonance frequencies of the human body than those in countries where 87-108 MHz are transmitted. Nevertheless, it is surprising that as an antenna measurement arm-leg and torso were used and not the entire length of the body because when measurements are taken in this way the conclusions would not be correct. Since most transmitters are horizontally polarized, the most dangerous position for humans would be a horizontal one and the most dangerous time would be during the night. Correspondingly, one would recommend placing one's bed in the direction of the weakest fields. The section on confounders is very short and only states that an increase in traffic density has been observed or recently more attention has been paid to the diagnose of melanoma. The effects of UV were only marginally mentioned. Changes in holiday and travel habits, which will certainly have a sustained effect on northern Europeans or an increase in the number of visits to solariums was not dealt with in this paper. (Hallberg, O. and Johannsson, O.: Melanoma incidence and frequency modulation (FM broadcasting. Arch. Environm. Health 57, 32-40. 2002).

After the first investigations concerning **the influence of high frequency mobile communication fields on EEG and sleep.** (Borbely et al. Neurosci. Lett. 1999, 275, 207; Huber et al. Neuroreport 2000, 11, 3321), this Swiss group presented the results of investigations, which also included measurements taken on regional cerebral blood flow by means of Positronen-Emissions-Tomography (PET). It could

be shown with great significance that probands who had been exposed for half an hour on the left side with GSM similar pulsed fields (900 MHz, 1 W/kg), exhibited after 10 minutes an increase in local circulation in the exposed half of the brain. With regard to non-pulsed fields of the same intensity, these effects could not be established. The authors came to the conclusion that the effect could not be attributed to an increase in temperature. (Is the space-time temperature gradient in both irradiation modes really identical?) In a further experiment the effects on sleep were investigated with an identical irradiation plan. A EEG frequency analysis done before falling asleep showed an increase in the intensity of the alpha-spectral range, which only occurred after irradiation with pulsed fields. Even when the sleep phase itself was not significantly effected by irradiation, with pulsed fields a similar EEG-change was also measured in the NREM sleep phase, which even increased during the course of the night. The authors stressed that the measured effects were slight and no conclusions could be drawn with regard to health but their results should not be disregarded. (Huber, R.; Treyer, V.; Borbely, A.A.; Schuderer, J.;Gottselig, J.M.; Landolt, H. P.; Werth, E.; Berthold, T.; Kuster, N.; Buck, A., and Achermann, P.: Electromagnetic fields, such as those from mobile phones after regional cerebral blood flow and sleep and waking EEG. J. Research. 11, 289-295. 2002)

D.L. Hamblin and A.W. Wood from the Swinburne University of Technology in Melbourne, Australia analysed in an exhaustive and meticulous study on current research pertaining to the **effects of mobile phone emissions on brain activity and sleep parameters.** Basically, since 1995 up to the point when this paper was concluded in January 2002 there were only18 publications on the subject. Low frequency effects have been investigated in the past and these types of publications are more frequent, however it must be emphasized and rightly so that these results are at most relevant with regard to the magnet fields which originate from the working currents of mobile phones. An overview of the study shows that there is little consistency regarding the results. Occasionally, the same authors could not reproduce their results in a second series of experiments which they obtained in the first study. What could be the cause of this? A series of methodical limitations has been discussed: e.g. differences in frequencies and intensities, as well as antenna configurations; differences in measurement time schemes and in irradiation and differences in how the results are statistically worked out. While some authors investigated changes **during** irradiation, only some registered such changes at different times **after** irradiation. The number of groups investigated did not always allow for reliable statistical statements. What was generally criticised was that all of the measurements were carried out on young healthy probands and therefore, it is not possible to make any direct statements concerning children or the elderly. In any case it seems as if fields of a maximum mobile phone intensity range held to the head can temporarily have an effect, especially on the alpha-waves of EEG. How can this be explained? Are they subtle thermal effects, which promote blood flow, or must a cellular mechanism be held responsible, this is always discussed over and over again, (but never proven) namely calcium efflux? Could it be that perhaps the effects can not be attributed to HF-fields but attributed much more to the circa 7,5 microtesla, 8Hz magnet fields of the working currents of mobile phones? (Concerning this point the authors see a need for further research to be done!) Other methods proving brain activity should be incorporated, e.g. the positron-emissions-tomography (PET), which can provide information on blood flow changes (please see the report by Borbely et al. in this review of scientific publications). To sum up, the authors have come to the conclusion that there are indications of effects that must be scientifically explained, but there is no reason at all to be concerned about health risks. The current valid limit values are completely adequate in protecting the public from possible risks, particularly when currently published epidemiological results indicate that there is no evidence whatsoever indicating a risk to health. (Hamblin, D. L. Wood, A.W.: Effects of mobile phone emissions on human brain activity and sleep variables. Int.J. Radiat. Biol. 78, 659-669. 2002)

Professor Roti Roti's working group (Division of Radiation and Cancer Biology, Univ. St. Louis, USA) published the results of an extensive study on the **effects of FDMA and CDMA modulated HF-field systems on the induction of micronuclei in the fibroblasts cell-lines of mice.** In contrast to the positive control group where irradiation was carried out with gamma-rays, between 0.3 and 1.2 Gy and where a clear dose-effect-curve could be shown. With regard to the HF-fields, even in extreme cases (5 W/kg, 24 hours) with the three independent experiments a significant effect could not be found neither in the exponential phase of growth nor in the plateau phase. The authors discussed the divergence of these results with the findings of Tice et al. (Bioelectromagnetics.23, 133-126.) 2002, compare "Neues aus der Wissenschaft" (The latest scientific news) issue 1, 2002 of this journal) which reported on a four fold increase in the number of microneuclei but with a double SAR value. Perhaps this is due to differences in cell sensitivity (tice used cultured human lymphocytes) which was also evident in the number of microneuclei in the control group, perhaps when there is an increase in the field strength there is

also an micro-thermal effect in the experimental receptacle? In any case these findings should be more closely and critically investigated. (Bisht, K.S., Moros, E.G., Straube, W.L., Baty, J.D., and Roti, J. L. R.: The effect of 835.62 MHz FDMA or 847.74 MHz CDMA modulated radiofrequency radiation on the induction of micronuclei in C3H 10T1/2 cells, Radiat. Res. 157, 506-515. 2002)

A Finnish working group reported on an **increase in protein-phosphorylation and an expression of heat shock protein (HSP) in cultured human endothelial cells which were in vitro irradiated with 900 MHz GSM signals.** The SAR- values in the two Petri dishes, which were simultaneously irradiated, were calculated so that the thermal measurements of the inhomogeneous fields were between 1.8 and 2.5 W/kg. Since the Petri dishes were cooled from below by a flow system, and the temperature corresponded to the measurements taken before and after irradiation, which complied with the limit of 0.3 degrees, the authors considered this to be a non-thermal effect. Unfortunately, no statistical evaluation was given, not for the threefold increase in the total protein-phosphorylation nor for the extent of the increase in HSP-development. The error bars shown in the diagram 2D and 5 do not indicate any significance. From a qualitative perspective it seems that the hsp27 presents itself in two different conformations. Within the study there is an extensive scheme recording the way from these changes to the induction of cancer and its consequences are discussed. However, since HSP-development is a normal physiological protective mechanism, which occurs frequently when various cell stress related conditions are present, one wonders why cancer does not occur more often. (Leszcynski, D., Joenvaara, S. Reivinen, J., Kuokka, R.: Non-thermal activation of the hsp27p38MAPK stress pathway by mobile phone radiation in human endothelial cells: Molecular mechanism for cancer- and blood-brain barrier related effects. Differentiation **70**, 120-129. 2002).

In 1998 a working group of the University of Freiburg published the results of their investigations in which the **radio fields of a mobile phone lead to an increase in the blood pressure of test persons** (Braune et al., Lancet. 351, 1857.1998), and this study was criticised due to its lack of statistics (Reid et al., Lancet. 352, 576.1998). In the meantime, the authors have done the experiments again, but this time under stricter experimental conditions. In simple blind experiments conducted with 40 probands between the ages of 20 and 34, finger measurements were taken of blood pressure, heart rate and capillary blood flow. In contrast to the earlier experiments no effects where found from the fields of a mobile phone held to the head (GSM 900 MHz, 0.5-0.84 W/kg) (Braune, S.: Reidel, A. ; Schultemonting, J., and Raczek, J.: Influence of a radio frequency electromagnetic field on cardiovascular and hormonal parameters of the central nervous system in healthy individuals. Radiat. Res. 158, 352-356. 2002)

Is hearing affected by the electromagnetic fields of mobile phones? The working group of the medical faculty of the Inonu-University (Turkey) set out to answer this question. Experiments were conducted with 20 probands, a mobile phone was held to the left ear in order to measure possible oto-auditory changes after a 10 minute telephone call with a Pansonic GD 600 device. No effects could be found. Unfortunately, the study did not contain a dosimetry, it was merely mentioned that this device functions with 900 MHz in GSM mode and has an electrical power of 0.02 and 2 watts (Ozturan, O., Erdem, T., Miman, M. C., Kalcioglu, M.T., and Oncel, S.: Effects of the electromagnetic field of mobile telephones on hearing, Acta Oto Laryngologica 122, 289-293. 2003).

Are there any **"non thermal" effects stemming from high frequency electromagnetic fields,** effects that occur below the intensity-level, which can be proven as thermal? Robert K. Adair has quoted from two 1996 studies where it was established that such supposed effects have been proven to be the result of measurement errors. As far as the experiments are concerned, we may question from a biophysical point of view if such effects can be expected to occur at all. Robert Adair, who has repeatedly critically analysed publications on this subject by various authors, systematically analyses the problem. A focal point is of course thermal noise. A physiological primary reaction is only possible when a special mechanism has been found where the absorbed energy exceeds the thermal energy. It should not be forgotten that in the range of the HF-fields the effect of the magnetic field vectors, e.g. through the radical-pair-recombination mechanism, has to be ruled out. Even with a power flow density of 10 mW/cm^2 the magnetic field is still four powers of 10 smaller than what is required for this mechanism. The author categorised conceivable electric mechanisms into three classes: A - charge motion, B – the triggering of dipole motion, C - electro restrictive effects. With regard to category A he calculated charge movement and molecular rotation. Even when coherent behaviour is considered, it would be many powers of ten below thermal noise. In the process a power flow density was respectively presupposed at $10mW/cm^2$, which corresponds to an E-field of 200 V/m. Category B was assigned the concept that a field could affect the dipole of a transport protein and, therefore, effect the excitation process of the membrane. What speaks against this is not only the time constant of this process but the lack of energy as well. However with regard to electrostriction, about one cell (class C) in fields of this dimension effects occurred, but on the other hand,

these were concealed by thermal membrane oscillations. Resonance-effects have to be ruled out because of the viscosity characteristics of the cell. The Fröhlich theory of coherent excitement is also being discussed and it has been established that even when the vixcose loss is not considered, this mechanism placed in class B, cannot function. On the other hand the experiment and the theory seem to be in agreement that athermal reactions of this kind do not exist and they cannot possibly exist. Nevertheless, the author refers to the electrostrictions as the only possibility, at least with regard to energy that cannot be completely ruled out. Comprehending this train of thought is well worth it (in spite of a few printing errors in formulas and in the text). (Adair, R. K.: Biophysical limits on athermal effects of RF and microwave radiation. Biolectromagnetics. 24, 39-48. 2003).

While directly deducting nerve impulses with the aid of micro-electrodes, it was found out how cells in the cerebrum and the cerebellum of zebra finches react to weak GSM-signals (900 MHz, 217 Hz-Pulse, 0.1 m W/cm², 0.05 W/kg). For this purpose the birds were anaesthetized and were irradiated in a tuned wave guide. The microelectrodes were put into place through a 4 mm hole in the skull. From the 133 cells which were examine, 52% exhibited under field effects a circa 3.5 fold increase in spontaneous impulse rate and 17% showed a slight decrease. The effects occurred after switching on the field with a latent time of 104±197 seconds and faded out with a time constant of 308±68s after turning off the field again. Nonpulsed fields triggered no reaction. The authors are aware of the possibility of artefacts, which among others, could occur when the measuring electrode under the effects of the field could turn into a stimulus electrode. This is avoided with the corresponding field orientation. A reproduction of the results done with independent methods seems to be required here. (Beason, R. C. and Semm, P.: Responses of neurons to an amplitude modulated microwave stimulus. Neuroscience Letters; 333, 175-178. 2002).

K.A. Hossmann and D.M. Hermann at MPI for neurological research published a **literature overview on the possible effects of mobile radio emissions on the central nervous system.**

The results of in-vitro investigations, animal experiments, investigations with probands and epidemiological evaluations were critically assessed and refereed. The authors came to the conclusion that some of the material has to be more closely examined. For instance, the effects that were found on sleep and cognitive functions, which are very difficult to reproduce, should be pursued further. However, all together there is a slight possibility that pulsed or continuous mobile radio emissions can effect the functional and structural integrity of the human brain. Only in thermal cases is the effect consistent, but this is beyond the normal mobile phone exposure. On the other hand, there are indirect effects for instance the increase in the number of traffic accidents caused by using a mobile phone while driving. This has to be taken into account and how to avoid such accidents has to be more intensely discussed. (Hossmann, K. A. and Hermann D.M.: Effects of electromagnetic radiation of mobile phones on the central nervous system. Bioelectronmagnetics 24, 49-62. 2003).

Three years ago, the working group of Lennard Hardell used data (from 1994-96) taken from the Swedish cancer register and compared the incidence of brain tumours with mobile phone use (Hardell, L: et. al.: Intern. J. Oncology, 15, 113-116. 1999). Now there is a new study, emphasizing the years 1997-2000, without using the old values. It deals with data from patients who are still alive (total no. of patient 588, aged 20 to 80). These patients were compared to the same number of test persons. Data on the test persons was recorded with questionnaires, and sometimes telephone consultations were made concerning the private exposure, smoking habits etc. and also on the settings of the telephone calls (e.g. the average time spent on the phone per day, if the telephone was held to the left or right ear. The study dealt with analogue (18.7%), digital (34.7 %) and cordless phones (30.4%). With regard to these three categories, as in the previous study, no significant risk increase could be found. However, the results would be different if a correlation between both sides would be taken into account with regard to the incidence of cancer and normal telephone use and the occurrence of brain tumours. Analogue- telephones resulted in an OR of 1.85 (95% confidence interval: 1.16-2.96) digital telephones 1.59 (1.05-2.41) and cordless telephones 1.46 (0.96-2.23).

These values are not high and statistically they are not very certain, but nevertheless they must be considered. It must however be considered that the absolute number of cases with regard to this differentiation decreases drastically (analogue: 50/27, digital 59/37, cordless 55/37). It is an open question whether the authors can justifiably ascertain that the patients even after a diagnose and therapy did not know in what part of the brain their tumours were located. In any case the objectivity of the statement if the probands telephoned on the left or the right side does not seem certain. The authors are of the opinion that statistical errors can of course not be excluded, however it seems that due to this, the results cannot be explained. (Hardel, L.; Mild, K.H., and Carlberg, M.: Case-controlled study on the use of cellular and cordless phones and the risk for malignant brain tumours. Int. J. Radiat. Biol. 78, 931-936. 2002).