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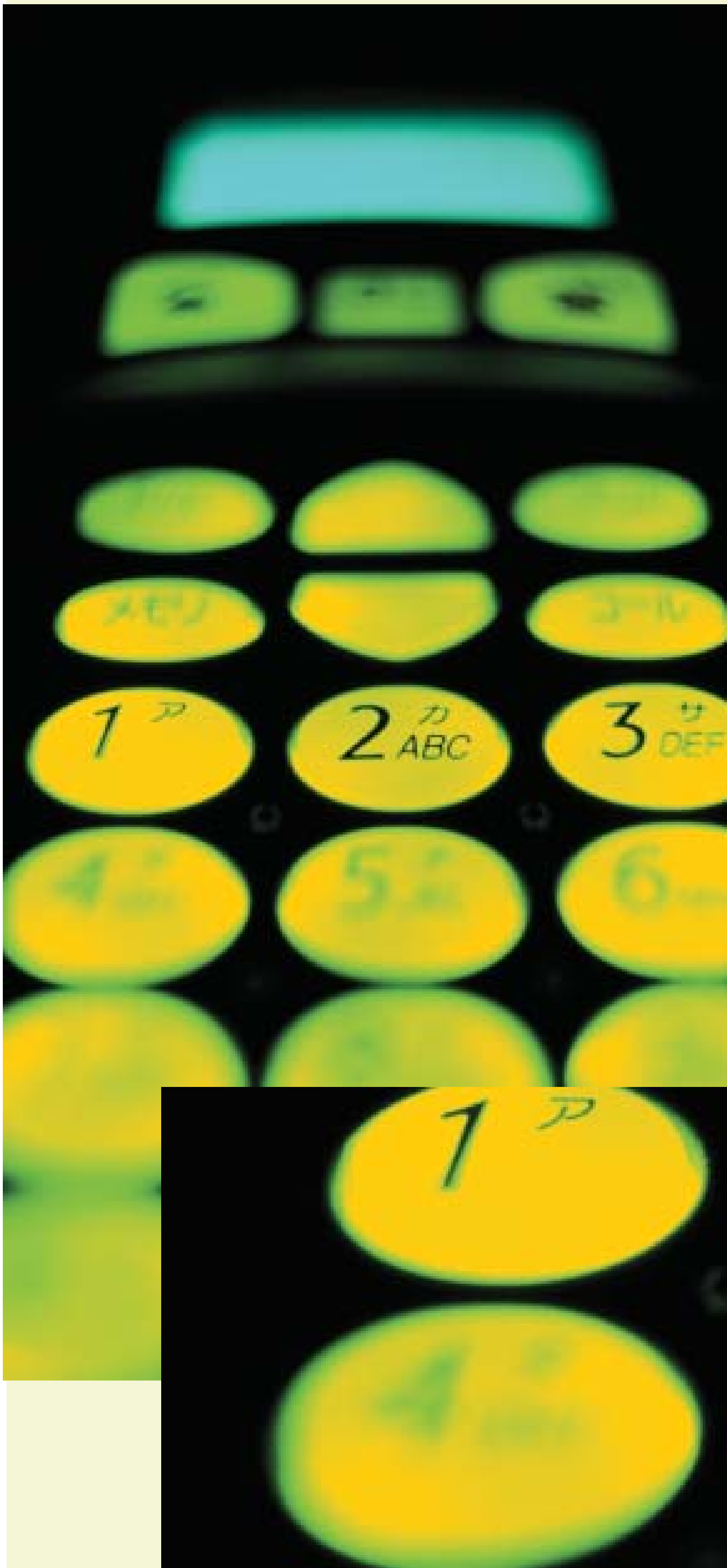

When heeding basic hygienic rules and the manufacturers' instructions, other dangers such as toxication (use of wrong dishware), diseases caused by salmonellas, etc. (insufficient heating), and burns (carelessness) can also be excluded. In fact, all these problems can also occur when using other cooking methods.

Dipl. Ing. Regina Reichardt, Forschungsgemeinschaft Funk, Bonn

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Kenneth R. Foster

How act mobile radio fields in the organism? Is a theoretical question with important real-world implications. Many scientists have speculated about mechanisms by which RF fields might cause biological effects (for a recent example see J. Silny 2000), but no mechanisms for biological effects at the low exposure levels associated with wireless communications have been established. Two recent scientific studies raise this issue once again.

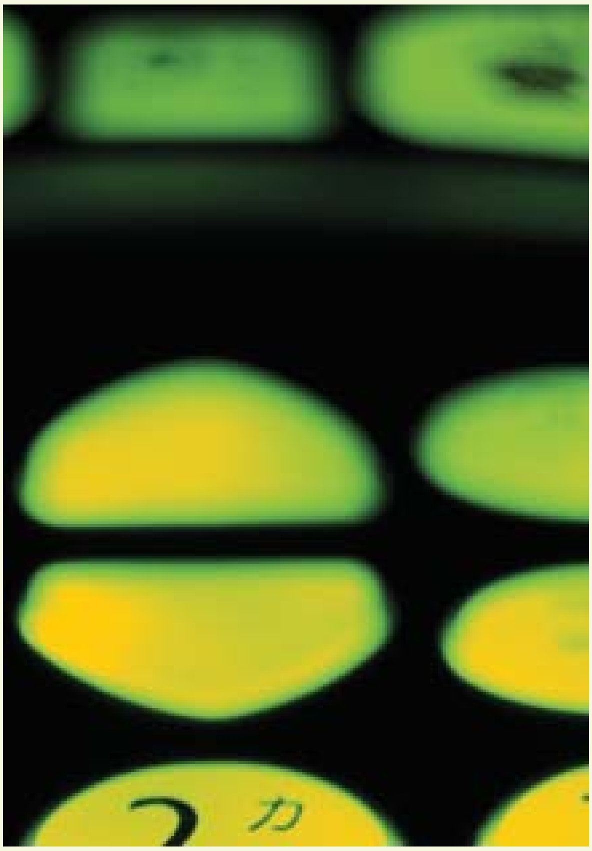
The first study, a paper by the respected physical chemist Bo Sernelius (Linköping University, Sweden), was published on-line in early 2004, accompanied by considerable media attention. The study is now described on many activists' websites as yet another proof of harmful effects of RF energy.

Sernelius calculated a particular kind of force between cells, called dispersion forces. He found a huge increase in these normally weak forces in the presence of mobile phone radiation by eleven orders of magnitude, which compares to the ratio of the height of a man to the distance between the earth and sun. Under normal circumstances, dispersion forces between cells are insignificant. Sernelius claimed that dispersion forces, in the presence of mobile phone radiation, would be sufficient to cause cells to move together, potentially causing biological effects.

There is, however, a serious flaw in the theory, which Yale physicist Robert Adair described in an as-yet

„It is natural to assume that one might be able to manipulate the force between objects in solutions, with a high water content, by electromagnetic waves in the microwave range. This range happens to be where mobile phones operate.

This gave me the idea to investigate how the forces between two blood cells were affected by the radiation from mobile phones“
Interview with Bo E. Sernelius
http://www.rsc.org/is/journals/current/pccp/Sernelius.htm



unpublished letter to the journal. Dispersion forces arise from the interaction between the very small dipole moments that spontaneously arise in particles by due to the motion of their electrons. The same motion of the electrons is responsible for black body radiation (which is emitted by all matter at temperatures above absolute zero). Thus the dispersion forces between particles are linked to the black body radiation they emit.

Sernelius, in his calculation, had replaced the normal black body radiation from a cell by "cell phone radiation", in effect assuming that the cells are radiating energy at 850 MHz at an intensity similar to that produced in tissue by a mobile phone. As Adair showed, such fields, from an external source, are not capable of inducing forces of the strength that Sernelius claimed. There is clear experimental evidence that electric fields will induce forces between cells, but at 850 MHz the fields would have to be very strong to cause noticeable movements in the cells (Foster 1992, 2000).

Yet another theoretical study on mechanisms of interaction appeared in the European Biophysics Journal in October 2003. Authors A. Budi and colleagues modeled the motions of atoms in an insulin molecule during "short-lived thermal stress" produced by (numerically) increasing the temperature by 100°C for 2 nanoseconds. The calculations found significant thermally-induced changes in the molecule. What this implies about biological effects of pulsed microwave energy is less clear, however. Not even RF-experts can make transmitters capable of producing such large temperature increases in a biological preparation in such a short time.

The mechanisms of interaction between RF fields and biological systems have been studied for many years. A variety of mechanisms have been well established by which such fields could potentially produce biological effects. However, these require very high field strengths are needed to produce observable effects, far above those that will produce injurious heating. Theories that claim to show mechanisms for low-field effects are either technically flawed (Sernelius) or involve enormous exposure levels (Budi et al).

Why should anybody be concerned about the mechanisms of interaction between RF fields and tissue? In the real world, health risks are judged by human and animal data. The molecular mechanisms for few if any risks are well understood.

While health agencies would be reluctant to dismiss a potential hazard in the absence of an understanding of its mechanism, *some* understanding of mechanism is needed, if only to anticipate the exposure conditions that might be hazardous. This is particularly important with RF energy, which can be produced at many frequencies, modulation characteristics, and intensities. As health agencies have pointed out, many "nonthermal" effects have been reported from RF fields, but sufficient understanding is lacking to use these data to establish safety guidelines.

After many years of study, a variety of mechanisms for interaction between RF fields and biological systems have been well documented. Major exposure limits (such as those ICNIRP) are based on avoiding excessive heating of tissue, a thermal mechanism. A variety of nonthermal mechanisms have been demonstrated as well (Foster 2002) but these generally require very strong fields to produce observable effects.

The lack of a plausible mechanism of interaction for weak-field effects, on the other hand, is reason to look carefully at the validity of the experimental data that purport to show such effects. Many of these reported effects disappear on further examination, and presumably were artifacts.

Meanwhile, the search for mechanisms for low-level effects continues, and new candidates are appearing at frequent intervals.

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We aim to establish methods for studying the molecular mechanisms of protein structural and energetic changes occurring due to external stresses related to nonionizing radiation by using a combination of experimental and theoretical approaches."

From A. Budi, S. Legge, H. Treutlein, I Yarovsky (2004) Effect of external stresses on protein conformation: a computer modelling study. European Biophys. J. 33:121-129.

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