

Letters

Comments on "Nonthermal Effects of Extremely High-Frequency Microwaves on Chromatin Conformation in Cells *in vitro*—Dependence on Physical, Physiological, and Genetic Factors"

John M. Osepchuk and Ronald C. Petersen

As long-time workers on development of microwave safe-exposure standards, we are keenly aware of the deficient quality in many of the papers in the bioeffect literature, particularly those relating to microwave artifacts. In the November 2000 issue of this TRANSACTIONS, there are many good papers but there are also papers displaying deficiencies. We are not able to review all such deficiencies, but we restrict our comments here to the above paper,¹ which makes the extraordinary claim [1] of a significant microwave bioeffect at an incident power density of 10^{-19} W/cm², well below that of thermal noise in a bandwidth of practical significance.

In the above paper, Belyaev *et al.* reiterate that claim and dismiss our critique [2], but they do not demonstrate that they have monitored or controlled the level of temporal harmonic signals. These, we claim, probably play a role in their experiments, especially when they reduce the fundamental signal by as much as 100 dB, using a simple vane-type waveguide attenuator. They thereby neglect the fact that such attenuators are ineffective at harmonic frequencies in an overmoded waveguide. As we stated before [2], such extraordinary claims as theirs [1] demand extraordinary proof. They do not provide such proof.

The above paper is a broad review of a wide range of purported frequency-specific athermal effects at millimeter-wave frequencies reported in the German and Soviet/Russian literature. We do not refer to the substantial U.S. literature [3], [4] that reports failure to replicate much of the work reviewed by Belyaev *et al.*

Belyaev *et al.* refer to "successful therapy" of millimeter waves as further evidence of the validity of their effects, but that is analogous in the U.S. to stating that the booming business [5] in magnet therapy proves the validity of the alleged science basis for their business. The hard-science community, however, rejects this conclusion and even suggests that it is voodoo science [6].

The history of microwave bioeffect research is replete with examples of reports that eventually were judged as nonreplicable for various reasons [7], [8]. In the past, this disjointed record could be excused as researchers slowly learned the artifacts and other pitfalls of a new endeavor. In today's enlightened state of research, e.g., note Guy *et al.* [9] and Chou *et al.* [10], there is little justification for recurrence of such artifacts. Reviewers and editors, please take note.

REFERENCES

- [1] I. Y. Belyaev, V. S. Shcheglov, Y. D. Alipov, and V. A. Polunin, "Resonance effect of millimeter waves in the power range of 10^{-19} to 3×10^{-3} W/cm² on *Escherichia coli* cells at different concentrations," *Bioelectromagnetics*, vol. 17, no. 4, pp. 312–321, 1996.

Manuscript received March 3, 2002.

J. M. Osepchuk is with Full Spectrum Consulting, Concord, MA 01742 USA.

R. C. Petersen is with Petersen Associates, Bedminster, NJ 07921 USA.

Publisher Item Identifier 10.1109/TMTT.2002.800432.

¹I. Y. Belyaev, V. S. Shcheglov, E. D. Alipov, and V. D. Ushakov, *IEEE Trans. Microwave Theory Tech.*, vol. 44, no. 11, pp. 2172–2179, Nov. 2000.

- [2] J. M. Osepchuk and R. C. Petersen, "Comments on 'Resonance effect of millimeter-waves in the power range from 10^{-19} to 3×10^{-3} W/cm² on *Escherichia coli* cells at different concentrations,'" *Bioelectromagnetics*, vol. 18, pp. 527–528, 1997.
- [3] S. M. Motzkin, "Biological effects of millimeter-wave radiation," in *Biological Effects and Medical Applications of Electromagnetic Energy*, O. P. Gandhi, Ed. Englewood Cliffs, NJ: Prentice-Hall, 1990, pp. 373–413.
- [4] L. Furia, D. W. Hill, and O. P. Gandhi, "Effects of millimeter-waves on growth of *Saccharomyces Cervisiae*," *IEEE Trans. Biomed. Eng.*, vol. BME-33, pp. 993–999, Nov. 1986.
- [5] W. H. Philpott and D. W. Kalita, *Magnet Therapy*. Tiburon, CA: AlternativeMedicine.com Books, 2000.
- [6] R. Park, *Voodoo Science*. Oxford, U.K.: Oxford Univ. Press, 2000.
- [7] R. K. Olsen, "Microwave-induced developmental defects in the common mealworm, (*Tenebrio Molitor*)—A decade of research," Naval Aerospace Med. Res. Lab., Pensacola, FL, NAMRL Rep. 1283, 1981.
- [8] K. Foster and W. F. Pickard, "Microwaves: The risk of risk research," *Nature*, pp. 531–532, 1987.
- [9] A. W. Guy, C. K. Chou, and J. A. McDougall, "A quarter century of *in vitro* research: A new look at exposure methods," *Bioelectromagnetics*, vol. 20, pp. 21–39, Sup. 4, 1999.
- [10] C. K. Chou, H. Bassen, J. Osepchuk, Q. Balzano, R. Petersen, M. Meltz, R. Cleveland, J. C. Lin, and L. Heynick, "Radio frequency electromagnetic exposure: Tutorial review on experimental dosimetry," *Bioelectromagnetics*, vol. 17, no. 3, pp. 195–208, 1996.

Authors' Reply

Igor Y. Belyaev, Eugene D. Alipov, and Vadim L. Ushakov

In the above paper,¹ we analyzed various parameters, both physical and biological, which are important for the nonthermal effects of millimeter waves (MMWs). In particular, effects of MMWs on chromatin conformation have been observed at power levels well below that of thermal heating [1], [2]. The aim of these experiments was to decrease power flux density (PD) as low as possible in order to compare the observed resonance-type responses of cells at different PDs. As we have previously clearly stated, direct measurements at powers lower than 10^{-7} W/cm² were not available and, therefore, the PDs were calculated based on usage of calibrated attenuators. Therefore, all figures below 10^{-7} W/cm² must be treated as calculated values. In the absence of direct measurements, we could not exclude that the error of 2–4 orders of magnitude might occur. Therefore, the lowest power density at which the MMW effect was observed might be somewhere between the background level and 10^{-15} W/cm². Only direct measurements at these low

Manuscript received April 13, 2002.

I. Y. Belyaev is with the Department of Genetic and Cellular Toxicology, Stockholm University, S-106 91 Stockholm, Sweden and is also with the Department of Radiation Physics, Biophysics and Ecology, Moscow Engineering Physics Institute, Moscow 115409, Russia.

E. D. Alipov and V. L. Ushakov are with the Department of Radiation Physics, Biophysics and Ecology, Moscow Engineering Physics Institute, Moscow 115409, Russia.

Publisher Item Identifier 10.1109/TMTT.2002.800436.

¹I. Y. Belyaev, V. S. Shcheglov, E. D. Alipov, and V. D. Ushakov, *IEEE Trans. Microwave Theory Tech.*, vol. 44, no. 11, pp. 2172–2179, Nov. 2000.