BIOELECTROMAGNETICS SOCIETY NEWSLETTER

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GERMAN RESEARCH ON BONE GROWTH

A broad range of medical and surgical research is being conducted at the Institut fur Experimentelle Chirurgie (IEC) der Technischen Universitat Munchen (Institute for Experimental Surgery of the Technical University Munich) and at the Garmisch-Partenkirchen Hospital (G-PH). These two groups cooperate very closely, with some of the staff working part time in one location and part time in the other. The head of the Munich group is Prof. Dr. G. Blumel, and the head of the G-PH team is Dr. F. Lechner. One of the most active researchers in the group is Dr. Rudolf Ascherl, who spends about half of his time at each place.

During a recent visit with Ascherl, I found that the teams at IEC and G-PH are extremely active and engaged in four major lines of research: (1) electrical stimulation of bone, (2) implantation of limbs and joints, (3) drug delivery and artificial skin, and (4) fibrin adhesion and skin grafts. Described below is a brief summary of the work on electrical stimulation of bone.

The electrical stimulation of fractured bone has gained wide acceptance in recent years, being used primarily as a supplementary treatment for certain types of fractures that do not respond to normal orthopedic procedures. The most-studied cases involve breaks or nonunions that have not mended over a period of several months to several years. Pseudarthrosis is the most commonly treated malady in this class. (Pseudarthrosis is deossification of a weight-bearing long bone, followed by bending and pathologic fracture, with inability to form normal callus leading to the existence of the "false joint" that gives the condition its name.) In the US, the most popular electrical stimulation technique, that of Bassett, is almost always given without further surgical intervention. It uses a set of external magnetic-field coils to induce electric current in the bone. The groups at IEC and G-MP also use external coils but prefer to implant pick-up coils at the site of the joint. The external solenoid coil, shaped to the region of the body to be treated, is driven by a function generator at a frequency ranging from 2 to 30 Hz. A magnetic field strength of approximately 2.4×10^3 A/m is generated by the alternating current in the external coil. Correspondingly, AC potentials with an amplitude of several hundred millivolts are generated in the implanted pick-up coil, which has a ferromagnetic core. The implants are designed to be part of the internal fixation device that is holding the ends of the fracture in place.

In addition to implantation of the pick-up coil, spongious bone is grafted into the gap of the fracture. (Spongious bone is a form of bone in which the matrix is arranged in a network of rods, plates, or tubes between which are spaces filled with marrow.) The spongious bone is more conductive than compact bone and thus better able to bridge the fracture gap electrically. Peak electric fields on the order of 400 mV/cm are often measured in the pseudarthrotic gap. The technique used by the group is reported to be more effective than electrical stimulation alone. More than 400 patients have been treated at the G-PH in the past 12 years, with a healing rate of about 93 percent for all types of pseudarthroses, including those with infection. On an average, the patients treated have undergone 3.6 prior surgeries, and the mean time of the nonhealed fractures is 38 months. The researchers have found that hospitalization rarely takes more than 4 weeks. After that time, the patients are able to treat themselves with rentable devices.

There is little reduction in the healing time of fresh fractures (10 to 15 percent). But when the bone is severely crushed, when there is a compound fracture, or when there is infection, this technique might significantly reduce the amount of time that injured military personnel are off duty.

T. C. Rozzell
ONR-London

GETTING YOUR MAIL?

The BEMS Office has received reports by Society members of non-delivery by the postal service of the BEMS Seventh Annual Meeting Program. If you did not receive a program, please call the BEMS Office in Gaithersburg, Maryland, (301) 948-5530. A copy will be sent immediately.

EPA SCIENTISTS RECEIVE RESEARCH AWARDS

EPA scientists in the nonionizing radiation health effects research program at Research Triangle Park won four 1984 Science and Technological Achievement Awards. This awards program is used to motivate excellence in EPA scientists and engineers and to provide greater exposure of EPA research to the public. There are five disciplinary areas in which cash awards are made at three levels of distinction. Research papers published in peer-reviewed journals are eligible for award. Nominations are screened by EPA management and submitted to the Science Advisory Board (SAB) for evaluation and ranking. The SAB is a panel of 58 prominent scientists from outside EPA and was established by Congress seven years ago to advise EPA on scientific issues.

In the health category 86 papers published in 1982-83 were nominated and 9 of these received awards. Four of these nine were written by staff members in the nonionizing radiation program. Furthermore, only one Level I award, the highest level of distinction, was made. The winner was "Measurement of Blood-Brain Barrier Permeation in Rats During Exposure to 2450 MHz Microwaves" by T.R. Ward, J.A. Elder, M.D. Long, and D. Svendsgaard [Bioelectromagnetics 3:371-383 (1982)]. The authors shared a cash award of $4000.

Level I awards are made to those who have accomplished an exceptionally high quality research or development effort of national significance, which affects a major mission or organizational component of EPA or which has a high impact on a broad area of science. The remaining three awards were Level III awards which are made to nominees who have accomplished an unusually good research or development effort that relates to a mission component of EPA or which significantly affects some area of science. Level III awards include a cash prize of $750.

The three Level III awards were made to: E. Berman, H.B. Carter, and D.E. House for "Reduced Weight in Mice Offspring After in Utero Exposure to 2450 MHz Microwaves" [Bioelectromagnetics 3: 285-291 (1982)]; C.J. Gordon for "Effects of Ambient Temperature and Exposure to 2450 MHz Microwave Radiation on Evaporative Heat Loss in the Mouse" [J. Microwave Power 17: 145-150 (1982)]; and, to R.J. Spiegel for "The Thermal Response of a Human in the Near Zone of a Resonant Thin-Wire Antenna" [IEEE Trans. Microwave Theory and Tech. MTT-30: 177-185 - (1982)].

VDT RADIATION: GUY'S REPORT FOR IBM

Though it is highly unlikely that there is any relationship between the birth defect clusters and VDT emissions, the clinical work on magnetic bone growth stimulators and the magnetic field work of Ubeda et al. (1983) replicated by Mild (1984) does indicate that there could be a relationship. This perceived relationship prevails even though the wave form of VDT emissions differs markedly from those of bone growth stimulators and the Delgado apparatus. A major question, however, is the validity of the bone growth stimulation work and the reported effects by Ubeda et al. Until this validity issue is resolved, critics will use the results of the above work to argue that the level of emissions from VDTs are not safe. The localized E-fields at the surface of an unshielded cover of a VDT nearest the flyback transformer can reach extremely high values as a result of the associated high voltage and close proximity of the transformer to the cover. Since these fields have a capability of inducing much greater currents in an exposed user of the device than the relatively low magnetic field emissions, it certainly is desirable to shield the cover of the VDT. Since such shielding is relatively inexpensive, the benefit to cost ratio is large. Such shielding is generally present in newer models of VDTs to satisfy FCC requirements for reducing electromagnetic interference. Since the magnetic fields emitted by the VDTs are significantly lower and induce much less current in an exposed subject, there is less need to provide magnetic shielding. Therefore unless it can be shown that there is a real hazard due to the magnetic field exposure such cost may not be warranted. Since the Ubeda, et al. (1982) work implies that there may be a hazard, however, the work should be replicated and the data carefully analyzed to determine whether further research is needed to answer the questions concerning the applicability of the results to the VDT magnetic field waveform. Such work should be carried out by a team of highly reputable teratologists and engineers to minimize or eliminate possible artifacts in the exposure systems and the biological assay protocols. Also a careful and thorough characterization of the induced fields and currents in subjects exposed to VDTs should be carried out and the levels compared to levels known to be safe, based on the most reputable scientific literature.

[Recommendations of Dr. Bill Guy to IBM in his October 29 report, *Health Hazards Assessment of Radiofrequency Electromagnetic Fields Emitted by Video Display Terminals.*]

ASILOMAR WORKSHOP

A small workshop on high-frequency effects was held at Asilomar, Pacific Grove, California, April 28-30, 1985. The workshop, sponsored by the Office of Naval Research and the Center for Devices and Radiological Health, was organized under the auspices of Science Applications International Corporation (SAIC). It brought together approximately 20 scientists from various disciplines. Discussion was limited to two selected areas: molecular experiments, for example, effects on DNA, and theories to include vibrational, electronic, and cooperative responses. The purpose of the workshop was to advise program managers at the Office of Naval Research and the Center for Devices and Radiological Health on research issues in these areas.

The workshop was organized along the lines of an "extended journal club" which was envisioned as an extension of the types of discussion that occur in many graduate research groups aimed at keeping students and faculty up to date on recent advances. This format proved to a most effective approach at promoting scientific discussion, not only on issues related to the papers that formed the basis for discussion, but on other related studies as well.

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INVEST IN PHYSICS - OWN A PIECE OF DIRAC

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The BIOELECTROMAGNETICS Society Newsletter is published approximately ten times per year and distributed to all members of the Society. Information regarding the Society may be obtained by writing the Society Headquarters at 1 Bank Street, Gaithersburg, MD 20878. Institutions and libraries may subscribe to the Newsletter at an annual cost of $35 ($45 for overseas subscriptions).

The Newsletter serves the membership and subscribers in part as a forum for the presentation and discussion of ideas and issues related to bioelectromagnetics research. It is intended that ideas and issues will be presented on which a consensus has not been reached. Accordingly, all submissions to the Newsletter are signed and reflect the individual views of the authors and not official points of view of the Society or of the institutions with which the authors are affiliated. The Society solicits contributions to the Newsletter from its members and others in the scientific community. News items as well as short research notes and book reviews are welcome. Submit items for consideration for publication to Michael Marron, Editor BEMS Newsletter, P. O. Box 3651, Arlington, VA 22203.

CLOTH SHIELDS ELECTROMAGNETIC FIELDS

Devex S.A. of Switzerland has just announced the availability of a new line of metallised textiles that tests have shown are effective in shielding against non-ionizing electromagnetic energy. The unique technology of Devex S.A. permits the covering of textiles made from either synthetic or natural fibers with a continuous metallic coating of nickel or other metals which covers all of the crossing points of the fibre. Depending on the fabric chosen, attenuation values have been shown to range between approximately 40 and 90 dB at power densities from 6 to 30 W/cm (measured at 12 GHz for 10 minutes). Several properties of the textiles make them ideally suited for electromagnetic compatibility problems:

- High shielding performance
- Ease of fabrication by sewing, gluing, soldering, etc.
- Low specific weight
- Transparency to air and visible light

Currently, Devex S.A. has a range of metallised textiles available that include: woven monofilament, polyester multifilament, knitted polyester interlock jersey, "Kevlar" multifilament, and "Nomex" twill. In addition, all Devex textiles can be supplied with a coating on one or both sides of polyurethane, silicone, "neoprene", glass, ceramics, etc. They are manufactured in lengths up to 400 meters and widths of 1.6 meters. These materials can be used as light weight "curtains" to shield certain types of equipment or areas of a room (as a Faraday cage, for instance), as cable wrappings, as waveguide gaskets, as conductive fillers for plastics, or to make protective clothing. Since the textiles are excellent reflectors, they can be used as antennas, as target systems, as lifeboats, lifejackets or as passive reflectors.

One of the most important uses of these textiles from the standpoint of military applications was demonstrated by another company in Switzerland, Invertag S.A. They are producing a human protection system in the form of an overall that completely shields and protects people from working in electromagnetic field environments, such as antenna maintenance personnel.

These nickel-coated textiles may also be used in the marine environment as gaskets to replace copper and silver loaded ones which suffer badly from corrosion. According to Devex S.A. officials, preliminary testing shows that the nickel coating is more resistive to corrosion breakdown than the other metals.

Devex S.A. will soon open an office in Dallas, Texas. In the meantime, additional information can be obtained from the office in Switzerland. Contact: Dr. Stephen Potter, Managing Director, Devex S.A., 1618 Chatel-St.-Denis, Switzerland. Telephone (21) 56 78 08; Telex 452 116.

HISTORY OF BIOELECTROCHEMISTRY

In the eighteenth century the term galvanism (animal electricity) and, later on, electrophysiology was commonly used. Nowadays, the general denotion "bioelectrochemistry" has been introduced and may be considered as a "daughter" of electrochemistry and a "granddaughter" of chemistry. It is worthwhile to remember briefly the beginning of Luigi Galvani's well-known discovery (1786) of the convulsion of muscles in contact with different metals. Galvani wrongly believed that many little organic Leyden yars are producing electricity in the muscle. This hypothesis of "animal electricity" was suggested by the actions of the battery like organs of "electric fish."

The experimental approach of L. Galvani was carefully modified by Alessandro Volta (1745-1827), who pointed out that this kind of electricity comes from outside to the muscle - from the contact between both metals. The muscle acts as an indicator (electroscope) only, whereas the nerves are working as conductors. Volta's interpretation of galvanism as contact electricity was erroneous, too. The right description of Galvani's and Volta's experiments was given by Johann W. Ritter (1776-1810) at Jena, who pointed out the relationship between Volta's series of metal potentials and their oxidation states. Furthermore, Ritter discovered chemical reactions at electrode surfaces and showed unambiguously that it is the chemical process which is responsible for the galvanic action of living beings: "Solange wir keine strengeren Beweise haben, daß chemische Krafte es nicht allein sind, die im lebenden Korper wirken, so lange durfen wir auch keine neuen Krafte dafur annehmen." (Fragment 393 (1810)). Because Ritter describes the animal electricity in terms of chemistry he is, in my opinion, the founder of scientific electrochemistry. Moreover, Ritter made contributions to describe phenomena like excitation, accommodation, and other sensoric effects depending on the voltage of his piles. Therefore, J.W. Ritter founded the theoretical bioelectrochemistry and stimulated scientists like Th. v. Grotthuss, E. Du Bois-Reymond (1816-96), F. Hoppe-Seyler (1825-95), H. v. Helmholtz (1821-94).

The development of electrochemical research during 200 years reveals that in many biochemical reactions electrical charges play an eminent role. Consequently, a primary aim of bioelectrochemistry is to apply the current knowledge of electrochemistry to living systems (I) and to the analysis of biopolymers, membranes, effectors and inductors (II), and to the broad field of biosynthesis, biotechnology, genetechnology, neurosciences, medicine (III). Of course, there are overlapping interrelations with other disciplines like organic electrochemistry, analytical chemistry, biophysics, biophysical chemistry, bioelectricity, electrophysiology, or bionics.

Nevertheless, bioelectrochemistry today contributes to discoveries in all life sciences and is an independent discipline which is supported and developed by international societies: International Bioelectrochemical Society (BES), Bioelectromagnetics Society (BEMS), Bioelectric Repair and Growth Society (BRAGS); international symposia.

(I) Living systems.

Since life processes proceed in colloid-like solutions of polyelectrolytes, low molar mass electrolytes, ionic effector molecules and at charged membranes, the bioelectrochemical field of research is almost universal. The tools of measurement are microelectrodes combined with potentiometric, amperometric and conductometric equipments, or indicators of microspectrophotometry, or noninvasive techniques such as dielectric measurements, nuclear magnetic resonance (e.g. for pH-determinations in tissue), electric and magnetic fields. Electron exchange, proton transfer, ion transport, electrostatic interactions and current induction are involved in phenomena like respiratory chain, photosynthesis, ATP-synthesis, phase transitions of membranes and membrane transport, vision and photoreceptor potential, transfer of action potentials and synoptic transduction, cell fusion and transformation by electrostimulation, electrochemical information transfer at cell surfaces, anaesthesia.

Recently, an electrochemical interpretation of the whole metabolism, that means a hypothesis on the living cell as an electrochemical system, has been postulated by M. Berry. Last not least, complex bioelectrochemical processes are involved in: electrocardiography, electroencephalography, electroacupuncture, electroanaesthesy, enzymatic clotting processes.

(II) Isolated components.

Besides the properties of isolated biological membranes, their constituent lipids and proteins and especially lipid bilayers as models, the main interest is focused on the ionic and (or) polyelectrolyte behavior, on conformational transitions, and on interactions of proteins (enzymes) and aminoacids; nucleic acids, nucleoproteins, and heterocyclic bases; polysaccharides, lipopolysaccharides; radicals, ionic effectors, coenzymes.

(III) Applications.

In the broad field of applications there are topics like the following - (a) basic electrochemistry: biocatalysts accelerating electrode processes; (b) analytical chemistry: polarographic determinations, ion-selective electrodes, enzyme electrodes; (c) biosynthesis: electrophoretic separations, cofactor reoxidation, electrochemical transitions of steroids; (d) biotechnology: biological fuel cells, electrophoretic cell separation, microbiological membrane electrodes; (e) genetechnology: electrofusion and electrotransformation, dielectrophoresis of dividing cells; (f) neurosciences: ion-selective electrodes; and (g) medicine: hormone electrodes, immunselective electrodes (pacemaker), bone healing by pulsating electromagnetic induced current.

There is also a vast field of theoretical concepts to elucidate complex problems, e.g. the electrical network theory representing a new way (bondgraphs) for energy storage and dissipation in biological hierarchies, inclusively membrane diffusion (with and without a transducer), proton pump, coupling of ATP reactions and protein synthesis.

[Reprinted with permission from the February 1985 issue of the Bioelectrochemistry Newsletter, a publication of the Bioelectrochemical Society. H. Berg Jena, DDR]

IN CASE YOU MISSED IT

A Lecture Series entitled, "The Impact of Proposed Radio Frequency Radiation Standards on Military Operations" was implemented in Rome, Lisbon and Paris during April 1985 by the Consultant and Exchange Programme of the Advisory Group for Aerospace Research and Development (AGARD). The series, normally limited to NATO Nation scientists and physicians, was sponsored by the Aerospace Medical Panel of AGARD under the Directorship of John C. Mitchell, USAF School of Aerospace Medicine, Brooks AFB, Texas. (An article on the Lecture Series will be published in a future **Newsletter.)

**The Japan Health Physics Society (JHPS) held its 20th Annual Meeting in Kyoto, Japan, on May 13-14. Included on the agenda was a symposium on "Some Problems on Health Physics of Non-Ionizing Radiation." The symposium was chaired by Dr. Y. Honda of Kinki University. Information on the symposium may be obtained by contacting: JHPS, c/o Kyoto University Research Reactor Institute, 590-04 Osaka-fu, Sennan-gun, Kumatori-cho, Noda, Japan, 81-7245-2-0901.

**In April, 1985, the Food and Drug Administration's Center for Devices and Radiological Health resumed publication of both the Radiological Health Bulletin and the Medical Devices Bulletin. The bulletins are available at no charge. Contact: Division of Information Services, Office of Management and Systems, Center for Devices and Radiological Health, FDA, Rockville, MD 20857.

**Nonlinear Electrodynamics in Biological Systems, the Proceedings of an International Conference held in Loma Linda, California in 1983, as edited by W. Ross Adey and Albert F. Lawrence, is now available through Plenium Press, 233 Spring St., New York, NY 10013 ($89.50).

**J.R. Lymangrover, E. Keku, Y.J. Seto, "60-Hz Electric Field Alters the Steroidogenic Response of Rat Adrenal Tissue, In Vitro," Life Sciences, Vol. 32, 691-696, 1983.

**Y.J. Seto, F.T. Fox, D. Majeau-Chargois, J.R. Lymangrover, W.P. Dunlap, S.T. Hsieh, "Chronic 60 Hz Electric Field Exposure Induced Subtle Bioeffects on Serum Chemistry," J. Environ. Sci. Health, A19(8), 865-885, 1984.

**Y.J. Seto, S.T. Hsieh, D. Majeau-Chargois, W.P. Dunlop, J.R. Lymangrover, "Food Consumption, Water Intake and Growth Data on Rats Chronically Exposed to a High-Intensity 60-Hz Field," J. of Bioelectricity, 2(2&3), 197-205, 1983.

**Y.J. Seto, D. Majeau-Chargois, J.R. Lymangrover, W.P. Dunlop, C.F. Walker, S.T. Hsieh, "Investigation of Fertility and In Utero Effects in Rats Chronically Exposed to a High-Intensity 60-Hz Electric Field," IEEE Trans. on Biomed. Eng., Vol. BME-31, No. 11, 693-791, Nov. 1984.

MEETINGS

1986 - URSI International Symposium on Electromagnetic Theory: August 25-29, 1986, Budapest, Hungary. Sponsored by the International Union of Radio Science and the Hungarian Academy of Sciences; organized by the Scientific Society for Telecommunication (Hungary) and the Research Institute for Telecommunication (Hungary). The Symposium will be devoted to all aspects of electromagnetic fields and waves. The following topics may be included: field analysis and numerical methods; scattering and diffraction; antennas; guided waves (waveguides, open structures, etc.); transient phenomena; inverse scattering; and, fields of biological media. Submission and presentation of papers will be in English. Abstracts due October 15, 1985. Acceptance or rejection to be mailed to authors before January 31, 1986. See **Calendar** for point of contact.

ASSUME A SPHERICAL COW . . .

Throughout history, at any time before a particular problem has been fully solved, it was inevitable that certain pieces of information important to the solution of the problem were simply not available. Either no one had chosen to seek the information or the opportunity to do so had not presented itself. Under such circumstances, there were and are two possible approaches. One alternative is to walk away from the problem by saying, we simply don't know *everything*, and therefore we can do *nothing*. The other approach is to make reasonable approximations where they are needed, and to identify them clearly and unequivocally. Sometimes it is possible to say just what degree of uncertainty is introduced by a particular approximation.

The author would like to share with the reader a lesson of enormous importance which he learned from the great chemist, Kenneth S. Pitzer, when the author took a course in quantum mechanics from Dr. Pitzer. On one examination, a problem was presented without all of the data necessary to solve it. One piece was missing. Later, we all learned that the omission was no accident. We were meant to try out a wide range of imaginary values inorder to discover whether the exact value of the one missing piece would really make much of a *difference* in the final answer. If it did not, an approximation would clearly provide a "ballpark" answer valid for many purposes, and would certainly be preferable to no answer at all! Said Pitzer, "Any scientist who walks away from a problem just because he can't have a certain datum is not much of a scientist."

In still other instances, one must make certain assumptions about the *relationships* between hard data. One must not be apologetic about assumptions; they are part and parcel of scientific procedure. It is simply of the highest importance that assumptions be labeled as such.

[Excerpted from J.W. Gofman, Radiation and Human Health, Sierra Club Books, San Francisco, 1981, pp. 6-7.]

US-USSR WORKSHOP PROCEEDINGS

"Proceedings of a US-USSR Workshop on Physical Factors - Microwaves and Low Frequency Fields", a report of the National Institute of Environmental Health Sciences dated May 1985 is available upon request from Dr. Donald I. McRee, NIEHS, Box 12233, Research Triangle Park, NC 27709.

JUNE EVENTS IN SAN FRANCISCO

March 16-June 16	Master Drawings from the Fine Arts Museum of San Francisco, Palace of the Legion of Honor.
May-Oct	San Francisco Historic Trolley Festival; Market Street.
June	San Francisco Summer Opera Festival, War Memorial Opera House, (864-3330). The four operas of Der Ring der Niebelungen by Wagner will be performed as three series: June 2,4,5,8/June 7,9,11,13/June 12/15/16/19 (Das Rheingold, Die Walkuere, Siegfried, Die Goetterdaemmerung).
June 7-August 11	Facets of Modernism: sixty prints from the permanent collection. S.F. Museum of Modern Art.
June 8-29	Beethoven Festival, San Francisco Symphony, Davies Symphony Hall (431-5400).
June 13-16	San Francisco Ballet, War Memorial Opera House, (392-4400). Ethnic Dance Festival, Herbst Theatre.
June 15-21	Cable Car Festival, Second Annual.
June 16	Kitemakers 13th Annual Father's Day Kite Festival; Marina Green, 12 to 4 p.m.
June 16-August 18	Midsummer Music Festival; free Sunday concerts of ballet, symphony opera, musicals, jazz and ethnic programs, Stern Grove, 2 p.m.
Theatre	American Conservatory Theatre (ACT) is a regional repertory theatre which runs November to June. ACT frequently sponsors other productions at its theatre, particularly during summer months.
Theatre	Best-of Broadway Series: Presents plays and musicals that have played in NY or are headed for NY. Three theatres are: Curran Theatre, 445 Geary St, (673-4400), Golden Gate Theatre, Golden Gate at Taylor, (775-8800), and Orpheum Theatre, 1192 Market St., (474-3800).

All Year	Merola Opera Program, Brown Bag Opera, Western Opera (864-3330).
All Year	At least 10 concert series exist in San Francisco, from chamber groups to contemporary music. Several of these regularly present internationally known concert groups, artists, orchestras, on tours, etc. in any of the four major concert halls: Davies Symphony Hall, Opera House, Herbst Theatre and Masonic Auditorium.

CALENDAR

June 3-7: International Microwave Symposium. St. Louis, Missouri. Sponsored by the Microwave Theory and Techniques Society of the IEEE. Contact: James C. Lin, University of Illinois at Chicago, Box 4348, Chicago, IL 60680, (312) 996--2331.

June 16-20: Seventh Annual Bioelectromagnetics Society Meeting, San Francisco Hilton Hotel, San Francisco, CA. Contact: BEMS Headquarters, Suite 307, Gaithersburg, MD 20878, (301) 948-5530.

June 17-21: 1985 North American Radio Science Meeting and International IEEE/AP-S Symposium, University of British Columbia, Vancouver, B.C., Canada. Contact: K. Charbonneau, Conference Services, National Research Council, Montreal Rd., M-58, Ottawa, Ontario, Canada K1A 0R6, or Coordinator: Dr. E. V. Jull, Dept. of Electrical Engineering, University of British Columbia, Vancouver, B.C. V6T 1W5 (604) 228-3282.

June 24-29: Eighth International Symposium on Bioelectrochemistry and Bioenergetics, Bologna, Italy. Contact: C. Bonfiglioli, c/o Institute of Botany, Via Irnerio 42, 40126 Bologna, Italy, Tel. 051-234376.

August 11-16: XIV International Conference on Medical and Biological Engineering/VII International Conference on Medical Physics, Espoo (Helsinki) Finland. Preconference Teaching Course oh Bioelectric and Biomagnetic Phenomena; Conference theme planned on Biomagnetism. Contact: XIV ICMBE/VII ICMP, Secretariat, P.O. Box 105, 00251 Helsinki, Finland.

August 26-30: International Conference on Magnetism 1985, San Francisco, CA. Contact: Diane Suiters, Suite 300, 655 15th St., NW, Washington, DC 20005.

September 9-12: 15th European Microwave Conference, Palais des Congres, Paris, France. In cooperation with SEE, EUREL, IMPI, IEEE and URSI. It is planned to have a biological applications workshop on Sept. 13. Contact: Prof. M.Y. Bernard, 15th European Microwave Conference, c/o GIEL, 11 Rue Hamelin, F-75783 Paris, Cedex 16, France.

September 27-30: Engineering in Medicine and Biology—Frontiers of Engineering and Computing in Health Care, Chicago. Sponsored by IEEE. Technical program inquiries should be directed to: Prof. James C. Lin, Chairman, Dept. of Bioengineering, Univ. of Illinois, Chicago, IL 60680, (312) 996-2335.

October 13-17: Fifth Annual Meeting of the Bioelectrical Repair and Growth Society (BRAGS), Boston, MA. Abstract deadline, May 15. Contact: Prof. W. Williams, Program Chairman, c/o BRAGS, P.O. Box 64, Dresher, PA 19025.

December 4-5: International Conference on Electric and Magnetic Fields in Medicine and Biology, London, England. Contact: Secretariat, Conference Services, The Institution of Electrical Engineers, Savoy Place, London WC2R OBL, UK, Tel. 01-240-1871, Ext. 222.

December 9-13: The Tenth International Conference on Infrared and Millimeter Waves, Americana Dutch Resort Hotel, Lake Buena Vista, FL 32830. Contact: Kenneth Button, MIT, Box 72, MIT Branch, Cambridge, MA 02139-0901.

May 12-15 (1986): International Scientific Conference: Work With Display Units, Stockholm, Sweden. Organized by the Swedish National Board of Occupational Safety and Health, Research Dept., and supported by Swedish Agency for Administrative Development. Apply to: WWDU, c/o Stockholm Convention Bureau, Box 1617, S-11186 Stockholm, Sweden.

June 24-26 (1986): Eighth International Wroclaw Symposium on Electromagnetic Compatibility Technical University, Wroclaw, Poland. Summaries due August 15, 1985. Contact: Dr. W. Waszkis, EMC Symposium, Box 2141, 51-645, Wroclaw 12, Poland.

August 25-29 (1986): 1986 URSI International Symposium on Electromagnetic Theory, Budapest, Hungary. Sponsored by the International Union of Radio Sciences and the Hungarian Academy of Sciences. Contact: Prof. T. Bercelli, Research Institute for Telecommunications, 1525 Budapest 114, POB 15, Hungary. Telex: 22-4338.

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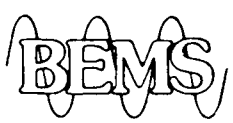

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