Human and Field: Submission or Interaction

ATDI and CAS WUT Symposium

Human and Field: Submission or Interaction

ATDI and CAS WUT Symposium

19-21 May 2017

Pałac Ossolińskich, Sterdyń, Poland

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Dr. Eng. Grzegorz Domański
Prof. Michael Giersig
MSc. Eng. Sébastien Grimoud
Prof. Krzysztof Kempa
MSc. Anna Łapińska
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Prof. Zbigniew Piotrowski
Dr. Jack Rowley
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Introduction

Human and Field: Submission or Interaction

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In spite of the long time of experimental and practical verification of electromagnetic field action on a huge variety of physical phenomena, a number of features of electromagnetic field interactions with living cells are still considered as unsatisfactory. According to what is reported among scientists, we find for example as the questions: can electric or magnetic field really account for anything else that intense energetic influence? Did the electromagnetic field can relate with subtle biological processes? What about the frequency coincidence of the field with sensitive periodic phenomena or highly controversed questions of influence on growth and stability of living structures? There are the new techniques and concepts which thrown a new light on the theoretical and practical aspects of interaction of electromagnetic field with advanced biological structures on which we shall focus our attention during this Symposium. The main subject of the meeting is "human hazard" and the impact of the electromagnetic waves on living structures. Symposium foresees to take account of large range of issues concerning interactions between electromagnetic field and humans. The experts of different knowledge areas, including physics, medicine and technical sciences, will introduce the newest achievements in the scope. The meeting will bring together young researchers and established scientists, those active in the wide spectrum of applied broadcasting. It gives an excellent opportunity to determine the new challenges, within an international cooperation of advanced researchers and research groups.

Symposium is organized in cooperation between the ATDI enterprise and Center for Advanced Studies at Warsaw University of Technology. Is held directly under the auspices of the Polish Ministry of Digital Affairs.

Symposium programme

19 May 2017 (Friday)

15:00	departure from Warsaw
17:00	arrival to Sterdyń
17:00-18:00	lunch
18:00-18:10	Inaugaration of symposium
18:10-19:00	Podium discussion
20:30	dinner/grill

20 May 2017 (Saturday)

7:45-9:00	breakfast
9:30-9:50	**Prof. Krzysztof Kempa,** *Molecular dissociation with low frequency electromagnetic radiation*, Department of Physics, Boston College, USA
9:50-10:10	**Prof. Zbigniew Piotrowski**, *Modern IEEE 802.11 standard systems and their impact on the electromagnetic environment in highly urbanised areas*, Faculty of Electronics, Military University of Technology, Warsaw, Poland
10:10-10:30	**MSc. Eng. Sébastien Grimoud**, *ATDI calculation method to identify high field strength exposure hot points at few meters precision*, Ingénieur spécialiste de la gestion du spectre, l'Agence Nationale de Fréquences, France

10:30-10:45	coffee break
10:50-11:10	**Dr. Jack Rowley**, *Factors affecting radiofrequency (RF) exposure levels from mobile devices and network antennas*, Senior Director Research & Sustainability, GSMA
11:10-11:30	**MSc. Artur Sobczyk**, *Sub-wavelength anti-reflection coatings for THz and millimeter wave region*, Faculty of Physics, Warsaw University of Technology
11:30-11:50	**Dr. Eng. Grzegorz Domański, MSc. Eng. Michał Wieteska**, *Thermal effects in tissues exposed on high frequency electromagnetic wave – MATLAB and 3D simulator results comparisons*, Institute of Radioelectronics and Multimedia Technology, Warsaw University of Technology
12:00-14:00	lunch
14:00-14:20	**Prof. Piotr Bogorodzki**, *In-vivo effects of tissue electromagnetic exposure by means of Magnetic Resonance Imaging*, Institute of Radioelectronics and Multimedia Technology, Warsaw University of Technology
14:20-14:40	**Prof. Michał Urbański**, *Remarks on quantum and structural approach to the interaction of electromagnetic signals with living systems*, Faculty of Physics, Warsaw University of Technology
14:40 -15:00	coffee break
15:00-15:20	**Prof. Marek Trippenbach**, *Optical processes in nanostructures with gain and loss*, Faculty of Physics, University of Warsaw
15:20- 15:40	**Prof. Michael Giersig**, *Effects of Electromagnetic Field Emitted by Cellular Phones*, Department of Physics, Freie Universität Berlin
15:40- 16:00	**Prof. Jacek Starzyński**, *Multiscale Approach to Neural Tissue Modelling,* Institute of Theory of Electrical Engineering, Measurement and Information Systems, Faculty of Electrical Engineering, Warsaw University of Technology
19:00- 21:00	dinner
21:30- 00:30	activities

21 May 2017 (Sunday)

7:45-9:00	breakfast
9:30-9:50	**Dr. Haim Mazar**, *Human Radio Frequency Exposure Limits: ITU activities and reference levels in Europe, USA, Canada, China, Japan and Korea*, RF Spectrum and Engineering ITU Expert, Vice Chair of ITU-R Study Group 5
9:50-10:10	**Prof. Michael J. Naughton**, *Nanostructures for Bioelectromagnetism: Sensing, Stimulation, and Demodulation*, Department of Physics, Boston College (USA)
10:10-10:30	**MSc. Anna Łapińska**, *Nanocomposite for efficient sub-terahertz radiation protection*, Faculty of Physics, Warsaw University of Technology
10:30-11:00	Conclusion remarks
12:00-13:00	lunch
13:00	departure

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Molecular dissociation with low frequency electromagnetic radiation

K. Kempa, A. Shvonski
Boston College

Electromagnetic radiation can damage molecules. This talk will focus on molecular damage done by non-ionizing, low power electromagnetic radiation in the low frequency range (THz - mid IR). As an example, selective damage to DNA (double strand breaks, DSBs) has been induced *in vivo* with moderate intensity broadband radiation in this range, with no detectable damage to other molecules or cells. Also, a recent work reported computer simulations of DSB in DNA caused by very weak THz radiation, in an attempt to address the issue of safety of the THz security systems being introduced at e.g. airports. This, and our non-linear dynamics study shows, that even weak THz radiation can lead to DNA DSBs, and that these occur in parameter domains where the frequency and the amplitude of the radiation are coupled, i.e. the intensity needed to damage the molecule depends on frequency, and so knowledge of the linear absorption spectrum alone is insufficient for predicting these domains. In the second part of this talk, a possibility of using such a selective molecular dissociation in the so-called finger-print spectral region, for a therapeutic purposes will be discussed.

Modern IEEE 802.11 standard systems and their impact on the electromagnetic environment in highly urbanised areas

Zbigniew Piotrowski

Institute of Telecommunications, Faculty of Electronics
Military University of Technology, Warsaw, Poland

The paper examines the observed, basic trends in the electromagnetic environment with reference to the IEEE 801.11 standard systems, commonly known as Wi-Fi. The number of mobile terminals and access points has increased substantially in recent years, especially in highly urbanised areas. Radio nonionising radiation affects the deterioration of radio signal propagation conditions, among others by the phenomena related to the results of multipath propagation and signal interference, resulting in reduced data bit rates in radio networks and radio directions and finally deterioration in service quality. Continuous exposure to high levels of electromagnetic radiation under extreme conditions may adversely affect human health. The need for monitoring the electromagnetic environment, especially in very popular Wi-Fi frequency bands and in selected areas and locations, becomes as much necessary as the need to monitor smog in the centres of large cities and agglomerations.

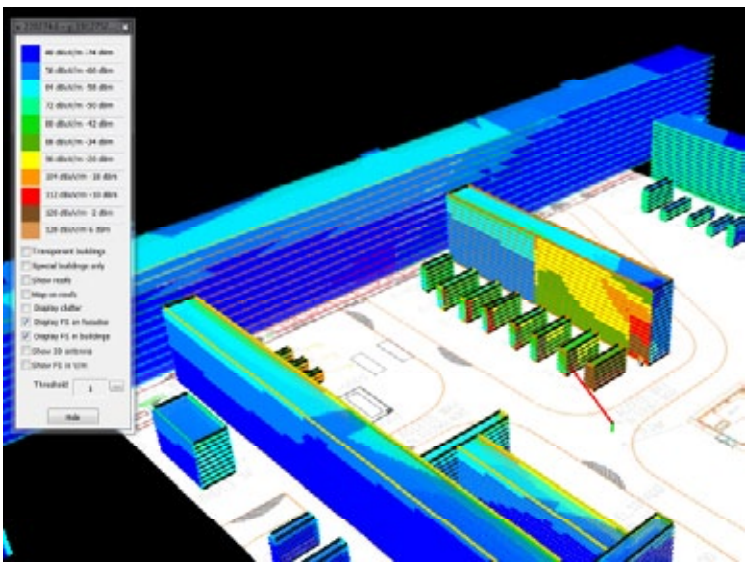
ATDI calculation method to identify high field strength exposure hot points at few meters precision

Sébastien Grimoud

Ingénieur spécialiste de la gestion du spectre, l'Agence Nationale de Fréquences, France

The potential health risks of radiofrequency electromagnetic fields (RF EMFs) emitted by cellular networks (GSM, UMTS, WiFi…) are currently of considerable public interest. A very important issue is the requirement for coexistence between wireless equipment and people living around those types of transmitters.

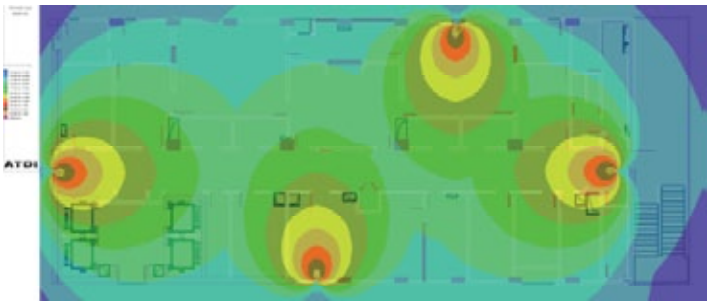
In the last few years a noticeable acceleration in the activities related to the technical standards in the area of the human exposure of electromagnetic fields has been investigated at international, European and national levels. Notifications have been specified by the European Union to the regulation authorities and cellular operators in the Europe union community (IEEE standard 95.1-1-1999). The purpose of those recommendations was to take into account the potential health risk especially when the antennas used by the operators are located in urban areas (usually located on rooftops) and when they are close to sensitive areas like hospital, schools, people living near by the RF transmitters…



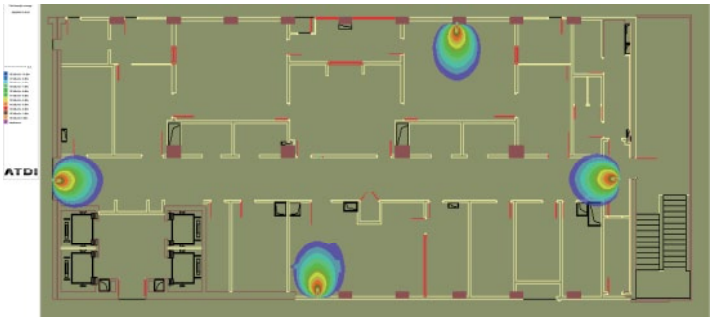
3D view of Field strength

Today, the observance of existing EMF maximum permissible levels (standards) is mandatory for all base station equipment installations.

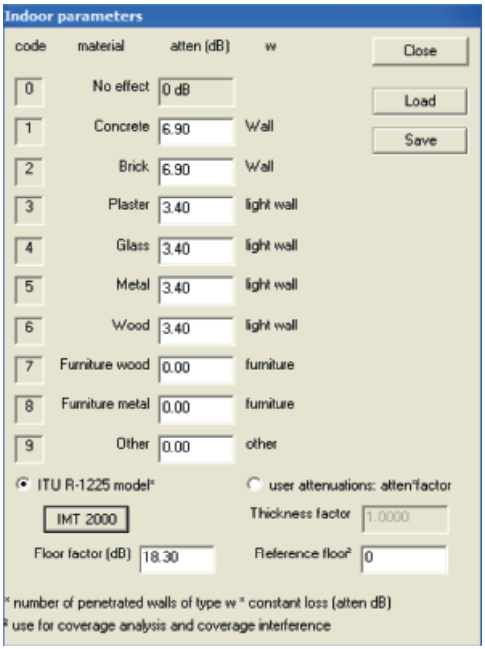
- The maximum permissible exposure (MPE) in a frequency range from 10kHz to 300GHz.
- The area of exposition risk where the field strength is higher than the acceptable level (in outdoor or indoor environment).
- All the EMF (electromagnetic fields) sources with different frequencies and different modulations.
- Full access to clear and accurate information about EMF emitting sources.



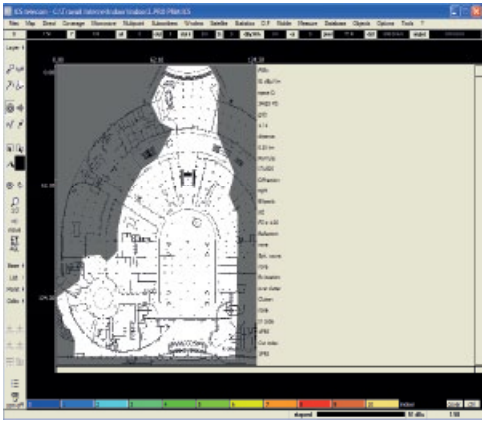
Threshold coverage for Wifi indoor stations



Field strength exposure ≥ 1 V/m for Wifi indoor stations



Indoor parameters for the Attenuation per material



Basic digital floor plan In ATDI tools

Factors affecting radiofrequency (RF) exposure levels from mobile devices and network antennas

Jack Rowley

Senior Director Research & Sustainability, GSMA

Cellular mobile networks rely on continuous coverage from mobile network antennas sites to provide connectivity to portable devices. The radio connection between the fixed antenna sites and the mobile device is constantly monitored and the output power adjusted to maintain the target communication service, initially voice but increasingly now data. Any person using a mobile or portable telecommunications device is exposed to the radiofrequency electromagnetic fields (RF-EMF) that are transmitted by the device and network antennas. These RF-EMF transmissions are necessary to convey the communication signals (voice or data) between the device and its corresponding wireless network. This paper will review existing research on the relative radiofrequency (RF) exposure levels and factors that influence exposures for both fixed and mobile sources. Both sources typically result in exposure levels that are a small fraction of international RF exposure guidelines. For example, mobile devices typically operate at about 1% of their maximum power [1, 2] and the mean environmental RF levels from cellular mobile communications systems are typically less than 0.1 μW/cm^2 (the international public limit is 450 μW/cm^2 at 900 MHz) [3].In some countries misunderstanding by the public and policy makers has been associated with the adoption of policies that cause inefficient deployment of cellular services. Scientifically based policy for the siting of antennas is associated with lower levels of public concern and more efficient antenna deployment. Some good practice policy recommendations are proposed based on evidence and practical experience.

References:

[1] Joshi, P., et al., *Output Power Levels of 4G User Equipment and Implications on Realistic RF EMF Exposure Assessments*. IEEE Access, 2017. **5**(1): p. 4545-4550.
[2] Gati, A., et al., *Exposure induced by WCDMA mobiles phones in operating networks*. IEEE Transactions on Wireless Communications, 2009. **8**(12): p. 5723-5727.
[3] Rowley, J.T. and K.H. Joyner, *Observations from national Italian fixed radiofrequency monitoring network*. Bioelectromagnetics, 2016. **37**(2): p. 136–139.

Sub-wavelength anti-reflection coatings for THz and millimeter wave region

A. Sobczyk, J. Bomba, M. Makowski and M. Sypek

Faculty of Physics, Warsaw University of Technology
Koszykowa 75, 00 662 Warsaw, Poland

Terahertz and Millimeter-Wave (MMW) radiation has a growing number of practical applications in telecommunication, nondestructive industrial inspection, security, military and medicine. On the other hand electromagnetic waves in the range of millimeters exhibit strong unwanted reflections while a wave is transferred to the media with different refractive index. Such reflections can be controlled by adding anti-reflection (AR) coatings. Generally we consider two cases. Perfect shielding element where the media is totally absorbing and the reflection is totally suppressed resulting in removal of the uncontrolled interferences. The second case is a fully transparent element with no attenuation and no reflections which is applicable in various kinds of optical elements.

AR coatings are broadly used in optics. We adapt "moth eye" AR coatings to MMW and Terahertz region. We present a simple way of design and manufacturing of one-sided and two-sided anti-reflection polyamide layers for the THz beams using modern 3-D printers based on Selective Laser Sintering technology. Feature size of 3-D printed elements is less than considered wavelength that makes 3-D printing technique suitable for this purpose.

Pyramid-like anti-reflection structures fabricated using this technology were tested in THz-TDS setup with goniometric angular measurements of both transmitted and reflected fields in the range between 0.1 and 0.3 THz, which took into account diffractive effects on the periodic 3-D printed structure. AR layers successfully reduced the reflected energy and suppressed internal reflections leading to spurious Fabry-Perot interference.

Lastly we consider using Graphene or Nanotube based polymer composites as AR coatings. High attenuation of material combined with AR coatings is very promising area of research.

Thermal effects in tissues exposed on high frequency electromagnetic wave – MATLAB and 3D simulator results comparisons

Piotr Bogorodzki, Piątkowska-Janko, Yevhen Yaszczyszyn, Michał Fiedorowicz, Michał Wieteska, Grzegorz Domański, Konrad Godziński

Institute of Radioelectronics and Multimedia Technology, Warsaw University of Technology

The simulation model consists of multilayered tissue with its proper dielectric model. Power absorption coefficient for plane wave and average penetration depth of the electromagnetic wave were calculated. The results of the simulation of the interaction of microwave radiation on the human skin model, the electric field distribution and loss density were presented. Numerical simulations have shown that a large part of the power is lost in the skin. The absorbed power values are similar to the phantom frontal power, and their greater value is due to the absorption of the wave reaching the phantom side surface. Analysis of research capabilities in biological and medical interactions of high power electromagnetic waves with biological tissues were carried. The next step was the simulation of temperature distribution in multi-layer tissue using simulation results of electrical field strength distribution. The following issues were included: the location of skin receptors responsible for pain in response to thermal stimulation and the model of thermal phenomena in tissue. For simplicity, only one dimensional analysis of bio-heat equation for layered tissue was done. The chosen method of approximate solution was the finite difference one. The results of calculations with assumption the standard thermal parameters of tissues were presented.

In-vivo effects of tissue electromagnetic exposure by means of Magnetic Resonance Imaging

Piotr Bogorodzki, Ewa Piątkowska-Janko,
Yevhen Yaszczyszyn, Michał Fiedorowicz,
Michał Wieteska, Grzegorz Domański, Konrad Godziński

Institute of Radioelectronics and Multimedia Technology, Warsaw University of Technology

In the last 10–20 years, magnetic resonance imaging (MRI) has become one of the most important research techniques in medicine, especially in neuroscience. It allows either structure or function of the central nervous system noninvasively and without radiation exposure. It has an excellent spatial resolution (up to the sub-mm range) and allows investigation of a broad range of scientific and medical problems. With MRI, a researcher has access to local perfusion as well as the structural and functional connectivity between different body regions or to infer on regional metabolite concentrations. Besides the basics of MRI (physics, image contrast, image construction, MRI sequences), there is a lot of possibilities in functional imaging (BOLD-contrast), as well as perfusion and diffusion imaging and MR spectroscopy. The aim of this talk is to present research capabilities of medical and biological effects of high frequency electromagnetic wave exposure in tissues by means of Magnetic Resonance Imaging. An example population studies on brain structures, in superconducting 7T scanner with horizontal bore dedicated for small animals will be presented. Additionally, an example functional 'forepaw' fMRI study on rats will be presented.

Remarks on quantum and structural approach to the interaction of electromagnetic signals with living systems

Michał K. Urbański

Faculty of Physics, Warsaw University of Technology
E-mail: murba@if.pw.edu.pl

In my presentation I suggest that the analysis of interaction of electromagnetic signals with a living system should be studied in two following aspects: as the physical mechanism and the transmission of information respectively. A signal is the time function of physical variables that carry some portion of information. To describe the interaction of electromagnetic signals with biological systems we should study two aspects of interaction:

1. the physical mechanism of the interaction between electromagnetic field and a living matter,
2. the structural model of the transmission of signals due to decoding of the information conveyed by the signal.

In describing the physical mechanism of interactions between electromagnetic field and a living matter we can distinguish, in a simplified way, two models of living organic systems:

1. the biochemical model in which the interactions between electromagnetic waves and living systems are studied within the molecular paradigm (see [1])
2. the quantum model in which is examined the connection between long-range coherent molecular excitations and long-range biological order (Fröhlich model [2, 3]).See figures on the next page.

In biology the biochemical model of the transmission of signals in the living system is dominating, and the quantum models are much less popular. Very interesting here is the theory of Fröhlich who assumed that coherence in living systems should be described as condensation of phonons interacting with thermodynamic bath due to nonlinear interaction with the metabolism process. This approach, in my opinion, gives an opportunity for explaining the interaction of electromagnetic signals in living organisms, however there is little work in this area (see [3]).

The structural aspect of the field effect on organisms is related to the coding and decoding of biological information. The influence of the information transmitted by the signal on the transmission of biological information in the organism should be also considered. This direction of research is, however, very neglected (for example see the effect of the modulation of GSM signal on human brain reviewed in [4]). In theoretical models it is also necessary to combine the quantum information theory with the quantum field theory [5, 6].

References:

[1] W. Ross Adey, *Biological Eects of Electromagnetic Field*, Journal of Cellular Biochemistry **51**:410-416 (1993).
[2] H. Fröhlich, *Long-range coherence and energy storage in biological systems*, Int. J. Quantum Chem. **2**, 641-649 (1968).
[3] P. Turner, L. Nottale, *The physical principles underpinning self-organization in plants* (Review Article) Progress in Biophysics and Molecular Biology, 123, 48-73 (2017).
[4] M Terzi, et.all, *Electromagnetic field and brain development* (review), Journal of Chemical Neuroanatomy, **75 B**,77-84 (2016).
[5] A. Khrennikov, *Quantum-like model of processing of information in the brain based on classical electromagnetic field*.
Biosystems, **105** (3),250-262 (2011).
[6] C. Baladrón, A. Khrennikov, *Quantum formalism as an optimisation procedure of information flows for physical and biological systems*, Biosystems, **150**, 13-21 (2016).

Optical processes in nanostructures with gain and loss

Marek Trippenbach

Institute for Theoretical Physics, Faculty of Physics
University of Warsaw

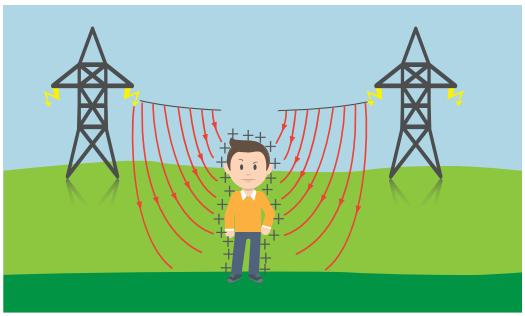
Gain and loss are omnipotent in the physical, chemical and biological systems. Their effects can in a convenient way be modelled by effective non-Hermitian Hamiltonians. Imaginary contributions to the potential introduce source and drain terms for the probability amplitude. A special class of non-Hermitian Hamiltonians are those which possess a parity-time symmetry. In spite of their non-Hermiticity these Hamiltonians allow for real energy eigenvalues, i.e. the existence of stationary states in the presence of balanced gain and loss. This effect has been identified theoretically in a large number of quantum systems. Its existence has also been proved experimentally in coupled optical wave guides. But this class of effects has very broad context. In my short talk I consider a nanostructure of two coupled ring waveguides with constant linear gain and nonlinear absorption - the system that can be implemented in various settings including polariton condensates, optical waveguides or atomic Bose-Einstein condensates. It is found that, depending on the parameters, this simple configuration allows for observing several complex nonlinear phenomena, which include spontaneous symmetry breaking, modulational instability leading to generation of stable circular flows with various vorticities, stable in homogeneous states with interesting structure of currents flowing between rings, as well as dynamical regimes having signatures of chaotic behavior.

Effects of Electromagnetic Field Emitted by Cellular Phones

Michael Giersig

Department of Physics, Freie Universität Berlin

As use of cell phones, tablet computers, wearables, WiFi, and many other wireless devices and technology has sky-rocketed, so has our exposure to the potentially harmful electromagnetic fields (EMF) they generate. Cellular mobile phones (MP) emit high-frequency electromagnetic fields (EMF). The close proximity of a mobile phone to the user's head leads to the absorption of a part of the EMF into the head and brain. The possible effects of such fields on the human body, brain and health have recently been broadly studied and we will be briefly discussed. Logically, due to the increasing MP usage, recently interest has arisen towards possible long-term MP usage effects, highusage MP effects and MP effects on children. There are concerns that children may be more vulnerable to potential MP effects as their brains are still developing, their head size is smaller, and hence absorb more energy from EMF, and their exposure over lifetime will be greater.



Low-frequency electric fields

Radiofrequency field

Multiscale Approach to Neural Tissue Modeling

Jacek Starzyński

Institute of Theory of Electrical Engineering, Measurement and Information Systems,
Faculty of Electrical Engineering, Warsaw University of Technology

In the talk a multiscale model of neural tissue will be presented. The neural tissue is usually modeled in different areas. In the microscopic approach the tissue is modeled on a cellular or ion channels level. On the macroscopic level the tissue parameters are averaged over large domains representing whole organs and the models simulate distributions of different quantities. On the informational level the neural tissue is considered as a medium transferring and transforming data. In this presentation an idea of connecting the microscopic and macroscopic levels into one simulation model for the purpose of modeling electrical stimulation and activation propagation will be presented. For the purpose of linking quantities from micro and macro scales a bidomain theory will be used. The bidomain theory has an established position for the simulation of heart electrical and mechanical activity. In the domain of neural tissue modeling it is less popular and needs deeper scientific investigations. The presentation will show a general concept of bidomain in which the microscopic electrical activity quantities simulated with a set of ordinary differential equations are averaged over larger domains and reused in macroscopic model. For the purpose of coupling the two scales an iterative, time-domain simulation of the electrical activity will be used.

The results of realistic simulations of models on an organ level will be presented. The simulations will show evident practical applications of the model on an example of a prototype device stimulating vagus nerve with contact-less external electromagnetic source field. Also the results of an electrical stimulation of a geometrically realistic model of a brain will be presented.

The presented methodology allows to simulate realistic models accounting the time-domain behavior of a neural tissue. The dynamic characteristic of the tissue is implemented by the microscopic model while the macroscopic model allows for modeling the propagation of the activity. The model is highly anisotropic thus allowing to model different velocities of propagation in different directions. It is best suitable for modeling peripheral nervous system, however there are attempts to model also central nervous system.

Human Radio Frequency Exposure Limits: ITU activities and reference levels in Europe, USA, Canada, China, Japan and Korea

Haim Mazar

RF Spectrum and Engineering ITU Expert
Vice Chair of ITU-R Study Group 5

Compliance with human exposure limits for electromagnetic fields (EMFs) is a significant health and safety issue to regulators, service providers and wireless equipment suppliers. The recent exposure limits are reported. In addition to WHO, IEEE and ICNIRP, following the ITU Plenipotentiary Conference in 2014 (PP-14) Resolution 176 on "Human exposure to and measurement of electromagnetic fields", ITU-R, D and T are most active to regulate and standardise the radio aspects of the EMF. The Specific Absorption Rate (SAR) and the power-density (PD) reference levels in European countries, USA, Canada, China, Japan and Korea are compared and contrasted. The allowed SAR cellular handsets' exposure limits for localized heating are more restrictive in the USA, Canada and Korea (1.6 W/kg), relative to others (2 W/kg). Even the averaging is more restrictive: averaged over 1 g in N. America and Korea, versus 10 g tissue in ICNIRP 1998 and ANSI/IEEE C95.1-2006. Europe in general follows the ICNIRP 1998 PD levels from base stations. Despite the (non-mandatory) EU Council Recommendation 1999/519/EC, some EU countries adopt more restrictive thresholds. USA and Japan are the most liberal countries, adopting in 300–1,500 MHz power- density 4/3 of the ICNIRP1998 and IEEE 2006 levels. On 13 March 2015, Health Canada revised the 2009 PD limits (that were identical to the USA) and published more restrictive reference levels. There is no scientific reason to use different exposure limits in different countries. Some explanations of the different limits are provided.

Nanostructures for Bioelectromagnetism: Sensing, Stimulation, and Demodulation

Michael J. Naughton

Department of Physics, Boston College (USA)

We discuss our recent work on the interaction of nanomaterials and micro/nanostructures with biological systems, and the role of bioelectrics and biomagnetics in the detection and remediation of human disease. One structure shows enhanced sensitivity (~100x) for electrochemical biosensing, as well as forms the basis high spatial resolution bioelectric, neuroelectric and optogenetic interrogation. In one example, we are investigating the ability to direct stem cell differentiation by electrically controlling membrane potential with nanoarrays. Two others structures show promise for neuromagnetic stimulation and measurement. In the case of stimulation, we are developing implants containing microcoils which use the electric field gradient arising from a transient magnetic field to stimulate proximal neurons. In the case of measurement, we are developing implantable micro-cantilevers to measure the local magnetic fields emanating from neuroelectronic activity. Finally, the role of plasmonic nanoparticles in an *in vivo* scheme to address human disease via demodulation of THz radiation is discussed.

Some relevant publications:

Shielded coaxial optrode arrays for neurophysiology, J.R. Naughton, J. Varela, M.J. Burns, T.C. Chiles, J.P. Christianson and M. J. Naughton, Frontiers in Neuroscience **10**, 252 (2016). doi:10.3389/fnins.2016.00252

A nanocoaxial-based electrochemical sensor for the detection of cholera toxin, M.M. Archibald, B. Rizal, M. Rossi, T. Connolly, M.J. Burns, M.J. Naughton and T.C. Chiles, Biosensors and Bioelectronics **74**, 406-410 (2015). doi:10.1016/j.bios.2015.06.069 PMID: 26164012

Nanocoaxes for optical and electronic devices (Invited Critical Review), B. Rizal, J.M. Merlo, M.J. Burns, T.C. Chiles and M.J. Naughton, Analyst **140**, 39-58 (2015). (JOURNAL COVER). doi:10.1039/c4an01447b, PMID: 25279400

Capacitance platform magnetometer for thin film and small crystal superconductor studies, M. Chaparala, O.H. Chung and M.J. Naughton, in Superconductivity and its Applications, H.S. Kwok, D.T. Shaw and M.J. Naughton, Eds., A.I.P. Conference Proceedings **273**, 407-413 (1993). doi:10.1063/1.43588

Nanocomposite for efficient sub-terahertz radiation protection

A. Lapinska [1], M. Zdrojek [1], J. Bomba [1], M. Świniarski [1], M. Sypek [1], L. Stobiński [2], J. Judek [1]

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We demonstrate that nanocarbon-polymer composite thin film exhibit very good shielding efficiency in the sub-THz frequency range (0.1-1THz). To show this we employed time-domain terahertz spectroscopy measuring the amplitude and the phase of transmitted and reflected radiation. We used ~600μm thick composites consisting of graphene platelets, less than 1%wt (and small fraction of carbon nanotubes) embedded in flexible elastomer matrix. For example, at 0.6 THz the composite exhibit more than 30dB shielding efficiency, which is more than for PA12 – material commonly used for manufacturing antireflection components for THz frequency range. Finally, our nanocomposites shows rather low refraction values ~10%.

These results suggests that nanocarbon based composites are good candidates for application in optical THz components.

The importance of electromagnetic fields' affect in the context of location sites intended for permanent people's stay

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Presentation will be about the necessity of isolation sites intended for permanent people's stay especially residential areas from sites which may be affected by the electromagnetic waves due to potential negative impact of the electromagnetic waves on human body.

The necessity of isolation areas exposed to the strong impact of electromagnetic waves is included in legal acts in Poland as well as at European level. We will discuss topic of legal regulations concerning issue of electromagnetic fields in Polish law and in European law and we compare the differences.

Presentation will include also selected research result on the impact of electromagnetic waves on living structures and human body. So far studies do not state clearly that there is negative impact of electromagnetic waves on human bodies but simultaneously they do not show that there is no impact. Due to the potential risk related to affect of electromagnetic waves there is a real need to isolate existing and planned high-voltage power lines as well as substations from residential areas and other areas intended for permanent people's stay likewise commercial and recreational areas what is included in mentioned above legal acts.

Human and Field: Submission or Interaction

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