Saratov State University

Research-Educational Institute of Optics & Biophotonics

Saratov Fall Meeting SFM'12

XVI International School for Junior Scientists and Students on Optics, Laser Physics & Biophotonics

September 25 - 28, 2012
Saratov, Russia

Conference Chair

Valery V. Tuchin,
Saratov State University, Institute of Precise Mechanics and Control RAS, Russia; University of Oulu, Finland

Conference Secretary

Elina A. Genina,
Saratov State University

Workshops:

- Optical Technologies in Biophysics & Medicine XIV
- Laser Physics and Photonics XIV
- Spectroscopy and Molecular Modeling XIII
- Modern Optics XI
- Electromagnetics of Microwaves, Submillimeter & Optical Waves XII
- English as a Communicative Tool in the Scientific Community XI
- Workshop on Management of High Technologies Commercialization and Regional Innovation Systems IX
- Nanobiophotonics VIII
- Nonlinear Dynamics and Computational Biophysics III
- Internet Biophotonics V
- Microscopic and Low-Coherence Methods in Biomedical and Non-Biomedical Applications V
- History, Methodology and Philosophy of the Optical Education V
- Telemedicine VII
- Low-dimensional structures II

Special events:

Russian-Chinese Workshop "Biophotonics and Biomedical Optics"

Co-chairs: *Qingming Luo*, Britton Chance Center for Biomedical Photonics, HUST, P.R. China, and *Valery V. Tuchin*, Saratov State University

SPIE/OSA SHORT COURSE SESSION

OSA SC:
Optical elastography: Prospects in medicine for micro-imaging of tissue mechanical properties
David Sampson, Professor, PhD, University of Western, Australia

SPIE SC:
Laser Tissue Bonding Using ICG and Gold Nanoparticles
Roberto Pini, Professor, PhD, Istituto di Fisica Applicata "Nello Carrara", Consiglio Nazionale delle Ricerche, Sesto Fiorentino, Italy

Special session on P4L Saratov Cluster "Photonics for Diagnostics and Therapy" of Photonics4Life Consortium of EC FP7: Network of Excellence for Biophotonics

Special session on student reports awarded by the Russian Foundation on Innovations U.M.N.I.K. in Optics, Laser Physics, and Biophotonics

Organized by

N.G. Chernyshevsky Saratov State University

Institute of Precise Mechanics and Control, Russian Academy of Sciences

Research-Educational Institute of Optics and Biophotonics at Saratov State University

Research-Educational Center of Nonlinear Dynamics & Biophysics (REC-006) of CRDF and Ministry of Education and Science of RF

International Research-Educational Center of Optical Technologies for Industry and Medicine "Photonics" at Saratov State University

Volga Region Center of New Information Technologies at Saratov State University

Biomedical Photonics Committee of Chinese Optical Society

University of Oulu, Finland

Saratov State Medical University

SPIE Student Chapter

OSA Student Chapter

In cooperation with

Academy of Natural Sciences, Saratov Regional Division

Russian Society for Photobiology

Saratov Science Center of the Russian Academy of Sciences

Photonics4Life Consortium of EC FP7: Network of Excellence for Biophotonics

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SPIE – The International Society of Photo-Optical Instrumentation Engineers

SPE "Nanostructed Glass Technology" Ltd., Saratov

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The main goal of the School and the Workshops is to involve junior researches and students in the field of recent developments and applications of laser and optical technologies in medicine and biology, coherent optics of random and ordered media, material and environmental sciences, nonlinear dynamics of laser systems, laser spectroscopy and molecular modeling. The main attention will be paid to discussion of fundamentals and general approaches of description of coherent, low-coherent, polarized, spatially and temporally modulated light interactions with inhomogeneous scattering media, photonic crystals, tissue phantoms, and various types of tissues *in vitro* and *in vivo*. Such effects as static and dynamic light scattering, Doppler effect, optoacoustic and optothermal interactions, mechanical stress, photodynamic effect, etc will be considered. On this basis the variety of

laser and optical technologies for medical diagnostics, therapy, surgery, and light dosimetry, as well as for spectroscopy of random and ordered tissue media will be presented.

SFM-12 will be organized as the morning plenary sessions, afternoon lecture and oral sessions and evening poster presentations. The original oral reports and posters will be presented by the junior scientists and students. Plenary lectures will be presented by well-recognized experts in the field.

Last year plenary speakers:

Mark Neil, Department of Physics, Blackett Laboratory, Imperial College, UK: *Programmable Optics and Programming for Optics: Applications in Biophotonics*

Alexei A. Kamshilin, Department of Applied Physics, University of Eastern Finland, Finland: *Blood Perfusion Visualization in Vivo by Synchronous Detection Technique*

Ilya Yaroslavsky, Palomar Medical Technologies, Inc., USA: *Fractional Photothermolysis of Tissues as a New Paradigm in Laser Medicine*

Igor Meglinski, Otago University, New Zealand: *Optical diagnostics of stress conditions of aquatic organisms in Baikal Lake*

Qingming Luo, Britton Chance Center for Biomedical Photonics, P.R. China: *Optical Neuroimaging*

Alexander Shkurinov, **Maxim Nazarov**, **Anatoly Khodan**, Moscow State University, Institute of Physical Chemistry and Electrochemistry RAS, Russia: From nano- to tera-: applications of the terahertz radiation for studies of artificial material nanosize structures

Last year SPIE/OSA short courses:

Kirill V. Larin, University of Houston, USA: *Optical Coherence Tomography: Imaging and Sensing of Tissues and Cells*

Francesco Pavone, European Laboratory for Nonlinear Spectroscopy and Department of Physics Sesto Fiorentino, Italy: *Nonlinear Morphofunctional Imaging of Tissues*

The specificity of Saratov Fall Meetings is one-day Internet session. In **2011** such presentations have included plenary lectures made by

Lihong V. Wang, Washington University in St. Louis, USA: *Photoacoustic Tomography: From Cells to Organs*

Yu Chen, Fischell Department of Bioengineering, University of Maryland, USA: *In vivo 3D imaging of kidney microcirculation using Doppler OCT*

Martin Wolf, University Hospital Zurich, Switzerland: *Clinical application of near-infrared spectroscopy and imaging in neonates*

Participants from 30 countries have located their papers on the meeting website: http://optics.sgu.ru/SFM/. Among invited Internet lecturers were well recognized experts in the fields of biomedical optics and light scattering.

Official languages of the School and the Workshops are English and Russian, translation will be provided.

The Conference fee

For foreign participants the conference fee is US $ 200 (includes Program, two short-courses, Welcome Party, Barbecue, Volga-river voyage, and light refreshments), may be paid during the Meeting or transferred to the account number for request.

For Russian participants the Conference fee will depend on financial support from the Russian Foundation of Basic Research and other sponsors.

Lodging

Hotel "Slovakia" ashore the Volga river

http://slovakia.all-hotels.ru/

Hotel "Volga" in the downtown

Western style mini-hotel Bohemia in the downtown

http://www.bohemiahotel.ru

mail@bohemiahotel.ru

Student hostel "Volna" ashore the Volga river

Culture program

Visits to Conservatoire, Theaters, and Museums, 4-hour Volga-tour.

Registration

Electronic registration before **August 15, 2012**, at http://optics.sgu.ru/SFM/ is required.

Submission of Abstracts

Each author is requested to submit a one-page abstract. Abstract must be uploaded to the Conference website http://optics.sgu.ru/SFM/ before **August 15, 2012**.

Proceedings

Conference papers will be published as SPIE Proceedings (CD, SPIE Digital Library), Conference Proceedings (in Russian and English) under the title "Optical Physics and Biophotonics" and in Russian and International peer-reviewed journals: J. of Biophotonics, J. of Biomedical Optics, J. of Innovative Optical Health Sciences, Quantum Electronics (Russian/English), Applied Nonlinear Dynamics (Russian/English), Laser Physics (English), and Optics and Spectroscopy (Russian/English).

All papers will be subjected to the normal refereeing process for the journals. Manuscripts of papers should be submitted not later than **October 15, 2012**.

Visa application support

To apply for visa to Russian Consulate you need an official invitation letter. Procedure for letter preparation takes two months; the following information about you and accompany persons are needed:

1. Passport number:_____ dates of issue:___ and of expiry:_____ (copy of passport page with photo)
2. Date of birth:___, place of birth:__
3. Living address:_____
4. Working position:_____
5. Working address:_____

Please, send this information to secretary of the SFM-12

Elina A. Genina: eagenina@yandex.ru
eagenina@optics.sgu.ru

Important deadlines

Visa application support – information for official invitation letter, before
May 31, 2012

Submission of Abstracts – before
August 15, 2012

Registration – before
August 15, 2012

Hotel reservation – before
August 15, 2012

Conference fee –
September 25, 2012

Manuscripts submission – before
October 15, 2012

SFM-12 webpage:
http://optics.sgu.ru/SFM/

On behalf of the Organizing Committee of SFM'12 I have a pleasure in inviting you to attend this Meeting

Valery V. Tuchin

Workshop:
Optical Technologies in Biophysics & Medicine XIV

Chair

Valery V.Tuchin,
Saratov State University, Institute of Precise Mechanics and Control RAS, Russia; University of Oulu, Finland

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Elina A. Genina,
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Juergen Popp,
Inst. of Photonic Technology, Jena (Germany)

Alexander V. Priezzhev,
Moscow State Univ. (Russia)

Lihong Wang,
Washington Univ. in St. Louis (USA)

Ruikang K. Wang,
Univ. of Washington (USA)

Dan Zhu,
Huazhong Univ. of Sci. and Technol. (China)

The main goal of the Workshop is to involve junior researches and students in the field of recent developments and applications of laser and optical technologies in medicine and biology. The main attention will be paid to discussion of fundamentals and general approaches of description of coherent, low-coherent, polarized, spatially and temporally modulated light interaction with inhomogeneous absorbing media, tissue phantoms, and various types of tissues *in vitro* and *in vivo*. Such effects as static and dynamic light scattering, Doppler effect, photoacoustic and photothermal interactions, mechanical stress, photodynamic effect, etc will be considered. On this basis the variety of laser and optical technologies for medical diagnostics, therapy, surgery, and light dosimetry will be analyzed. Lasers and optical techniques for cardiology, dermatology, ophthalmology, gynecology, dentistry and other fields of medicine will be presented. Light scattering and photochemical techniques in cell biology and microbiology will be discussed.

Topics

The education and scientific program will include the following topics:

- Photon migration in tissues
- Diffusion wave and correlation spectroscopy of tissues
- Spectrophotometry, fluorescence and Raman spectroscopy of tissues
- Static and dynamic light scattering in tissues
- Coherent optical methods for medical diagnostics
- Cell and tissue coherent microscopy
- Optical diffusion and coherent medical topography and tomography
- Laser Doppler measuring systems for medicine and biology
- Full field speckle-correlation biomedical techniques
- Optical techniques of biovibrations measurements
- Optical polarimetric methods for study of tissues and cell structures
- Photothermal and photoacoustic methods for tissue diagnostics
- Optical biopsy
- Optical microelastography of tissues
- Osmotic effects and optical monitoring of matter diffusion in tissues
- Tissue and blood optical clearing
- Optical glucose sensing
- Laser and optical technologies in microbiology
- Tissue phantoms designing
- Photochemical, photothermal and photobiological effects, mechanisms of phototherapy
- High energy laser interactions with cells and tissues, laser surgery techniques
- Lasers and optical technologies in dermatology, ophthalmology, gynecology, cardiology, dentistry, etc
- Microchannel and photonic crystal technologies in biology and medicine
- Biosensors

Workshop: Internet Biophotonics V

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The main goal of the Workshop is to involve international community of junior researches and students in the field of recent developments of biophotonics via distant learning provided by the Internet facilities. SFM has a prolonged experience in organizing of Internet sessions during last 15 years. In 2011 such presentations have included plenary lectures made by

Lihong V. Wang, Washington University in St. Louis, USA: *Photoacoustic Tomography: From Cells to Organs*

Yu Chen, Fischell Department of Bioengineering, University of Maryland, USA: *In vivo 3D imaging of kidney microcirculation using Doppler OCT*

Martin Wolf, University Hospital Zurich, Switzerland: *Clinical application of near-infrared spectroscopy and imaging in neonates*

Participants from 30 countries have located their papers on the meeting website: http://optics.sgu.ru/SFM/.

In 2012 we are expecting 3-4 Internet Plenary lectures, 20-30 Internet invited lectures highlighting current research and recent progress in Biophotonics, which will be done by well-known experts, 30-40 Internet reports from junior researchers, post-docs and PhD students all over the world.

Topics

The education and scientific program will include the following topics:

- New photonic technologies for the analysis of cell and tissue processes
- Photonics for non- and minimally-invasive diagnosis and therapy
- Nanobiophotonics
- Optical micromanipulation of cells and particles
- Biosensors
- Modeling and data analysis in Biophotonics
- Clinical applications

Workshop: Low-Dimensional Structures II

Chair

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Institute of Radioengineering and Electronics (IRE) of RAS, Saratov (Russia)

Gennadiy V. Torgashov,
Institute of Radioengineering and Electronics (IRE) of RAS, Saratov (Russia)

We will discuss theoretical and experimental methods for studying of structure, properties (optical, electronic, etc.) and applications of the low-dimensional structures. We will discuss in detail a problem of the biomedical applications of low-dimensional structures as biomaterials. Also, within the workshop we will discuss different aspects of nanobiomechanics, molecular dynamics, nanobioelectronics.

The workshop program will include following **topics**:

- synthesis technology of the low-dimensional structures (nanofilms, nanocoating, nanotubes, nanowires, graphene, fullerenes);
- atomic framework and properties of the low-dimensional structures and their research methods;
- low-dimensional structures in external fields;
- biomedical and non-biomedical applications of low-dimensional structures;
- investigation of mechanisms for lipid-protein complexes diffusion into intima of arteries: biomechanical modeling, molecular modeling, 3D-computational modeling;
- atomic-force microscopy for topology of the endothelium surface.

Workshop:
Nonlinear Dynamics and Computational Biophysics III

Chair

Vadim S. Anishchenko,
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Alexey V. Shabunin,
Dmitry E. Postnov,
Saratov State University (Russia)

The main goal of the Workshop is to attract young scientists and students to the discussion of topical problems and results in the field of theoretical nonlinear dynamics with special attention to its application in the living systems, such as mathematical physiology, neuroscience and advanced time series analisys of biophysical and medical data.

The special attention will be given to the review of contemporary achievements in the field of research of dynamics of complex nonlinear systems, both deterministic and stochastic. It is planned to invite some leading experts for delivering plenary lectures and to present oral and poster contributions of young researchers, PhD students and graduate students.

Topics

The scientific program will include but is not limited to the following topic areas:

- Nonlinear Dynamics of Deterministic Finite-Dimensional and Distributed Systems;
- Stability and Bifurcations;
- Synchronization of Complex Processes;
- Role of Fluctuations in Nonlinear Dynamics;
- Diagnostics and Analysis of Physiological Rhythms;
- Mathematical Modeling of Living Systems.

Workshop:
Management of High Technologies Commercialization and Regional Innovation Systems IX

Chair

Valery V. Tuchin,
Saratov State University, Institute of Precision Mechanics and Control RAS, Russia; University of Oulu, Finland

Secretary

Yulia S. Skibina,
Saratov State University, SPE "Nanostructed Glass Technology" Ltd.

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Robert Breault,
Breault Research Organization, Arizona Optics Industry Association (USA)

Boris Reznik, BioRASI, Inc. (USA)

Natalya V. Romanova,
Saratov State University (Russia)

Sergey N. Sokolov,
INJECT Enterprise (Russia)

Stoyan Tanev,
University of Southern Denmark, Denmark

Andreas Thoss, THOSS Media GmbH, Berlin, Germany

The workshop program will include the following **topics**:

- High technology's commercialization, innovation management, high technologies and business, technologies of opening of the innovative companies, innovative business, transfer of technologies, financing of innovative activity, management of innovation risks, venture financing, education in the field of management in biophotonics and biotechnologies
- Development and monitoring of branch "road maps" as the basis for planning of regional branch clusters and innovation zones
- Actual priorities of the regional innovation policy
- Experience of IP commercialization and actual problems of Academy of Sciences, high schools, chambers of commerce and regional industrial company interaction
- Special session on student reports awarded by the Russian Foundation on Innovations U.M.N.I.K. in Optics, Laser Physics, and Biophotonics will be provided

Workshop:
Microscopic and Low-Coherence Methods in Biomedical and Non-Biomedical Applications V

Chair

Kirill V. Larin,
University of Houston (USA), Saratov State University

Secretary

Georgy G. Akchurin,
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University of Otago (New Zealand), Saratov State University (Russia)

Valery V. Tuchin,
Saratov State University, Institute of Precise Mechanics and Control RAS, (Russia); University of Oulu (Finland)

Ruikang K. Wang,
Univ. of Washington (USA)

Development of non- or minimally-invasive methods for imaging, monitoring, and quantification of different materials and processes are extremely important for many biomedical (including therapy, diagnostics, management, and advanced imaging of various devastating diseases) and non-biomedical applications (dimensional metrology, material research and non-destructive testing, art diagnostics, botany, microfluidics, data storage, and security applications). This workshop will put emphasis on two aspects of optical imaging: microscopy and low coherence interferometry.

Topics

The education and scientific program will include but is not restricted to the following topic areas:

- Optical microscopy
- Methods of Low Coherence Interferometry
- Optical Coherence Tomography
- Combinations of LCI/OCT with microscopy
- Biomedical applications of optical microscopy and LCI
- Non-biomedical applications of optical microscopy and LCI

OSA Short course

Optical elastography: Prospects in medicine for micro-imaging of tissue mechanical properties

David D. Sampson, Optical+Biomedical Engineering Laboratory, School of Electrical, Electronic & Computer Engineering and Centre for Microscopy, Characterisation & Analysis, The University of Western Australia, Perth, Western Australia, Australia

Palpation, the sensing of tissue mechanical properties through touch, has been a main means of physicians' identification of abnormal or diseased tissues for centuries. In the late 1980s, the first attempts were made to augment palpation using modern medical imaging. Mechanically loading a tissue and using a medical imaging modality to map the resulting tissue displacements can produce elastograms of a tissue's mechanical properties – the same properties that enable diagnosis through palpation. The resolution of the result is closely tied to that of the modality, most commonly either ultrasound or magnetic resonance imaging.

For applications such as cancer surgery, mapping tissue mechanical properties with still higher resolution is expected to bring additional benefits. For example, breast-conserving surgery for the treatment of breast cancer has suboptimal outcomes leading to approximately one out of three-to-four patients requiring a second operation due to insufficient removal of tumour, which is often discovered post-surgery upon microscopic assessment of the excised tissue. Improved resolution of tumour margins during surgery may help improve this statistic. Such resolution enhancement is the goal of optical coherence elastography, the use of optical coherence tomography to perform elastography.

In this short course, I will describe the historical development of elastography methods, including the optical methods developed since the 1990s. I will focus on recent advances, such as overcoming the limited penetration depth inherent to optical methods through needle elastography, and show examples of the current state-of-the-art optical elastography imaging of tissues, including human breast tumours.

Learning Objectives

This course will enable you to:

- Appreciate the opportunity for high-resolution optical elastography methods to improve patient outcomes from surgical procedures.
- Understand the basics of the mechanical properties of biological materials and how elastography can probe these properties in humans.
- Describe the basic principles and historical progression of optical elastography, including the underlying principles, technologies and signal processing techniques including speckle in coherent imaging, optical coherence tomography, and phase-sensitive methods for high-resolution displacement measurement.
- Gain an appreciation of the current state-of-the-art in optical elastography, of the issues that remain to be addressed, and the opportunities for future impact.

Intended audience

Engineers, scientists, and physicians who are interested in the principles and applications of optical and laser-based methods developed for clinical medical and biomedical science will benefit from this course.

Course level

Intermediate

Course Length

Half-day

Instructor:

Winthrop Professor Sampson is Director of the Centre for Microscopy, Characterisation & Analysis (CMCA), a core facility of the University of Western Australia, and heads the Optical+Biomedical Engineering Laboratory (OBEL) in the School of Electrical, Electronic & Computer Engineering. He directs the Western Australian nodes of the Australian Microscopy & Microanalysis Research Facility (AMMRF) and the National Imaging Facility (NIF), and the Western Australian State Government's Centre for eMedicine. W/Prof. Sampson's research interests are in biomedical optical engineering, with an emphasis on photonics, imaging and microscopy, and particularly their application in clinical medicine. He has authored more than 110 journal papers, raised more than $35M in research funding, and given more than 100 invited talks and colloquia. A major emphasis of his research is the medical imaging modality optical coherence tomography. He has pioneered anatomical optical coherence tomography, a version that enables dynamic 3D imaging of hollow organ anatomy, and its application in human airways. His team is extensively engaged in advancing microscope-in-a-needle technology and its application in intraoperative cancer imaging. He is active in methods and medical applications of optical elastography, the micro-imaging of tissue mechanical properties. He has also made advances in holographic microscopy.

SPIE Short Course:

Laser Tissue Bonding Using ICG and Gold Nanoparticles

Roberto Pini, Professor, PhD, Istituto di Fisica Applicata "Nello Carrara", Consiglio Nazionale delle Ricerche, Sesto Fiorentino, Italy

This course presents the principles of laser tissue bonding, as well as experimental and clinical applications of this technique in different surgical fields. Thermally induced modifications at the microscopic scale in proteins of the extracellular matrix is described as the basic mechanism of laser-induced tissue bonding. The association of near infrared laser irradiation with organic or nanostructured chromophores applied topically to induce tissue fusion an repair is discussed, showing how lasers hold the promise of providing instantaneous, watertight seals, which is important in many critical surgeries, such as, for example, for vascular repairs, without the introduction of foreign materials, such as sutures or staples. Other advantages over conventional suturing include reduced operation times, fewer skill requirements, decreased foreign-body reaction and therefore reduced inflammatory response, increased ability to induce regeneration of the original tissue architecture, and an improved cosmetic appearance. A particular focus will be given on corneal laser welding in ophthalmic surgery, which is presently the most used clinical applications of this technique in patients. Finally, recent experimental applications employing plasmonic gold nanoparticles as new laser-activated chromophores will be presented and discussed.

LEARNING OBJECTIVES

This course will enable you to:

- be introduced to laser-tissue photothermal interaction, with particular regard to the absorption of near infrared laser light in biotissue for applications in surgery and treatments, describe the transformation of laser light into heat by means of the bio-heat equation.
- explain the mechanisms of laser tissue welding and soldering, based on the thermal modification of endogenous proteins like collagen or endogenous materials like hyaluronan, albumin, chitosan, etc.
- understand the role of organic chromophores like Indocyanine Green (ICG) to enhance and localize light absorption and conversion into heat, in order to provide a more homogeneous heat distribution and reduce the operative laser power.
- get a historical and comprehensive overview on applications of laser tissue bonding in various surgical fields, proposed at experimental level, discussing the potential advantages offered by this technique in comparison with conventional suturing techniques.
- focus on applications in ophthalmology, in which laser tissue welding is presently employed in the clinics for the closure of corneal wounds and to perform various types corneal transplant, in association with the use of the femtosecond laser for cutting and sculpturing of the corneal graft.
- be introduced to plasmonic gold nanoparticles as new more

effective and stable chromophores for photothermal treatments, with brief notes on the synthesis of such nanoparticles to tune their optical absorption in the near infrared spectral region.

INTENDED AUDIENCE

Engineers, scientists, and physicians who are interested in optical and laser methods and application for medical science and clinics will benefit from this course.

COURSE LEVEL

Intermediate

COURSE LENGTH

Half-day

INSTRUCTOR

Roberto Pini, physicist, is a Senior Scientist at the Institute of Applied Physics (IFAC-CNR) of the CNR in Sesto Fiorentino, where he is the leader the Biophotonics and Nanomedicine Lab (BNLab). He is also a professor at the University of Florence, in charge of a chair of Optics at the Faculty of Medicine and Surgery, and a chair of Biomedical Optics at the Faculty of Optics and Optometry. His main research interests are related to studies on light propagation in biological tissues, development and applications of laser-activated gold nanoparticles and nanostructured chromophores for medical use, microscopic analyses on photothermal modifications of proteins, development of new medical laser devices, preclinical and clinical studies on the use of laser and other optoelectronics devices for minimally invasive surgery (e.g. in ophthalmology, microvascular surgery and dermatology). He is co-author of more than 200 scientific publications, including 6 books, and of 18 patents.