

Saratov Fall Meeting 2010

Optical Technologies in Biophysics and Medicine XII

Valery V. Tuchin

Elina A. Genina

Editors

5–8 October 2010

Saratov, Russian Federation

Organized by

Saratov State University (Russian Federation) • Institute of Precision Mechanics and Control, Russian Academy of Sciences (Russian Federation) • Research-Educational Institute of Optics and Biophotonics at Saratov State University (Russian Federation) • Research-Educational Center of Nonlinear Dynamics & Biophysics of CRDF and Ministry of Education and Science of RF (REC-006) (Russian Federation) • International Research-Educational Center of Optical Technologies for Industry and Medicine "Photonics" at Saratov State University (Russian Federation) • Volga Regional Center of New Information Technologies (Russian Federation) • Saratov State Medical University (Russian Federation)

In cooperation with

Academy of Natural Sciences, Saratov Regional Division (Russian Federation) • Russian Society for Photobiology Saratov Science Center of the Russian Academy of Sciences (Russian Federation) • Photonics4Life Consortium of EC FP7: Network of Excellence for Biophotonics • Wiley-VCH Verlag GmbH (Germany)

Sponsored by

Russian Foundation for Basic Research (Russian Federation) • Saratov State University SPIE Student Chapter • Optical Society of America (OSA) • Saratov State University OSA Student Chapter • Russian Academy of Sciences • U.S. Civilian Research and Development Foundation for the Independent States of the Former Soviet Union (CRDF) (United States) • SPE "Nanostructured Glass Technology" Ltd. (Russian Federation) • SPE "Erudit" Ltd. (Russian Federation)

Cosponsored and Published by

SPIE

Volume 7999

Proceedings of SPIE, 1605-7422, v. 7999

SPIE is an international society advancing an interdisciplinary approach to the science and application of light.

The papers included in this volume were part of the technical conference cited on the cover and title page. Papers were selected and subject to review by the editors and conference program committee. Some conference presentations may not be available for publication. The papers published in these proceedings reflect the work and thoughts of the authors and are published herein as submitted. The publisher is not responsible for the validity of the information or for any outcomes resulting from reliance thereon.

Please use the following format to cite material from this book:

Author(s), "Title of Paper," in *Saratov Fall Meeting 2010: Optical Technologies in Biophysics and Medicine XII*, edited by Valery V. Tuchin, Elina A. Genina, Proceedings of SPIE Vol. 7999 (SPIE, Bellingham, WA, 2011) Article CID Number.

ISSN 1605-7422

ISBN 9780819485724

Published by

SPIE

P.O. Box 10, Bellingham, Washington 98227-0010 USA

Telephone +1 360 676 3290 (Pacific Time) · Fax +1 360 647 1445

SPIE.org

Copyright © 2011, Society of Photo-Optical Instrumentation Engineers.

Copying of material in this book for internal or personal use, or for the internal or personal use of specific clients, beyond the fair use provisions granted by the U.S. Copyright Law is authorized by SPIE subject to payment of copying fees. The Transactional Reporting Service base fee for this volume is \$18.00 per article (or portion thereof), which should be paid directly to the Copyright Clearance Center (CCC), 222 Rosewood Drive, Danvers, MA 01923. Payment may also be made electronically through CCC Online at copyright.com. Other copying for republication, resale, advertising or promotion, or any form of systematic or multiple reproduction of any material in this book is prohibited except with permission in writing from the publisher. The CCC fee code is 1605-7422/11/\$18.00.

Printed in the United States of America.

Publication of record for individual papers is online in the SPIE Digital Library.

The logo for SPIE Digital Library features the word "SPIE" in a bold, sans-serif font above the words "Digital Library" in a smaller, lighter font. To the right of the text is a stylized graphic consisting of three vertical bars of increasing height, resembling a bar chart or a signal waveform.

SPIDigitalLibrary.org

Paper Numbering: Proceedings of SPIE follow an e-First publication model, with papers published first online and then in print and on CD-ROM. Papers are published as they are submitted and meet publication criteria. A unique, consistent, permanent citation identifier (CID) number is assigned to each article at the time of the first publication. Utilization of CIDs allows articles to be fully citable as soon as they are published online, and connects the same identifier to all online, print, and electronic versions of the publication. SPIE uses a six-digit CID article numbering system in which:

- The first four digits correspond to the SPIE volume number.
- The last two digits indicate publication order within the volume using a Base 36 numbering system employing both numerals and letters. These two-number sets start with 00, 01, 02, 03, 04, 05, 06, 07, 08, 09, 0A, 0B ... 0Z, followed by 10-1Z, 20-2Z, etc.

The CID number appears on each page of the manuscript. The complete citation is used on the first page, and an abbreviated version on subsequent pages. Numbers in the index correspond to the last two digits of the six-digit CID number.

Contents

vii	Conference Committee
ix	Introduction

BIOPHOTONICS FOR DIAGNOSTICS

7999 02	The resolving power of optical method to register erythrocytes agglutination enhanced by ultrasonic wave [7999-01] A. A. Dolmashkin, V. A. Doubrovski, Saratov State Medical Univ. (Russian Federation)
7999 03	The resolving power of the flowing method to register the process of human erythrocytes agglutination in vitro on the base of correlation analysis of microphotographs [7999-02] Yu. A. Ganilova, V. A. Doubrovski, I. V. Zabenkov, Saratov State Medical Univ. (Russian Federation)
7999 04	Multi-modal optical diagnostic approach for non-invasive imaging of blood and lymphatic vascular networks in vivo (Invited Paper) [7999-03] V. Kalchenko, Y. Kuznetsov, Weizmann Institute of Science (Israel); I. Meglinski, Univ. of Otago (New Zealand); A. Harmelin, Weizmann Institute of Science (Israel)
7999 05	Full complex spectrum simultaneous obtaining SD-OCT [7999-04] G. V. Gelikonov, V. M. Gelikonov, P. A. Shilyagin, Institute of Applied Physics (Russian Federation)
7999 06	Using phase gradient autofocus (PGA) algorithm for restoration OCT images with diffraction limited resolution [7999-05] A. A. Moiseev, G. V. Gelikonov, P. A. Shilyagin, V. M. Gelikonov, Institute of Applied Physics (Russian Federation)
7999 07	The delayed fluorescence kinetics as a method of biological tissue diagnostics [7999-06] S. N. Letuta, V. S. Maryakhina, Orenburg State Univ. (Russian Federation)
7999 08	Biodistribution and clearance of quantum dots in small animals [7999-07] Y. F. Salykina, V. V. Zherdeva, A.N. Bakh Biochemistry Institute (Russian Federation); S. V. Dezhurov, M. S. Wakstein, Applied Acoustics Research Institute (Russian Federation); M. V. Shirmanova, E. V. Zagaynova, Nizhny Novgorod State Medical Academy (Russian Federation); A. A. Martyanov, Lomonosov Moscow State Univ. (Russian Federation); A. P. Savitsky, A.N. Bakh Biochemistry Institute (Russian Federation)
7999 09	Numerical modeling and analytical treatment of IR spectra in the diagnosis of skin cancers (Invited Paper) [7999-08] N. Skrebova Eikje, MC Professional OÜ (Estonia)
7999 0A	Organic systems investigation by ion-photon spectroscopy [7999-09] I. A. Afanas'eva, V. V. Bobkov, V. V. Grytsyna, D. I. Shevtshenko, V.N. Karazin National Univ. (Ukraine)

- 7999 OB **Digital image correlation with fast Fourier transform for large displacement measurement** [7999-10]
A. A. Grebenyuk, Saratov State Univ. (Russian Federation); V. P. Ryabukho, Saratov State Univ. (Russian Federation) and Institute of Precision Mechanics and Control (Russian Federation)
- 7999 OC **The dynamics of the electromagnetic wave propagation in the nonlinear Bragg grating structure** [7999-11]
A. V. Sadovnikov, A. G. Rozhnev, Saratov State Univ. (United States)
- 7999 OD **Assessment of electrical burn injury using structured illumination in an in-vivo electrical injury model (Invited Paper)** [7999-12]
T. T. A. Nguyen, A. Basiri, The Catholic Univ. of America (United States); J. W. Shupp, L. T. Moffatt, M. H. Jordan, J. C. Jeng, E. Leto, Washington Hospital Ctr. (United States); J. C. Ramella-Roman, The Catholic Univ. of America (United States)
- 7999 OE **EMG parameters and EEG α Index change at fatigue period during different types of muscle contraction** [7999-13]
L. Zhang, B. Zhou, Wuhan Sports Univ. (China); G. Song, Zhengzhou Univ. (China)
- 7999 OF **Mechanism for tissue optical clearing: physical and physiological research** [7999-14]
X. Wen, T. Yu, Q. Luo, D. Zhu, Britton Chance Ctr. for Biomedical Photonics (China)
- 7999 OG **Preliminary investigations of rat skin after topical application of optical clearing agent (Invited Paper)** [7999-15]
J. Wang, D. Zhu, Britton Chance Center for Biomedical Photonics (China)
- 7999 OH **Exact solution in one model of cooperative molecular motors** [7999-16]
M. M. Stolnitz, Saratov State Univ. (Russian Federation);
A. A. Kudryashov, V.I. Razumovsky Municipal Clinical Hospital No. 2 (Russian Federation)

LIGHT SCATTERING IN TISSUES AND CELLS

- 7999 OI **Coherent back scattering of optical radiation in a turbid scattering medium for diagnostic purposes** [7999-17]
J. Chambers, I. Meglinski, Univ. of Otago (New Zealand)
- 7999 OJ **Influence of condition of growth of bacterial colonies on fractal dimension of bacterial speckle patterns** [7999-18]
A. S. Ulyanov, Saratov State Univ. (Russian Federation); A. M. Lyapina, Saratov Scientific and Research Veterinary Institute (Russian Federation); O. V. Ulianova, Saratov State Univ. (Russian Federation) and Saratov State Agrarian Univ. (Russian Federation); V. A. Feodorova, Saratov Scientific and Research Veterinary Institute (Russian Federation)
- 7999 OK **GPU-accelerated object-oriented Monte Carlo modeling of photon migration in turbid media (Invited Paper)** [7999-19]
A. Doronin, I. Meglinski, Univ. of Otago (New Zealand)

- 7999 OL **Fractal properties of biospeckles formed at the coherent illumination of histological preparation of cancer tissues** [7999-20]
A. S. Ulyanov, Saratov State Univ. (Russian Federation); A. V. Zotov, Saratov Regional Hospital with Pathologic Ctr. (Russian Federation)

PHOTODYNAMIC AND OTHER PHOTO-INDUCED EFFECTS

- 7999 OM **Inhomogeneity of photo-induced fat cell lipolysis** [7999-21]
V. A. Doubrovsky, Saratov State Medical Univ. (Russian Federation); I. Yu. Yanina, Saratov State Medical Univ. (Russian Federation) and Saratov State Univ. (Russian Federation); V. V. Tuchin, Saratov State Univ. (Russian Federation) and Institute of Precise Mechanics and Control (Russian Federation)
- 7999 ON **Photodynamic damage of glial cells in crayfish ventral nerve cord** [7999-22]
M. S. Kolosov, E. Duz, A. B. Uzdensky, Southern Federal Univ. (Russian Federation)
- 7999 OO **Involvement of the PI3K/Akt/GSK3 β pathway in photodynamic injury of neurons and glial cells** [7999-23]
M. A. Komandirov, E. A. Knyazeva, Y. P. Fedorenko, M. V. Rudkovskii, D. A. Stetsurin, A. B. Uzdensky, Southern Federal Univ. (Russian Federation)
- 7999 OP **Study of toxic properties of prototypes of photo inactivated vaccines against tularemia and brucellosis by speckle microscopy** [7999-24]
O. V. Ulianova, Saratov State Agrarian Univ. (Russian Federation) and Saratov State Univ. (Russian Federation); S. Ulyanov, Saratov State Univ. (Russian Federation)
- 7999 OQ **Glutamate-mediated protection of crayfish glial cells from PDT-induced apoptosis** [7999-25]
M. V. Rudkovskii, N. P. Romanenko, E. V. Berezhnaya, V. D. Kovaleva, A. B. Uzdensky, Southern Federal Univ. (Russian Federation)

HIGH TECHNOLOGY COMMERCIALIZATION

- 7999 OR **Examining the articulation of innovativeness in co-creative firms: a neural network approach (Invited Paper)** [7999-26]
G. di Tollo, Univ. degli Studi G. d'Annunzio (Italy); S. Tanev, Univ. of Southern Denmark (Denmark)
- 7999 OS **A combined qualitative-quantitative approach for the identification of highly co-creative technology-driven firms** [7999-27]
H. Milyakov, Sofia Univ. (Bulgaria); S. Tanev, Univ. of Southern Denmark (Denmark); P. Ruskov, Sofia Univ. (Bulgaria)
- 7999 OT **Pattern-based information portal for business plan co-creation** [7999-28]
B. Bontchev, P. Ruskov, Sofia Univ. (Bulgaria); S. Tanev, Univ. of Southern Denmark (Denmark)

Author Index

Conference Committee

Conference Chair

Valery V. Tuchin, Saratov State University (Russian Federation)

Conference Secretary

Elina A. Genina, Saratov State University (Russian Federation)

General Program Committee

Vadim S. Anishchenko, Saratov State University (Russian Federation)

Lev M. Babkov, Saratov State University (Russian Federation)

Valentin I. Berezin, Saratov State University (Russian Federation)

Michael V. Davidovich, Saratov State University (Russian Federation)

Vladimir L. Derbov, Saratov State University (Russian Federation)

Nikolai G. Khlebtsov, Institute of Biochemistry and Physiology of Plants
and Microorganisms, RAS, Saratov State University
(Russian Federation)

Vyacheslav I. Kochubey, Saratov State University (Russian Federation)

Kirill V. Larin, University of Houston (United States)

Boris A. Medvedev, Saratov State University (Russian Federation)

Leonid A. Melnikov, Saratov State Technical University
(Russian Federation)

Juergen Popp, Institute of Photonic Technology (Germany)

Alexander B. Pravdin, Saratov State University (Russian Federation)

Vladimir P. Ryabukho, Saratov State University, Institute of Precision
Mechanics and Control, RAS (Russian Federation)

Alexander M. Sergeev, Institute of Applied Physics, RAS
(Russian Federation)

Sergey N. Shtykov, Saratov State University (Russian Federation)

Yulia S. Skibina, Saratov State University, SPE "Nanostructured Glass
Technology" Ltd. (Russian Federation)

Andreas Thoss, John Wiley & Sons (Germany)

Valery V. Tuchin, Saratov State University, Institute of Precision
Mechanics and Control, RAS (Russian Federation)

Dmitry A. Zimnyakov, Saratov State Technical University, Institute of
Precision Mechanics and Control, RAS (Russian Federation)

Session Chairs

Plenary Session I

Valery V. Tuchin, Saratov State University (Russian Federation)

Plenary Session II

Steven L. Jacques, Oregon Health & Sciences University (United States)

Plenary Session III

Johannes F. de Boer, Vrije Universiteit (Netherlands) and Massachusetts General Hospital (United States)

Plenary Session Internet Biophotonics

Alexander V. Priezzhev, Moscow State University (Russian Federation)

Valery V. Tuchin, Saratov State University (Russian Federation)

Biophysics I

Kirill Larin, University of Houston (United States)

Biophysics II

Ivan V. Fedosov, Saratov State University (Russian Federation)

Biophysics III

Steven L. Jacques, Oregon Health & Science University (United States)

Biophysics IV

Igor Meglinski, Otago University (New Zealand)

Biophysics V

Johannes F. de Boer, Vrije Universiteit (Netherlands) and Massachusetts General Hospital (United States)

Nonlinear Dynamics/Biophysics VI

Igor S. Nefedov, Aalto University (Finland)

Photonics/Coherence

Vladimir L. Derbov, Saratov State University (Russian Federation)

Spectroscopy

Valentin I. Berezin, Saratov State University (Russian Federation)

Lev M. Babkov, Saratov State University (Russian Federation)

Introduction

The Annual International Multidisciplinary School for Young Scientists and Students on Optics, Laser Physics and Biophotonics (Saratov Fall Meeting (SFM-10)) was held 5–8 October 2010 in Saratov, Russia, with about 500 participants from Russia, USA, Europe, and Asia. The meeting covered a wide range of modern problems of fundamental and applied optics, laser physics, photonics, and biomedical optics. SFM-10 also contained 13 international workshops:

- Optical Technologies in Biophysics & Medicine XII
Valery V. Tuchin, Chair
- Laser Physics and Photonics XII
Vladimir L. Derbov, Chair
- Coherent Optics of Ordered and Random Media XI
Dmitry A. Zimnyakov, Chair
- Spectroscopy and Molecular Modeling XI
Valentin I. Berezin and Lev M. Babkov, Chairs
- Modern Optics IX
Vladimir P. Ryabukho, Chair
- English as a Communicative Tool in the Scientific Community IX
Alexander B. Pravdin and Svetlana V. Eremina, Chairs
- Management of High Technologies Commercialization and Regional Innovation Systems VII
Valery V. Tuchin and Julia S. Skibina, Chairs
- Luminescence VI
Vyacheslav I. Kochubey and Sergey N. Shtykov, Chairs
- Nanobiophotonics VI
Nikolai G. Khlebtsov, Chair
- Microscopic and Low-Coherence Methods in Biomedical and Non-Biomedical Applications III
Kirill V. Larin, Chair
- History, Methodology and Philosophy of the Optical Education III
Vladimir P. Ryabukho and Boris A. Medvedev, Chairs
- Internet Biophotonics III
Valery V. Tuchin, Chair
- Nonlinear Dynamics
Vadim S. Anishchenko, Chair

SFM-10 also featured a seminar on Telemedicine: Opportunities, Applications, Prospects IV (Irina L. Maksimova and Elena V. Karchenova, chairs) and a Special Internet Session of European Network of Excellence for Biophotonics WP 5: Software for Modeling and Data Analysis in Biophotonics (Valery V. Tuchin and Mark Neil, chairs).

The main goal of the School, Workshops, and Seminars is to involve young researchers 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 was paid to discussion of fundamentals and general approaches of description of coherent, low-coherent, polarized, spatially and temporally modulated light interactions with inhomogeneous absorbing media, photonic crystals, tissue phantoms, and various types of tissues *in vitro* and *in vivo*. Such effects as static and dynamic light scattering, Doppler, optoacoustic and optothermal interactions, mechanical stress, photodynamic effect, etc., were 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 media were presented.

SFM-10 was organized as the morning plenary sessions, afternoon lecture and oral sessions and evening poster presentations and internet discussion. The original oral reports and posters were presented by the junior scientists and students. Plenary lectures were listened to with a great interest and discussed by audience.

Plenary and Invited lectures, oral and poster presentations covered a wide area of tissue optics, spectroscopy and imaging, controlling of optical properties of tissues, as well as biophysical and photo-chemical aspects of photo and laser therapy. Besides this Proceedings of SPIE volume, a few special issues and sections of well-recognized peer-reviewed journals, such as *Quantum Electronics*, *Journal of Biophotonics*, and *Journal of Innovative Optical Health Sciences*, will be published.

The SPIE/OSA short courses for students, engineers, scientists, and clinicians "Tissue Optics" by Prof. Steven L. Jacques, Oregon Health & Science University (USA) and "OCT, Polarization and Dynamic Light Scattering Techniques in Biophotonics" by Prof. Johannes F. de Boer, Vrije Universiteit (The Netherlands) and Massachusetts General Hospital (USA), accompanied the conference. There were more than 50 attendees each, mostly students, and were organized by Saratov University SPIE and OSA Student Chapters, and supported by SPIE, OSA and Saratov State University.

The specificity of Saratov Fall Meetings is Internet Workshop and one-day on-line discussion. In 2010, this session included the following plenary lectures: "Optical imaging for the study and early detection of cancer" by Jennifer Barton, The University of Arizona, USA; "Photoacoustic tomography: breaking through the optical diffusion limit" by Lihong V. Wang, Washington University in St. Louis, USA; "Biophotonics opportunities and challenges in point-of-care medicine" by Dennis L. Matthews, School of Medicine, NSF Center for Biophotonics, Cancer Center, UC Davis and LLNL, USA; "Nonlinear morphofunctional imaging of tissues" by Francesco Pavone, European Laboratory for Nonlinear Spectroscopy and

Department of Physics, Italy; "Global networking in eHealth one event – one society: Linking eHealth professionals worldwide" by Frank Lievens, International Society for Telemedicine & eHealth, Switzerland & Med-e-Tel, Belgium and Malina Mitkova Jordanova, Space and Solar-Terrestrial Influences Institute, Bulgarian Academy of Sciences & Med-e-Tel, Sofia, Bulgaria.

Participants from USA, Russia, Austria, Australia, Bulgaria, Canada, Finland, Germany, Ireland, UK, Canada, China, Italy, Japan, Ukraine, Belarus, Switzerland, Spain, Singapore, the Netherlands, Poland, New Zealand and other countries have located their papers on the meeting website: <http://optics.sgu.ru/SFM/>, which was available during the meeting and will be available for a whole year up to the next meeting. Three-hour on-line Internet discussion of all presented on Internet session papers via chat moderated by Alexander Priezhev was held.

A great number of presented materials are the result of collaboration between research groups from different countries supported by international scientific programs such as CRDF, PHOTONICS4LIFE, and others.

The major part of this volume includes papers presented on the Workshop "Optical Technologies in Biophysics and Medicine XII," however, a few papers presented on the Workshops "Management of High Technologies Commercialization and Regional Innovation Systems VII" and "Internet Biophotonics III" are also published in the volume.

It is a great pleasure and privilege for the editors to thank all of the authors for their contributions to SFM-10, especially to Internet lecturers for their exciting presentations, and to Alexander Priezhev, who was a moderator of Internet sessions last 10 years, for his talent and impressive moderation.

The organizers of SFM-10 are grateful to all of the sponsoring organizations and programs that supported this meeting very effectively, especially to: SPIE; Optical Society of America; Russian Foundation for Basic Research; U.S. Civilian Research & Development Foundation for the Independent States of the Former Soviet Union (CRDF), grant REC-006; PHOTONICS4LIFE of FP7-ICT-2007-2 (№ 224014, 2008-2013); RF Program on the Development of High School Potential (Project №2.2.1.1/2950, 2009-2011); and Volga Region Center of New Information Technologies.

Valery V. Tuchin
Elina A. Genina

