7th International A.M. Prokhorov Symposium on Biophotonics

TECHNICAL PROGRAM

7TH INTERNATIONAL A. M. PROKHOROV SYMPOSIUM ON BIOPHOTONICS

PLENARY SESSION

Location: Piedmonte room, floor 3

13:45–14:00 **Opening and welcome remarks**

14:00–14:45 **Valentin Gapontsev, ideas implementation. Prospects for fiber lasers**
N. N. Evtikhiev
"IRE-Polus" Ltd., National Research Nuclear University "MEPhI", Russia

14:45–15:30 **Biodegradable containers for drug delivery to tumours**
A. V. Zvyagin
MQ Photonics Centre, Faculty of Science and Engineering, Macquarie University, Sydney, Australia

16:00–16:45 **New opportunities for nanobiotechnology based on ultrasensitive methods of physical measurements**
P. I. Nikitin
Prokhorov General Physics Institute of RAS, Russia

16:45–17:30 **Multimodal photonic exploration of early embryonic development**
I. V. Larina
Baylor College of Medicine, USA

Section A. Advanced laser medical systems and technologies

Advanced laser medical systems and technologies I

Location: Petrov Vodkin 3 Room, floor 2. 09:00-11:00

TuSYA-01 09:00-09:30

Mechanisms of short wavelength light - biological tissue interaction *(Invited paper)*

I.A. Abushkin[1], V.M. Chudnovsky[2], M.A. Guzev[3], A.E. Anchugova[4,5], M.Y. Galiulin[5]; [1]Center for Medical Laser Technologies; [2] Ilyichev Pacific Oceanological Inst.; [3]Inst. of Applied Mathematics; [4]Chelyabinsk State Univ.; [5]South Ural State Medical Univ., Russia

The processes of formation and transfer of heat from exposure to short-wave infrared light - 1.5, 1.9 and (1.5 + 1.9) μm were studied in physiological solution, donor blood, and during interstitial thermotherapy of rabbit liver in vivo. Heat transfer corresponded to forced convection caused by boiling at the end of the fiber.

TuSYA-02 09:30-10:00

Comparative study of the endovenous laser coagulation with 1.47 and 1.94 μm clinical effiscacy *(Invited paper)*

V.Yu. Bogachev[1,2], K.A. Kaperiz[2], V.P. Minaev[3]; [1]Pirogov Russian National Research Medical Univ.; [2]The First Phlebological Center; [3]IRE-Polus Ltd, Russia

Studies have shown that EVLT with a wavelength of λ= 1.94 μm is accompanied by significantly less intraoperative pain syndrome and the risk of skin hyperpigmentation in the target vein projection. A lower penetration depth at wavelength λ= 1.94 μm reduces the risk of thermal damage to the nerve trunks near the target vein.

TuSYA-03 10:00-10:30

Prospects of automating the process of endovasal laser coagulation with using the visualization of the venous bed *(Invited paper)*

P.A. Ryabochkina[1], A.N. Belyaev[1], A.A. Artemov[1], A.D. Taratynova[1], A.A. Lyapin[1], S.A. Khrushchalina[1], S.V. Kostin[1], D.V. Pyanzin[1], A.V. Spirin[1], A.N. Chaldyshkin[1], D.N. Artemyev[2]; [1]National Research Mordovia State Univ.; [2]Samara National Research Univ., Russia

The scheme of the hardware and software complex which will be used at the clinical practice during EVLC operation for the treatment of varicose vein minimized postoperative complication.

This research was supported by RFBR Grant(s) # 18-29-20,039

TuSYA-04 10:30-10:45

Evaluation of vascularization parameters of experimental tumors of different morphogenesis

K.G. Pavlova[1,2], A.A. Kurnikov[1], D.A. Khochenkov[3], Yu.A. Khochenkova[3], A.A. Glyavina[1,2], I.V. Turchin[1], P.V. Subochev[1], A.G. Orlova[1]; [1]Inst. of Applied Physics RAS; [2]Lobachevsky State Univ. of Nizhny Novgorod; [3]Blokhin National Medical Research Center of Oncology, Russia

Using OA and DOS the comparison of vascular structure and oxygenation of renal (SN-12C) and colon (Colo320, HCT116) cancer models was carried out. High vascularity was found for Colo320 and SN-12C as compared to HCT116. For Colo320 the presence of extended hemoglobin-containing structures was revealed, as well as a significantly decreased level of oxygenation.

This research was supported by RFBR Grant(s) # 21-15-00032

TuSYA-05 10:45-11:00

The use of femtosecond laser pulses for controlled laser-assisted hatching of fresh and frozen/thawed mammalian embryos

I.V. Ilina[1], M.A. Filatov[2], D.S. Korshunova[2], Y.Y. Silaeva[3], D.S. Sitnikov[1]; [1]JIHT RAS; [2]Center for Precision Genome Editing and Genetic Technologies for Biomedicine, IGB RAS; [3]Core Facility Centre, IGB RAS, Russia

Femtosecond laser pulses were applied for the microsurgery of mammalian embryos at the late stages of preimplantation development. An artificial opening in the outer envelope of mouse blastocysts was created and promoted hatching to start immediately through the hole formed. Laser exposure parameters were optimized to perform delicate laser-assisted hatching either on fresh or frozen/thawed mammalian embryos.

– Break –

Advanced laser medical systems and technologies II

Location: Petrov Vodkin 3 Room, floor 2. 11:30-13:45

TuSYA-06 11:30-12:00

Laser engineering of biological tissue and microbial systems *(Invited paper)*

N.V. Minaev, Inst. of Photon Technologies, FSRC "Crystallography and Photonics" RAS, Russia

The report presents the results related to developing laser additive technologies for use in regenerative medicine in tissue engineering and microbiology. The results of developing approaches to form tissue engineering structures based on biocompatible and bioresorbable polymeric materials and the research results on the development of laser-induced bioprinting of living cells, cell aggregates, and microorganisms are presented.

This research was supported by RFBR Grant(s) # Russian Science Foundation 20-14-00286

TuSYA-07 12:00-12:30

Surgery guidance in urology using optical spectroscopy *(Invited paper)*

P.S. Tseregorodtseva[1], K.E. Buiankin[1,2] , B.P. Yakimov[1,2,3], A.A. Kamalov[2], G.S. Budylin[1,2,4], D.A. Davydov[1,2], E.A. Shirshin[1,2]; [1]Faculty of Physics, Lomonosov Moscow State Univ.; [2]Medical Research and Education Center, Lomonosov Moscow State Univ.; [3]World-Class Research Center "Digital Biodesign and Personalized Healthcare", Sechenov First Moscow State Medical Univ.; [4]Inst. of Spectroscopy RAS, Russia

Diffuse reflectance spectroscopy and imaging are increasingly being used in surgical guidance for tumor margin detection during endoscopic operations. In this work, using optical phantoms mimicking normal and pathological bladder tissues, the accuracy of tumor margin detection using single-fiber diffuse reflectance spectroscopy and spatial frequency domain imaging was evaluated.

TuSYA-08 12:30-12:45

Pro- and anti-inflammatory genes expression during the healing of biological tissues after exposure to 2-micron laser radiation

S.A. Filatova[1], M.S. Kopyeva[1,2], V.A. Kamynin[1], A.V. Lokhonina[3], M.S. Fomina[4], P.V. Novokreshchenov[5], I.M. Pushkar[5], V.V. Astashov[5], T.K. Fatkhudinov[3,4], V.B. Tsvetkov[1]; [1]Prokhorov General Physics Inst. RAS; [2]Faculty of Science, Peoples Friendship Univ.; [3]Histology Department, Peoples Friendship Univ. of Russia; [4]Department of Growth and Development, Science Research Inst. of Human Morphology; [5]Human Anatomy Department, Peoples Friendship Univ. of Russia, Russia

We present the results on the expression of pro- and anti-inflammatory genes during the healing process of mice's muscle and skin tissues after exposure to continuous-wave laser radiation of an all-fiber holmium laser at a wavelength of 2.1 μm with different powers.

This research was supported by RFBR Grant(s) # Ministry of Science and Higher Education of Russian Federation (grant № 075-15-2020-912)

TuSYA-09 12:45-13:00

Thermal effect of femtosecond laser pulses in terms of laser-assisted hatching procedure on mammalian embryos

D.S. Sitnikov, I.V. Ilina, A.A. Pronkin; Joint Inst. of High Temperatures RAS, Russia

An assessment of thermal effects of femtosecond laser pulses during microsurgical procedures on embryos is performed. Issues of nonlinear absorption of laser pulses in aqueous medium are of crucial significance, as well as issues of subsequent heat transfer. Temperature evolution in the center of focused laser beam is presented from femtosecond to millisecond time scales.

TuSYA-10 13:00-13:15

Study of hemo- and lympho-dynamics in the healing process of laser wound on mouse skin

M.S. Kopyeva[1,2], S.A. Filatova[1], E.A. Tatarchenko[2], V.A. Kamynin[1], V.V. Astashov[2], T.K. Chekhlova[2], V.B. Tsvetkov[1]; [1]Prokhorov General Physics Inst. RAS; [2]Peoples' Friendship Univ. of Russia, RUDN Univ., Russia

This work presents a study of hemo- and limpho- microcirculation in mouse skin before and after exposure to laser radiation, as well as studying changes in microcirculation in the healing process of the wound using laser Doppler flowmetry. The continuous-wave (CW) radiation was induced using an all-fiber holmium (Ho) laser with a wavelength of 2.1 μm.

TuSYA-11 13:15-13:30

Device for goniometric measurement of diffusely reflected light from the surfaces of biological tissues

A.V. Smirnov[1], N.V. Kovalenko[1,2], O.A. Ryabushkin[1,2]; [1]Moscow Inst. of Physics and Technology, Russia; [2]Fryazino branch of Kotelnikov Inst. of Radio-Engineering and Electronics, Russia

The biological tissue surface can be studied through analysis of diffuse reflected radiation. The experimental setup is introduced in this work to conduct the measurements and prove existing mathematical model.

TuSYA-12 13:30-13:45

Dual-wavelengths copper vapour laser technologyfor eyelid intradermal melanocytic nevi treatment.

I.V. Ponomarev[1], S.B. Topchy[1], L.D. Shakina[2], A.E. Pushkareva[3]; [1]Lebedev Physical Inst. RAS; [2]National Medical Research Center of Children Health; [3]ITMO Univ., Russia

Intradermal melanocytic benign eyelid nevus of Miescher occupied eyelid ciliary edge gives rise the poor blinking and vision limitation.Copper vapour laser provides complete elimination of eyelid nevus without side effects due to the high absorption by melanin and oxyhemoglobin.

Section B. Laser interaction with cells and tissues: clinical imaging and spectroscopy

Laser interaction with cells and tissues: clinical imaging and spectroscopy I

Location: Petrov Vodkin 1 Room, floor 2. 09:00-11:00

TuSYB-01 09:00-09:30

Light sheet flow cytometry: study of polyelectrolyte microcapsules in whole blood *(Invited paper)*

D.N. Bratashov[1], O.A. Sindeeva[2], O.A. Mayorova[1], R.A. Verkhovskii[1], A.V. Ermakov[1,3], O.V. Grishin[1], I.O. Kozhevnikov[1], M.A. Makarkin[1], E.S. Prikhozhdenko[1]; [1]Saratov State Univ.; [2]Skolkovo Inst. of Technology; [3]Sechenov Medical State Univ., Russia

Lightsheet-based flow cytometry system with the ability of measuring in the whole undiluted blood and magnetic separation of objects of interest was developed. It was used to investigate how the magnetic targeting of polyelectrolyte microcapsules influenced by the concentration of magnetic nanoparticles, microcapsule size and flow speed in the vessel.

TuSYB-02 09:30-10:00

Biophotonics for point-of-care diagnostics: noninvasive sensing and imaging of the skin physiological parameters *(Invited paper)*

D.A. Davydov[1,4], G.S. Budylin[1,2,3], N.Z. Zlobina[1,2,3], A.V. Baev[4], B.P. Yakimov[1,3,4], E.A. Shirshin[1,3,4]; [1]Medical Research and Education Center, Lomonosov Moscow State Univ.; [2]Inst. of Spectroscopy RAS; [3]World-Class Research Center "Digital Biodesign and Personalized Healthcare", Sechenov First Moscow State Medical Univ.; [4]Faculty of Physics, Lomonosov Moscow State Univ., Russia

In this work the possibility of determining the physiological parameters of the skin: water concentration and dermis thickness, was studied by diffuse reflectance spectroscopy. Effects of water concentration and dermal thickness changes on skin optical properties have been studied experimentally and using numerical Monte-Carlo simulation. The obtained experimental dependences are confirmed both by the simulation results and experimentally by ultrasonography.

This research was supported by RFBR Grant(s) # This work was supported by the grant of the Russian Science Foundation (grant No. 22-25-00864)

TuSYB-03 10:00-10:30

Novel approaches in 3D live cell microscopy *(Invited paper)*

H. Schneckenburger[1], V. Richter[1], M. Rank[2], A. Heinrich[2]; [1]Inst. of Applied Research; [2]Center for Optical Technologies (ZOT), Aalen Univ., Germany

Microscopy methods for 3D live cell imaging including various techniques, challenges and restrictions are described. Novel devices for application of these methods in combination with 3D printed optics are presented and discussed.

TuSYB-04 10:30-10:45

Raman and fluorescence lifetime imaging of cellular carotenoids distribution in algae

A.N. Semenov, E. Protasova, Eu. Parshina, K. Chekanov, T.A. Fedorenko, D.N. Ahaev, E.S. Lobakova, Eu.G. Maksimov; M.V. Lomonosov Moscow State Univ., Russia

The results of the complex multimodal optical study utilizing Raman and fluorescence lifetime imaging of the spatial distribution of carotenoids in the cells of algae Haematococcus pluvialis and Bracteacoccus aggregatus are presented.

This research was supported by RFBR Grant(s) # Russian Scientific Foundation grant № 22-25-00183

TuSYB-05 10:45-11:00

Intraoperative video-fluorescent diagnostics of pituitary adenomas during tumor resection

E.I. Kozlikina[1,2], K.T. Efendiev[1,2], A.Y. Grigoriev[3,4], O.Y. Bogdanova[3], I.S. Trifonov[3], V.V. Krylov[3], V.B. Loschenov[1,2]; [1]Prokhorov General Physics Inst. of the RAS, Russia; [2]National Research Nuclear Univ. MEPhI, Russia; [3]Federal State Budgetary Educational Inst. of Higher Education "Evdokimov Moscow State Univ. of Medicine and Dentistry", Russia; [4]The National Medical Research Centre for Endocrinology, Russia

For the first time, Ce6 photosensitizer and two-channel video-fluorescence system were used for fluorescence-guided resection of pituitary adenomas. The study involved three patients. Recorded during resection data showed a high level of Ce6 accumulation in pituitary adenoma tissues that helped achieve a high degree of tumor /resection.

– Break –

Laser interaction with cells and tissues: clinical imaging and spectroscopy II

Location: Petrov Vodkin 1 Room, floor 2. 11:30-13:30

TuSYB-06 11:30-12:00

Noninvasive glioblastoma diagnosis using spectral methods and machine learning *(Invited paper)*

O. Cherkasova[1,2], M. Konnikova[2,3], E. Dizer[4], A. Mankova[3], D. Vrazhnov[5,6], Yu. Kistenev[6], Y. Peng[6], A. Shkurinov[2,3]; [1]Inst. of Laser Physics SB RAS, Russia; [2]Inst. on Laser and Information Technologies - Branch of the Federal Scientific Research Centre "Crystallography and Photonics" RAS, Russia; [3]Lomonosov Moscow State Univ., Russia; [4]National Research Nuclear Univ. "MEPhI", Russia; [5]Inst. of Atmospheric Optics, Siberian Branch of the RAS, Russia; [6]Tomsk State Univ., Russia; [7]Univ. of Shanghai for Science and Technology, R. P. China.

Terahertz, Infrared, and Raman spectra of mouse blood serum were studied in the dynamics of U87 glioblastoma development. Machine learning methods were used to identify the most informative frequencies associated with glioma molecular markers and verify the separability of the groups under study.

This research was supported by RFBR Grant(s) # The work was supported by the RFBR (project № 19-52-55004), by the Government of the Russian Federation (Agreement No. 075-15-2021-615 of 04 June 2021)

TuSYB-07 12:00-12:30

Medical applications of laser photoacoustic spectroscopy *(Invited paper)*

Yu. Kistenev[1], A. Borisov[1], V.V. Prishepa[1], V. Skiba1, E. Schnayder[1], G. Rasponin[1], D. Makashev[1], I.K. Lednev[1,2]; [1]Tomsk State Univ., Russia; [2]Univ. at Albany, SUNY, USA

The report is devoted to medical diagnostics implementations through the chemical-composition-based and pattern-recognition-based analysis of breath air using laser photoacoustic spectroscopy combined with machine learning.

This research was supported by RFBR Grant(s) # The research was carried out with the support of a grant under the Decree of the Government of the Russian Federation No. 220 of 09 April 2010 (Agreement No. 075-15-2021-615 of 04 June 2021)

TuSYB-08 12:30-12:45

Intraoperative video-fluorescence navigation by PpIX and tissue saturation measurement during surgical resection of gastric malignant tumor

D.M Kustov[1], D.V. Yakovlev[1,2], A.S. Moskalev[1], E.I Kozlikina[1,3], W. Blondel[4], C. Daul[4], V.V. Levkin[5], S.S. Kharnas[5], A.A. Shiryaev[5], M.V. Loshchenov[1,3], N.A. Kalyagina[1,3], V.B. Loschenov[1,3]; [1]Prokhorov General Physics Inst. RAS; [2]Shemyakin-Ovchinnikov Inst. of Bioorganic Chemistry RAS; [3]National Research Nuclear Univ. MEPhI, Russia; [4]Univ. de Lorraine, France; [5]Sechenov First Moscow State Medical Univ., Russia

Fluorescence visualization of pathologies is a popular form of endoscopic diagnostics in medicine. Interest in fluorescence optical visualization consists in providing information on the fluorescent signal spatial distribution by the photosensitizer fluorescence, which has a selective accumulation in tumor. Together with this, the determination of tissue saturation makes possible to assess of blood supply to anastomosis during surgical operation.

This research was supported by RFBR Grant(s) # 21-58-15005

TuSYB-09 12:45-13:00

The skin evanescent Fourier spectroscopy in vivo by extruded nanostructured silver halide fibers

L.N. Butvina[1], A.L. Butvina[1], V.D. Bitzoev[2]; [1]Prochorov General Physics Inst. RAS, Dianov Fiber Optics Research Center; [2]Mosgorzdrav, Russia

The evanescent Fourier spectroscopy of the skin in the finger print of biomolecules (600-4000 cm-1) using new extruded nanostructured fibers from silver halides were demonstrated. The quantitative molecular analysis of cellular components of the upper layers of the skin under different laser and light illumination were measured.

TuSYB-10 13:00-13:15

On the scattering phase function of the infinitesimal scattering volume of turbid biological media

D.A. Rogatkin, A.P. Tarasov; Lab. of Medical and Physics Research, Moscow Regional Research and Clinical Inst. "MONIKI" named after M.F. Vladimirsky, Russia

In the light transport theory, the scattering phase function (SPF) is commonly considered as independent on the absorption coefficient of a turbid medium. In this study for biological turbid media, we propose an approach to analytically derive SPF. It is shown that SPF for the infinitesimal scattering volume can depend on both scattering and absorption coefficient.

TuSYB-11 13:15-13:30

Infrared radiation transfer simulation of a two-layer bio-tissue based on the Bethe-Salpeter equation

V.L. Kuzmin[1], Yu.A. Zhavoronkov[2], S.V. Ul'yanov[2], A.Yu. Valkov[1,2]; [1]Peter the Great St. Petersburg Polytechnic Univ.; [2]St. Petersburg State Univ., Russia

We present results of Monte Carlo simulations of the infrared radiation backscattering from the "skull-brain" system based on the Bethe-Salpeter equation. Our original procedure for detecting backscattered photons gives a significant reduction in the computation time. We also modify the inverse transform procedure in the Monte Carlo method by explicitly considering radiation decay due to absorption in each scattering order.

– Lunch Break –

Laser interaction with cells and tissues: clinical imaging and spectroscopy III

Location: Petrov Vodkin 1 Room, floor 2. 15:00-16:30

TuSYB-12 15:00-15:30

Spectroscopic detection of pigments in tissues: correlation with tissue aging and cancer development *(Invited paper)*

L.M. Oliveira[1,2], T.M. Gonçalves[1], A.R. Botelho[1], I.S. Martins[2], H.F. Silva[2], I. Carneiro[3], S. Carvalho[3], R. Henrique[3], V.V. Tuchin[4]; [1]Physics Department, Polytechnic of Porto – School of Engineering (ISEP), Portugal; [2]Center of Innovation in Engineering and Industrial Technology, ISEP, Portugal; [3]Department of Pathology and Cancer Biology and Epigenetics Group, Portuguese Oncology Inst. of Porto, Portugal; [4]Science Medical Center, Saratov State Univ., Russia

Melanin and lipofuscin contents in tissues can be retrieved from their absorption spectrum. Analyzing various tissues between 200 and 1000 nm, it was found that the rabbit pancreas had similar contents of these pigments due to the aging process, while in the human kidney 83% of the melanin in the normal tissue was converted into lipofuscin in the cancer tissue.

This research was supported by RFBR Grant(s) # VVT was supported by the RF Government grant 075-15-2021-615

TuSYB-13 15:30-16:00

Calibration problem in laser ektacytometry of red blood cells *(Invited paper)*

S.Yu. Nikitin; Physics Faculty, Lomonosov Moscow State Univ., Russia

Problem of measuring red blood cell deformability by laser diffractometry in a shear flow (ektacytometry) is considered. A calibration equation is obtained that connects the geometric parameters of the isointensity line of the diffraction pattern with the level of light intensity on this line. A simplified algorithm for measuring the spread of red blood cell in deformability is proposed.

TuSYB-14 16:00-16:15

Digital diaphanoscopy data processing for differentiation of maxillary sinus pathologies

E.O. Bryanskaya[1], V.V. Dremin[1,2], I.N. Novikova[1], Yu.O. Nikolaeva[3], V.G. Pil'nikov[3], A.V. Bakotina[3], A.Y. Ovchinnikov[3], D.N. Panchenkov[3], A.V. Baranov[4], V.G. Artyushenko[5], A.V. Dunaev[1]; [1]R&D Center of Biomedical Photonics, Orel State Univ., Russia; [2]College of Engineering and Physical Sciences, Aston Univ., UK; [3]Yevdokimov Moscow State Univ. of Medicine and Dentistry; [4]Skobelkin State Scientific Center of Laser Medicine FMBA, Russia; [5]Art Photonics GmbH, Germany

The paper presents the results of the use of the digital diaphanoscopy method to detect the pathology of the maxillary sinuses with the participation of conditionally healthy volunteers and patients with various types of pathological changes, confirmed by CT results. The results sinuses state classifying based on a quantitative assessment of the registered scattering patterns of light are also presented.

This research was supported by RFBR Grant(s) # The reported study was funded by RFBR according to the research project № 20-32-90147

TuSYB-15 16:15-16:30

Near-Infrared and diffuse reflectance spectroscopy of ex vivo and in vivo cutaneous melanin - pigmented neoplasia

V.S. Mircheva[1], P.P. Troyanova[2], I.N. Terziev[2], Yu.A. Khristoforova[3], I.A. Bratchenko[3], L.A. Bratchenko[3], Ts.I. Genova[1], E. Borisova[1,4]; [1]Inst. of Electronics, BAS, Bulgaria; [2]Univ. Hospital "Tzaritza Yoanna – ISUL", Bulgaria; [3]Samara National Research Univ., Russia; [4]Research National Saratov State Univ., Russia

In the current study are investigated pigmented skin neoplasia - benign, dysplastic and malignant ones using Near- Infrared fluorescence technique and diffuse – reflectance spectroscopy in order to make them easier to distinguish.

Section C. Photonics and nanobiotechnology

Photonics and nanobiotechnology I

Location: Petrov Vodkin 2 Room, floor 2. 09:00-11:00

TuSYC-01 09:00-09:30

Detection of the receptor-binding domain of the SARS-CoV-2 spike glycoprotein using surface-enhanced Raman scattering *(Invited paper)*

A.K. Sarychev; Inst. for Theoretical and Applied Electrodynamics RAS, Russia

Label-free SERS recording of the receptor-binding domain of SARS-CoV-2 S-glycoprotein is proposed, which allows sensing characteristic protein Raman spectra at the concentrations sufficient for ultrasensitive detection of viral protein antigens.

This research was supported by RFBR Grant(s) # 20-21-00080

TuSYC-02 09:30-10:00

Gap-enhanced Raman tags: fabrication, optical properties, applications in biosensing and bioimaging *(Invited paper)*

B.N. Khlebtsov; Inst. of Biochemistry and Physiology of Plants and Microorganisms, Saratov Scientific Centre RAS, Russia

Gap-enhanced Raman tags (GERTs) are new emerging probes of the surface-enhanced Raman spectroscopy (SERS) that have found promising analytical and bioimaging applications. In this talk, we discuss recent progress in the synthesis, experimental studies of optical properties, and biomedical applications of novel GERTs fabricated with common plasmonic metal – gold (Au).

TuSYC-03 10:00-10:30

SERS-active substrates based on Au/Ag-decorated silicon nanostructures for the rapid detection of biomolecules *(Invited paper)*

L.A. Osminkina; Lomonosov Moscow State Univ., Russia

Surface-enhanced Raman scattering (SERS) has proven itself to successfully detect different biomolecules. Silicon nanostructures are attractive objects for creating sensitive sensors due to the simplicity of their preparation methods and silicon surface tailorability. We propose a new method for producing SERS-active substrates based on Au/Ag-decorated silicon nanostructures for the rapid label-free detection of bilirubin, pyocyanin and different proteins.

TuSYC-04 10:30-10:45

Using the SERS method and machine learning technology to detect the influenza A virus.

A.T. Tabarov[1], V.V. Vitkin[1], D.M. Danilenko[2], O.V. Andreeva[1], A.A. Shemanaeva[1], E.E. Popov[1], A.A. Dobroslavin[1], V.V. Kurikova[1], O.B. Kuznetsova[1]; [1]ITMO Univ.; [2]Smorodintsev Research Inst. of Influenza, Russia

The worldwide pandemic demonstrates the need to develop new methods for the respiratory viral diseases' diagnosis, which should be fast and accurate. Surface-enhanced Raman spectroscopy (SERS) can be one of such methods. Our work demonstrates the possibility of using SERS technology and machine learning for fast and accurate detection of the influenza A virus in a biological sample.

TuSYC-05 10:45-11:00

Gold nanolabels for SERS imaging excitable by red lasers

V.O. Svinko, A.I. Shevchuk, A. N. Smirnov, V.V. Sharoiko, E.V. Solovyeva; Inst. of Chemistry, St. Petersburg State Univ., Russia

The work is aimed to the design of plasmonic tags, having the most effective SERS signal upon the excitation by red lasers. Gold nanostars were synthesized to be used as a plasmonic core, covered by polymer shell containing Cyanine 5.5 and functionalized by folic acid as a model delivery vector. The obtained tags were tested on PANC-1 cell line.

This research was supported by RFBR Grant(s) # The work is supported by Saint-Petersburg State University, project № 92350587.

– Break –

Photonics and nanobiotechnology II

Location: Petrov Vodkin 2 Room, floor 2. 11:30-13:30

TuSYC-06 11:30-12:00

Combination of nanostructured materials and photonic tools for biomedical applications *(Invited paper)*

D.A. Gorin; Skolkovo Inst. of Science and Technology, Russia

The photonic tools, as well as acoustic tools, can be used for in vivo navigation, visualization, and activation of a new type of multifunctional nanostructured particles. These particles will combine the ability to deploy drugs in a controllable manner with physical triggering, multimodal detection, and visualization as well as sensing of important biological markers.

This research was supported by RFBR Grant(s) # 19-53-80047 БРИКС_т

TuSYC-07 12:00-12:30

Gene and small molecule delivery in vivo using novel nanoparticle-based systems *(Invited paper)*

M.P. Nikitin[1,2]; [1]Moscow Inst. of Physics and Technology; [2]Sirius Univ. of Science and Technology, Russia

Therapies based on co-delivery of drugs and nucleic acids have outstanding potential. Nanoparticles are a promising class of delivery vehicles due to their ability to simultaneously transport a great range and amount of payloads. Here, we demonstrate the possibility of adapting the properties of nanoparticles of various classes to deliver a wide range of therapeutic cargo for biomedical applications.

This research was supported by RFBR Grant(s) # the Russian Science Foundation grant #21-14-00269 , the Ministry of Science and Higher Education of the Russian Federation: agreement #075-03-2021-095, project 0714-2020-0004

TuSYC-08 12:30-12:45

The use of dielectric nanoparticles doped with rare-earth ions to increase the thermal effect of laser radiation of various wavelengths on biological tissues

S.A. Khrushchalina, I.A. Yurlov, P.A. Ryabochkina, V.P. Ageev, O.N. Kulikov, V.I. Shlyapkina, M.N. Tremasov, M.N. Zharkov, A.N. Belyaev, O.S. Bushukina; National Research Ogarev Mordovia State Univ., Russia

The paper presents the results of in-vivo experiments on the non-contact effect of laser radiation with different wavelengths on the skin of rats pre-coated with nanoparticles doped with rare-earth ions. We carried out a comparative assessment of the degree of damage to biological tissues after non-contact exposure to laser radiation with and without preliminary coating with nanoparticles.

This research was supported by RFBR Grant(s) # This work is financially supported by a grant from the President of the Russian Federation (MK-5500.2021.1.2)

TuSYC-09 12:45-13:00

Dual pH and oxygen sensor for application in FLIM-PLIM imaging

A.I. Solomatina, P.S. Chelushkin; Inst. of Chemistry, St. Petersburg State Univ., Russia

Simultaneous multiple sensing of physiologically relevant characteristics of biological samples remains a challenging issue in bioimaging. Herein we describe a new strategy and present the first example of dual pH/O2 lifetime sensor based on covalent conjugation of fluorescein (pH) and orthometalated iridium complex (O2) to human serum albumin (HSA) and demonstrate its applicability in FLIM-PLIM microscopic experiments.

TuSYC-10 13:00-13:30

Construction of optical and electrochemical biosensors by circular permutation of enzymes. *(Invited paper)*

K. Alexandrov; CSIRO-QUT Synthetic Biology Alliance, Queensland Univ. of Technology, Australia

Here we present an approach for the construction of fully integrated but modular biosensors with optical and electrochemical outputs. This is achieved by designing allosterically regulated circular permutated variants of enzymes such as PQQ-glucose dehydrogenase (PQQ-GDH) and NanoLuc luciferase.

– Lunch Break –

Photonics and nanobiotechnology III

Location: Petrov Vodkin 2 Room, floor 2. 15:00-17:00

TuSYC-11 15:00-15:30

Application of fluorescent nanoparticles in bioanalysis *(Invited paper)*

I.Yu. Goryacheva, A.A. Kokorina, E.A. Mordovina, D.V. Tsyupka, D.D. Drozd, T.S. Ponomaryeva, O.A. Goryacheva; Saratov State Univ., Russia

Fluorescent nanoparticles, first of all quantum dots, modified carbon-based and gold nanostructures present a perspective tool for fast and high-throughput signal enhancement and detection. Analysis in format Point-Of-Care or multisample readers allow to provide a basis for researcher or routine analysis. Future perspectives are related to the sensitivity improvement of conjugation protocols and assay schemes, application of non-incubation homogeneous formats.

This research was supported by RFBR Grant(s) # The work was supported by Russian Science foundation (project 20-13-00195).

TuSYC-12 15:30-16:00

Real-time detection of molecular markers in complex biological matrices *(Invited paper)*

A.V. Orlov; Prokhorov General Physics Inst. RAS, Russia

High-sensitive analytical systems have been developed based on interferometric optical and electronic magnetic registration of biolabels on 2-D, 2.5-D and 3-D solid phases. Real-time detection of a wide range of key biological markers (both high- and low-molecular-weight substances) has been demonstrated. The possibility of their direct registration in complex matrices has been shown.

TuSYC-13 16:00-16:30

QDs as a sensor of intra-endosomal microenvironment changes *(Invited paper)*

E.S. Kornilova[1,2,3], I.K. Litvinov[1], A.V. Salova[1], T.N. Belyaeva[1]; [1]Inst. of Cytology RAS; [2]Peter the Great St. Petersburg Polytechnic Univ.; [3]St. Petersburg State Univ., Russia

Fluorescent semiconductor nanocrystals Quantum Dots (QDs), due to long fluorescence lifetime attract attention as promising markers to follow endocytosis in live cells. We have studied the influence of such components of intra-endosomal medium, as hydrogen and peroxide as well as K+, Na+ and Ca2+ ions, on QDs lifetime. We conclude that QDs may manifest complicated changes in endosomal microenvironment.

This research was supported by RFBR Grant(s) # Russian Foundation for Basic Research, number No 20-04-00927.

TuSYC-14 16:30-16:45

An increase in luminescence brightness of Nd^{3+}: LaF_3 nanoparticles, synthesized by hydrothermal microwave method promising for NIR bioimaging

A.V. Popov[1], E.O. Orlovskaya[1], A.T. Shaidulin[1,2], E.E. Timofeeva[1], S.G. Fedorenko[3], Yu.V. Orlovskii[1,4]; [1]Prokhorov General Physics Inst. RAS; [2]Mendeleev Univ. of Chemical Technology of Russia; [3]Voevodsky Inst. of Chemical Kinetics and Combustion SB RAS, Russia; [4]Inst. of Physics, Univ. of Tartu, Estonia

By transferring the initial Nd3+: LaF3 nanoparticles synthesized by hydrothermal microwave treatment, from aqueous colloidal solutions to DMSO, the possibility of increasing the luminescence brightness in the near IR spectral range is shown.

TuSYC-15 16:45-17:00

Study of biodistribution and accumulation of nanoparticles in a tumor using various detection techniques

E.N. Mochalova[1,2], A.G. Burenin[1], M.V. Veremyeva[1], A.M. Skirda[1], B.G. Gorshkov[1]; [1]Prokhorov General Physics Inst. RAS; [2]Sirius Univ. of Science and Technology, Russia

Nanoparticles offer a variety of potentially effective solutions for the development of agents for targeted therapy and early diagnosis of cancer. Here we studied the biodistribution and tumor uptake of a wide range of nanoparticles to achieve their proper in vivo performance using a number of techniques such as optical imaging, ICP-OES, and magnetic particle quantification method.

This research was supported by RFBR Grant(s) # Russian Science Foundation grant No. 21-12-00407

Section A. Advanced laser medical systems and technologies

TuSYA-p01 15:00-18:30

Helicobacter pylori breath test by the Raman spectroscopy gas analyzer

E.E. Popov[1], A.V. Polishchuk[1], I.K. Chubchenko[2], O.B. Kuznetsova[1], V.V. Vitkin[1]; [1]ITMO Univ,; [2]Mendeleyev Inst. for Metrology (VNIIM), Russia

The features of the Helicobacter pylori pathogen diagnosis in the human gastrointestinal tract using Raman spectroscopy are described. The estimation of the Raman gas analyzer resolution was conducted. Experimental measurement of a gas mixture with a known composition has been carried out.

TuSYA-p02 15:00-18:30

δ13C measurements in a human exhalation

E.E. Popov[1], A.V. Polishchuk[1], I.K. Chubchenko[2], K.M. Grigorenko[1], A.V. Kovalev[1]; [1]ITMO Univ.; [2]Mendeleyev Inst. for Metrology (VNIIM), Russia

The ratio of stable 13C/12C carbon isotopes in the exhaled human breath was measured and compared to a standard value of reference material. Extended uncertainty of measurements was calculated. The factors influencing the measurement's uncertainty in the Raman spectroscopy analysis of the gas mixture's quantitative composition were determined.

TuSYA-p03 15:00-18:30

Laser mass spectrometry of volatile organic compounds for diagnostics of kidney damage

A.B. Bukharina[1], A.V. Pento[1], V.V. Iakovlev[2], O.L. Morozova[2]; [1]Prokhorov General Physics Inst. RAS, [2]Sechenov First Moscow State Medical Univ., Russia

A method of laser mass spectrometric express analysis of volatile organic compounds (VOC) without sample preparation is proposed. VUV radiation of laser plasma is used for VOCs ionization. The method was applied for early diagnostics of kidney damage in children with congenital uropathy.

TuSYA-p04 15:00-18:30

Study of the effect of dissection of biological tissues by 3 microns laser radiation

O.V. Tikhonevich[1], A.A. Sirotkin[1], N.E. Gorbatova[2], G.P. Kuzmin[1], Y.L. Kalachev[1]; [1]Prokhorov General Physics Inst. RAS; [2]Inst. of Emergency Children's Surgery and Traumatology, Russia

The results of exposure to laser radiation at a wavelength of 3 microns were studied and its parameters were determined for ablative destruction of surface tissues and dissection of tissue structures.

TuSYA-p05 15:00-18:30

Evaluation of the photoplethysmographic waveform by Monte Carlo simulation of light transport

D.G. Lapitan[1], A.P. Tarasov[1,2]; [1]Moscow Regional Research and Clinical Inst. (MONIKI) named after M.F. Vladimirsky; [2]Federal Research Scientific Center "Crystallography and Photonics" RAS, Russia

The photoplethysmographic waveform was modeled for different source-detector distances using the Monte Carlo technique. For this, a three-layer optical model of the skin for reflection was developed. It was found that the pulse wave is most pronounced for the distance of 6 mm.

This research was supported by RFBR Grant(s) # Russian Science Foundation (project No. 21-75-00037)

TuSYA-p06 15:00-18:30

Fluorescence visualization of superficial bladder cancer at TUR

M. Loshchenov[1,2], A. Seregin[3,4], N. Kalyagina[1,2], A. Borodkin[1]; [1]Prokhorov General Physics Inst. RAS; [2]National Research Nuclear Univ. MEPhI; [3]Botkin City Clinical Hospital of the Department of Health of Moscow; [4]Russian Medical Academy of Continuous Professional Education of the Ministry of Health of the Russian Federation, Russia

The study demonstrates the possibilities of video-fluorescence diagnostics with laser excitation at 635 nm at bladder TUR. The main tumor foci were resected, and then a fluorescence analysis of the tumor borders was performed. Small fluorescent tumor foci, not seen by cystoscopy in white light, were detected and the diagnostic fluorescence contrast was measured to quantify 5-ALA in tissues

TuSYA-p07 15:00-18:30

Laser radiation at a wavelength of 525 nm used for controlled hemostasis.

O.V. Tikhonevich[1], A.A. Sirotkin[1] , N.E. Gorbatova[2], D.A. Safin[2], Y.L. Kalachev[1], G.P. Kuzmin[1]; [1]Prokhorov General Physics Inst. RAS; [2]Inst. of Emergency Children's Surgery and Traumatology, Russia

The results of exposure to laser radiation at a wavelength of 525 nm were studied and its parameters were determined for laser radiation to effectively stop bleeding.

Section C. Photonics and nanobiotechnology

TuSYC-p01 15:00-18:30

Hybrid nanostructures based on InGaN nanowires with deposited Ag NPs-SiOx for visible emission range

T.M. Shugabaev[1], V.O. Gridchin[1,2], K.P. Kotlyar[1], A.S. Dragunova[1], A.S. Kulagina[3], G.E. Cirlin[1-3]; [1]St. Petersburg Academic Univ.; [2]St. Petersburg State Univ.; [3]Ioffe Inst., Russia

InGaN nanowires were synthesized by molecular beam epitaxy. The colloidal method was used to synthesize silver NPs coated with SiOx layers of different thicknesses. The dependence of the PL response of the InGaN-Ag-SiOx hybrid structure on the thickness of the SiOx layer has been studied for the first time.

This research was supported by RFBR Grant(s) # RSF grant (project № 19-7230010)

TuSYC-p02 15:00-18:30

Two-stage method for comparing the lengths of optical fibers using OFDR

I.R. Drozdov[1], K.A. Ovcinnikov[1,2], E.S. Boychuk[1,3], V.V. Krishtop[1,2,3]; [1]Perm Scientific-Industrial Instrument Making Company; [2]Perm State Univ.; [3]Perm National Research Polytechnic Univ., Russia

The paper proposes a two-stage method for comparing the lengths of optical fibers using the optical frequency domain reflectometry. The method was applied for comparing of of two fibers lengths.

TuSYC-p03 15:00-18:30

Modeling of local field enhancement and laser heating effects in iron oxide nanoparticles

D.V. Pominova[1,2], I.D. Romanishkin[1], A.V. Ryabova[1,2], V.B. Loschenov[1,2]; [1]Prokhorov General Physics Inst. RAS; [2]National Research Nuclear Univ. MEPHI, Russia

In this work, we have carried out theoretical modeling of heating of iron oxide nanoparticles under the action of laser radiation, modeling of scattering and absorption of exciting laser radiation on iron oxide nanoparticles and their dimers, as well as local field enhancement near individual iron oxide nanoparticles and between two nanoparticles of different sizes forming a dimer.

This research was supported by RFBR Grant(s) # The Russian Foundation for Basic Research grant 21-52-12030 NNIO_a

TuSYC-p04 15:00-18:30

Optical characterization of small-molecule—protein conjugates for development of express high-sensitive immunosensors based on magnetic biolabels

J.A. Malkerov[1], S.L. Znoyko[1], A.V. Pushkarev[1], N.N. Orlova[1], A.I. Nikitin[2], G.M. Sorokin[3], B.G. Gorshkov[1]; [1]Prokhorov General Physics Inst. RAS; [2]Volga branch of MADI; [3]Chuvash State Univ., Russia

Conjugates of ochratoxin A (OTA) with a carrier protein – bovine serum albumin – were characterized in terms of kinetics of their interaction with monoclonal antibodies against OTA. Spectral interferometric methods were used for label-free characterization in a real-time mode. An express sensitive method was developed for on-site OTA detection in food based on electronic registration of magnetic biolabels.

TuSYC-p05 15:00-18:30

Changes in the optical properties of plant tissues with cyclic temperature changes

E.A. Trefilova[1], T.K. Karpova[1], N.V. Kovalenko[1,2], O.A. Ryabushkin[1,2]; [1]Moscow Inst. of Physics and Technology; [2]Fryazino branch of Kotelnikov Inst. of Radio-Engineering and Electronics, Russia

Using the method of movable integrating spheres, the optical properties of the raw and freezing-unfreezing potato flesh were investigated. The significant effect of this process on both optical scattering and absorption is shown.

TuSYC-p06 15:00-18:30

Raman spectroscopy of the interaction of carbon-coated iron nanoparticles with proteins

V.A. Mozhaeva, E.I. Nagaev, T.A. Matveeva, E.A. Mol'kova, R.M. Sarimov, K.A. Prokhorov; [1]Biophotonics Center, Prokhorov General Physics Inst. RAS, Russia

Here, using Raman spectroscopy, the interaction of graphene-coated iron nanoparticles (G-Fe NPs) with the protein immunoglobulin G (IgG) is studied. Two additional peaks in the spectrum reflecting the interaction of G-Fe NPs with IgG were found for their solution. The amplitude of the found peaks decreases with change in pH to 4, which is below the IgG isoelectric point.

This research was supported by RFBR Grant(s) # 22-22-00951

TuSYC-p07 15:00-18:30

Internal reference method for the study of upconversion luminescence of nanoparticle suspensions

S.A. Burikov[1]; A.A. Fedyanina[1]; K.A. Laptinskiy[2]; T.A. Dolenko[1]; [1]Department of Physics, Lomonosov Moscow State Univ.; [2]Skobeltsyn Inst. of Nuclear Physics, Lomonosov Moscow State Univ., Russia

This paper presents new internal reference method for studying upconversion luminescence of nanoparticle suspensions. Idea of method is based on simultaneous excitation of luminescence of suspensions of upconversion nanoparticles and Raman scattering of medium. For this, signal and idler beams of optical parametric oscillator were used. Method allows to eliminate the influence of instability of excitation intensity on the results.

TuSYC-p08 15:00-18:30

Effect of high-power pulses of terahertz radiation on normal and tumor cell lines of the human brain

D.S. Sitnikov[1], I.V. Ilina[1], V.A. Revkova[2], S.A. Gurova[3], M.A. Konoplyannikov[2,4], V.A. Kalsin[2], V.P. Baklaushev[2]; [1]Joint Inst. for High Temperatures RAS; [2]Federal Research and Clinical Center of Specialized Medical Care and Medical Technologies of FMBA of Russia; [3]National Research Nuclear Univ. MEPhI, Obninsk Inst. for Nuclear Power Engineering; [4]Inst. for Regenerative Medicine, Sechenov Univ., Russia

A study was made of the impact of high-power pulses of THz radiation (0.1-3 THz) on cells of normal and tumor lines of the human brain. The formation of H2AX histone phosphorylation foci in cells under the influence of THz pulses was studied, taking into account the phase of the cell cycle.

This research was supported by RFBR Grant(s) # 19-02-00762

TuSYC-p09 15:00-18:30

Synthesis of polymer-coated metal-organic frameworks for gene delivery

A.A. Sizikov[1], E.V. Kalita[1], R.O. Melikov[1], A.V. Gopanenko[2], V.R. Cherkasov[1,3]; [1]Moscow Inst. of Physics and Technology, Russia; [2]Sirius Univ. of Science and Technology, Russia; [3]Prokhorov General Physics Inst. RAS, Russia

In vivo delivery of genes of interest is an ongoing challenging task. We performed optimization of synthesis of metal-organic frameworks with magnetic core to improve their ability to be nucleic acid carriers. We varied synthesis parameters to investigate their impact on DNA-binding capacity and on the ability of nanoparticles to be a vehicle for in vitro transfection.

This research was supported by RFBR Grant(s) # Russian Science Foundation grant # 21-14-00269, the Ministry of Science and Higher Education of the Russian Federation: agreements # 075-00958-2105 and 075-03-2021-095, project 0714-2020-0004

TuSYC-p10 15:00-18:30

Optimization of Au-based nanoparticle-beacon system for biomedical applications

A.A. Kotov[1], A.V. Gopanenko[2], B.G. Gorshkov[3], M.P. Nikitin[1,2]; [1]Moscow Inst of Physics and Technology; [2]Sirius Univ. of Science and Technology; [3]Prokhorov General Physics Inst. RAS, Russia

In this study, we explored new sensing oligos for a recently developed nanoparticle-beacon (NB) system, aiming to expand the set of NB that could be used to detect several clinically relevant targets in the format of lateral flow assay (LFA). We expanded the set of oligos exploited as sensors in the NB and applied them in different assays.

This research was supported by RFBR Grant(s) # 075-00958-2105, 075-03-2021-095, 0714-2020-0004

TuSYC-p11 15:00-18:30

Electrophoretic mobility of gold nanoparticles by electrophoretic light scattering method

E. Savchenko, O. Tkach, Peter the Great St. Petersburg Polytechnic Univ., Russia

In this research we describe principles of electrophoretic light scattering method and results on measuring electrophoretic mobility of gold nanoparticles depending on the concentration of the solution.

This research was supported by RFBR Grant(s) # This research was funded by RSF, grant number No 21-72-20029.

TuSYC-p12 15:00-18:30

Label-free method for screening antibodies against thyroxin

S.L. Znoyko, V.A. Bragina, J.A. Malkerov, B.G. Gorshkov; Prokhorov General Physics Inst. RAS, Russia

A label-free optical method is presented for screening antibodies against free thyroxine. The method features real-time monitoring of antigen-antibody interactions. The single-used sensor chip is a commonly available microscope glass cover slip. The benefits of the developed method include controllable in real time immobilization of virtually any biotinylated antigen/antibody on universal biotinylated chips due to the used biotin-streptavidin bond.

This research was supported by RFBR Grant(s) # 21-12-00407

TuSYC-p13 15:00-18:30

Continuous variable measurement-device-independent quantum communication scheme based on subcarrier waves

M. Fadeev[1,2], R. Goncharov[1], S. Smirnov[1], V. Chistyakov[1]; [1]ITMO Univ., [2]SMARTS-Quanttelecom LLC., Russia

In this work, we combine the achievements in terms of coherent detection based on the subcarrier wave method and measurement-device-independent approach. For such a scheme we provide a proof-of-principle experiment

TuSYC-p14 15:00-18:30

Evaluation of the influence of the contribution of laser-induced plasma in the synthesis of nanoparticles

A.V. Kharkova, D.A. Kochuev, K.S. Khorkov; Vladimir State Univ., Russia

A method of femtosecond laser synthesis of aluminum oxide nanoparticles has been developing. As a result of ablation of the material, the formation of a laser-induced plasma plume was observed. The influence of the energy contribution of the plasma plume on the process of ablation of nanoparticles is estimating.

TuSYC-p15 15:00-18:30

Development and characterization of a label-free method for detection of folic acid

D.O. Novichikhin[1,2], S.L. Znoyko[1], N.N. Orlova[1,3], F.A. Zavalko[3], B.G. Gorshkov[1]; [1]Prokhorov General Physics Inst. RAS; [2]National Research Nuclear Univ. MEPhI; [3]Moscow Inst. of Physics and Technology, Russia

Rapid inexpensive tests with single-used consumables for determination of folic acid are highly demanded in medicine. In this study, we propose and demonstrate a method of label-free detection of folic acid based on the spectral-correlation interferometry approach. The proposed method exhibits subnanomolar limit of detection and a wide dynamic range that covers clinically relevant concentrations of folic acid in humans.

TuSYC-p16 15:00-18:30

Fluorescence anisotropy of FAD in water-propylene glycol solutions under excitationby picosecond laser pulses at 355 nm

I.A. Gorbunova[1], M.K. Danilova[1], I.A. Gradusov[2], D.M. Beltukova[1] , V.P. Belik[1], O.S. Vasyutinskii[1]; [1]Ioffe Physical Technical Inst.; [2]Peter the Great St. Petersburg Polytechnic Univ., Russia

The experimental study of fluorescence anisotropy decay of FAD in water-propylene glycol solutions under excitation by picosecond laser pulses at 355 nm was carried out. Initial anisotropies and rotational diffusion times were determined from experimental data by fit. The determined relationship between the rotational diffusion times and solvent viscosity was compared with that in water-methanol solutions

TuSYC-p17 15:00-18:30

Phase edges detection in the presence of noise based on transport-of-intensity equation

I.V. Gritsenko[1], M.S. Kovalev[1,2]; [1]Lebedev Physical Inst.; [2]Bauman Moscow State Technical Univ., Russia

A method for phase edges detection is presented. This approach allows to retrieve phase of a light wave from the intensity measurement in multiple planes using transport-of-intensity equation. Then edges detection implemented via ridding of noise-induced artefacts.

TuSYC-p18 15:00-18:30

Anti-Stokes fluorescence excitation as a method for investigation of protein-protein interactions on example of cyanobacterial phycobiliproteins

E.A. Protasova, D.V. Zlenko, E.A. Slutskaya, E.G. Maksimov; Lomonosov Moscow State Univ., Russia

Phycobiliproteins are highly fluorescent components of the photosynthetic apparatus of cyanobacteria and red algae. This work shows the possibility of anti-Stokes fluorescence excitation of phycobiliproteins through the single-photon hot-band mechanism. Selective excitation of low-energy chromophores in phycobiliproteins-containing light-harvesting complex reveals features of interactions between pigments in a complex with orange carotenoid protein.

TuSYC-p19 15:00-18:30

Controlled surface topology for tunable kinetics of biomolecular interactions monitored with a label-free optical biosensor for detection of cardiac markers

A.V. Orlov, S.V. Miziev, N.V. Guteneva; Prokhorov General Physics Inst. RAS, Russia

The present research shows that the same functional coating applied onto surfaces of different topology produces materials that have different kinetic properties of interaction with the target. Direct optical monitoring of interactions was implemented using an original label-free detector. The approach was demonstrated during development of a sensitive analytical system for simultaneous express determination of several cardiomarkers.

TuSYC-p20 15:00-18:30

Optical label-free method for characterization of kinetics of antibodies to SARS-CoV-2

V.A. Bragina[1], A.V. Pushkarev[1], A.V. Orlov[1], S.L. Znoyko[1], D.O. Novichikhin[1,2], N.V. Guteneva[1], A.M. Skirda[1,2]; [1]Prokhorov General Physics Inst. RAS; [2]National Research Nuclear Univ. MEPhI, Russia

In this work, an optical label-free method is developed for measurements and characterization of kinetics of antibodies to severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) in real time. The proposed method employs inexpensive and widely available consumables compatible with various chemical interfaces. It is promising for assessment the kinetics of humoral response to SARS-CoV-2 infection or postvaccination.

TuSYC-p21 15:00-18:30

DIY plasma system for PDMS labs-on-a-chip

V.D. Khudyshkin, D.S. Andreyev; X-BIO Inst., Univ. of Tyumen, Russia

We present a low-cost DIY plasma activation system suitable for irreversible bonding PDMS to PDMS or glass substrates and changing the surface properties of materials.

Section B. Laser interaction with cells and tissues: clinical imaging and spectroscopy

Laser interaction with cells and tissues: clinical imaging and spectroscopy IV

Location: Petrov Vodkin 1 Room, floor 2. 09:00-11:00

WeSYB-16 09:00-09:30

Spectral approaches for depth analysis in diffuse optical diagnostics modalities *(Invited paper)*

M. Kirillin[1], D. Kurakina[1], A. Khilov[1], V. Perekatova[1], A. Getmanskaya[1,2], V. Shishkova[1,2], M. Shakhova[1,3], A. Orlova[1], A. Malygina[3], A. Mironycheva[1,3], I. Shlivko[3], S. Gamayunov[1,4], N. Orlinskaya[3], I. Turchin[1], E. Sergeeva[1]; [1]Inst. of Applied Physics RAS; [2]Lobachevsky State Univ. of Nizhny Novgorod; [3]Privolzhsky Research Medical Univ.; [4]Nizhny Novgorod Regional Oncological Hospital, Russia

Strong dispersion of biotissue optical properties in visible and NIR ranges determines difference in probing depths in optical diagnostics modalities thus allowing to control probing depth by the choice of the wavelength range. The paper discusses spectral dependence of the probing depth and the accuracy of oxygen saturation reconstruction in diffuse reflectance spectroscopy and reviews dual-wavelength approach in fluorescence imaging.

WeSYB-17 09:30-10:00

Raman-LIBS for tumor tissue imaging and cells detection *(Invited paper)*

Qingyu Lin, Yixiang Duan; Research Center of Analytical Instrumentation, School of Mechanical Engineering, Sichuan Univ., China

With cancer seriously hampering the increasing life expectancy of people, developing an instantly diagnostic method has become an urgent objective. we developed Raman-LIBS method for tumor tissues recognition and cancer cells detection.

WeSYB-18 10:00-10:30

Physical aspects and possibilities of laser drug delivery *(Invited paper)*

A.V. Belikov, Y.V. Fedorova, S.N. Smirnov, A.D. Kozlova; ITMO Univ., Russia

The features of active laser delivery of modern chlorin-containing photosensitizing drugs under the nail plate and skin are discussed. The mechanisms and optimal parameters for microporation and active laser delivery of drugs were determined.

This research was supported by RFBR Grant(s) # The research was supported by Russian Science Foundation (project No. 22-25-00468)

WeSYB-19 10:30-10:45

An ex vivo study of the impact of mid-infrared laser on ocular tissues

YU.N. Yusef[1], D.V. Petrachkov[1], E.N. Korobov[1], L. Alharki[1], I.M. Belousova[2], A.P. Zhevlakov[2], A.S. Narivonchik[2]; [1]Dept. Innovation Vitreoretinal Technology, Research Inst. of Eye Diseases; [2]Vavilov State Optical Inst., Russia

We are searching for the most suitable laser radiation, which will allow to make thin cuts on the retina with high accuracy, minimal damage to surrounding tissues. As the first wavelength we chose 3.0 μm. The retina, choroid and sclera of pig eyes were used. The impact of laser radiation on eye tissues was assessed using a scanning electron microscope.

WeSYB-20 10:45-11:00

Anisotropic relaxation in NADH excited state studied by polarized pump-probe spectroscopy in water-1,2-propandiol solutions

I.A. Gorbunova[1], D.A. Volkov[1], M.E. Sasin[1], D.V. Yashkov[2], Y. Wang[3], S. Zhang[3], O.S. Vasutinskii[1]; [1]Ioffe Inst., Russia; [2]Peter the Great St. Petersburg Polytechnic Univ., Russia; [3]State Key Lab. of Magnetic Resonance and Atomic and Molecular Physics, China

Energy transfer processes in NADH excited states in water-1,2-propandiol solutions has been studied using polarization-sensitive pump–probe technique. Fast picosecond anisotropic vibrational relaxation in NADH was observed at the first time that was shown to be due to the rotation of the molecular transition dipole moment in the course of fast rearrangement of NADH nuclear configuration.

– Break –

Laser interaction with cells and tissues: clinical imaging and spectroscopy V

Location: Petrov Vodkin 1 Room, floor 2. 11:30-13:30

WeSYB-21 11:30-12:00

Simultaneous measurement of fluorescent and magnetic resonance 3D images *(Invited paper)*

I.D. Solovyev[1], N.I. Kazachkina[1], V.V. Zherdeva[1], I.G. Meerovich[1], D.K. Tuchina[1,2], A.A. Bogdanov Jr.[1,3], V.V. Tuchin[1,2,4], A.P. Savitsky[1]; [1]Bach Inst. of Biochemistry, Federal Research Centre "Fundamentals of Biotechnology" RAS; [2]Saratov State Univ., Russia; [3]Univ. of Massachusetts Medical School, Radiology, USA; [4]Inst. of Precision Mechanics and Control RAS, Russia

The combination of magnetic resonance and fluorescence imaging will allow tying molecular events to their location in the body. The optical clearing is the major strategy for increasing the depth of light penetration into essentially non-transparent turbid environments such as biological tissues, which decreases the multiple scattering of light.

This research was supported by RFBR Grant(s) # The study was supported by the Ministry of Science and Higher Education of the Russian Federation (grant no. 14.W03.31.0023)

WeSYB-22 12:00-12:30

Evaluation of OCA diffusivity in tissues through diffuse reflection spectroscopy *(Invited paper)*

I.S. Martins[1], M.R. Pinheiro[2], H.F. Silva[1], V.V. Tuchin[3], L.M. Oliveira[1,2]; [1]Center of Innovation in Engineering and Industrial Technology, ISEP, Portugal; [2]Polytechnic of Porto – School of Engineering (ISEP), Portugal; [3]Science Medical Center, Saratov State Univ., Russia

The diffusion properties of water and optical clearing agents in a tissue are usually evaluated ex vivo. Using both collimated transmittance and diffuse reflectance kinetic measurements, the diffusion properties of water and propylene glycol were evaluated in muscle. The properties obtained by both methods presented a deviation of 0.8%, a result that opens the possibility for in vivo evaluation.

This research was supported by RFBR Grant(s) # VVT was supported by the RF MSHE grant 13.2251.21.0009

WeSYB-23 12:30-13:00

Osmotically-induced strain in biological tissues during optical clearing: dependence on agent type and concentration *(Invited paper)*

Yu.M. Alexandrovskaya[1], O.I. Baum[1], A.A. Sovetsvky[2], A.L. Matveyev[2], L.A. Matveev[2], V.Y. Zaitsev[2]; [1]Inst. of Photon Technologies, FSRC "Crystallography and Photonics" RAS; [2]Inst. of Applied Physics RAS, Russia

We apply phase-sensitive Optical Coherence Elastography (OCE) to evaluate and analyze spatially-resolved strain fields in porous biological tissues during their optical clearing. Particular examples of optical clearing agents diffusion in cartilage, eye tissues and liver are considered.

WeSYB-24 13:00-13:15

Recognising the cellular composition of brain tumours

Yu.S. Maklygina[1], A.S. Skobeltsin[1,2], I.D. Romanishkin[1], D.S. Farrakhova[1], L. Bezdetnaya[3,4], V.B. Loschenov[1,2]; [1] Prokhorov General Physics Inst. RAS; [2]Inst. of Engineering Physics for Biomedicine, National Research Nuclear Univ. MEPhI; [3]Centre de Recherche en Automatique de Nancy, CNRS, Univ. de Lorraine, France; [4]Inst. de Cancérologie de Lorraine, France

Due to their different metabolism, cells of different phenotypes that make up tumour tissue are able to accumulate photosensitizer in different ways, allowing physical methods to give a picture of the composition of tumour tissue.

This research was supported by RFBR Grant(s) # The reported study was funded by RFBR according to the research project No. 21-52-15025 and partly by IEA (International Emerging Action) CNRS grant 00534.

WeSYB-25 13:15-13:30

Laser microsurgery and fusion of multicellular spheroids for studying regeneration

N.V. Kosheleva[1,2,3,4], Y.M. Efremov[2,2], B.S. Shavkuta[3], I.M. Zurina[3,4], A.I. Shpichka[1,2,3], I.V. Ilina[5], I.N. Saburina[4], X.-J. Liang[1,6], P.S. Timashev[2,3,7,8]; [1]Lab. of Clinical Smart Nanotechnology, Sechenov Univ., Russia; [2]World-Class Research Center "Digital Biodesign and Personalized Healthcare," Sechenov Univ., Russia; [3]Inst. for Regenerative Medicine, Sechenov Univ., Russia; [4]FSBSI Inst. of General Pathology and Pathophysiology, Russia; [5]Joint Inst. for High Temperatures RAS, Russia; [6]National Center for Nanoscience and Technology, China; [7]Department of Polymers and Composites, Semenov Federal Research Center for Chemical Physics RAS, Russia; [8]Lomonosov Moscow State Univ., Russia

Analysis of multicellular spheroids regeneration and fusion process was obtained. The energy of laser pulses of microdissection for softer spheroids was less than for stiff, softer spheroids fused 1 day faster than stiff. Reparative processes after microdissection occurred gradually over seven days. Cell spheroids fusion is not entirely captured with the models based on the coalescence of liquid drops.

This research was supported by RFBR Grant(s) # Research at Sechenov University was funded by the Ministry of Science and Higher Education of the Russian Federation (№. 075-15-2021-596, spheroids); by the RFBR (№ 20-04-60063, cells)

– Lunch Break –

Laser interaction with cells and tissues: clinical imaging and spectroscopy VI

Location: Petrov Vodkin 1 Room, floor 2. 15:00-17:00

WeSYB-26 15:00-15:30

Evaluation of optical clearing potential of natural oils and gels *(Invited paper)*

H.F. Silva[1], D.S. Teixeira[2], I.S. Martins[1] , V.V. Tuchin[3] , L.M. Oliveira[1,2]; [1]Center of Innovation in Engineering and Industrial Technology, ISEP, Portugal; [2]Physics Department, Polytechnic of Porto – School of Engineering (ISEP), Portugal; [3]Science Medical Center, Saratov State Univ., Russia

Various liquids have been used to study the increase of tissue transparency. Some were found beneficial, while others presented poor clearing efficiency. In this study the clearing potential of some oils and gels was evaluated. The clearing efficiency of electronic cigarette liquid and almond oil was good, while cinnamon and anise oils turned the tissues opaquer to light transmittance.

This research was supported by RFBR Grant(s) # VVT was supported by the RF Government grant 075-15-2021-615

WeSYB-27 15:30-16:00

Nanoparticles fabricated by laser ablation and fragmentation of nano- and microstructured silicon: perspectives in optical bioimaging and photohyperthermia *(Invited paper)*

S.V. Zabotnov[1], V.Yu. Nesterov[1], O.I. Sokolovskaya[1], D.V. Shuleiko[1], L.A. Golovan[1], P.K. Kashkarov[1], A.V. Khilov[1,2], D.A. Kurakina[2], P.D. Agrba[1,3], E.A. Sergeeva[1,2], M.Yu. Kirillin[2,3]; [1]Lomonosov Moscow State Univ.; [2]Inst. of Applied Physics RAS; [3]Lobachevsky State Univ. of Nizhny Novgorod, Russia

Pulsed laser ablation and fragmentation of porous silicon, silicon nanowires and silicon microparticles in water and ethanol allowed to fabricate crystalline silicon nanoparticles with mean sizes 25 – 200 nm. Such particles are promising both in fluorescence and scattering bioimaging techniques and in photohyperthermia of tumors.

This research was supported by RFBR Grant(s) # the Russian Science Foundation, Grant #19-12-00192

WeSYB-28 16:00-16:15

Fluorescence evaluation of tissue samples from skin collagen-related diseases

Ts.I. Genova[1], E.G. Borisova[1,2], I.P. Angelov[1,3], P.P. Troyanova[4], I.N. Terziev[4]; [1]Inst. of Electropnics BAS, Bulgaria; [2]National Research Saratov State Univ., Russia; [3]Inst. of Organic Chemistry with Center of Phytochemistry, BAS, Bulgaria; [4]Univ. Hospital "Tzaritza Yoanna – ISUL", Bulgaria

We have implemented excitation-emission matrices for fluorescence assessment of tissue samples from degenerative skin diseases. Those measurements are part of a proof of concept study for the development of a new technique for noninvasive optical diagnostic of degenerative skin diseases.

WeSYB-29 16:15-16:30

Filtering Raman spectral features of glial tumor sites based on biochemical correlates

T.A. Savelieva[1,2], I.D. Romanishkin[2], A.V. Orlov[1], A.V. Kosyrkova[3], S.V. Shugaj[3], S.A. Goryajnov[3], D.A. Golbin[3], V.B. Loschenov[1,2]; [1]National Research Nuclear Univ. MEPhI; [2]Prokhorov General Physics Inst. RAS; [3]Burdenko National Medical Research Center of Neurosurgery, Russia

Raman spectroscopy is a sensitive and fast tool to differentiate glial tumor and normal tissues during surgery. The structure of Raman spectra motivated us to implement the feature selection technique, based on statistically significant differences between the groups. Finally they were matched to the main biochemical components of the studied tissues.

This research was supported by RFBR Grant(s) # This work was supported by a Ministry of Science and Higher Education of the Russian Federation (agreement 075-15-2021-1343, October 4, 2021)

WeSYB-30 16:30-16:45

Detection of Influenza A and B viruses by Raman spectroscopy

A.T. Tabarov[1], V.V. Vitkin[1], D.M. Danilenko[2], O.V. Andreeva[1], A.A. Shemanaeva[1], E.E. Popov[1], A.A. Dobroslavin[1], V.V. Kurikova[1], O.B. Kuznetsova[1]; [1]ITMO Univ.; [2]Smorodintsev Research Inst. of Influenza, Russia

The large-scale outbreaks of various respiratory viral diseases have occurred several times over the past decades. Optical spectroscopy, with Raman scattering spectroscopy in particular, can serve as an alternative approach to the diagnosis of respiratory viral diseases. The paper demonstrates the possibility of using machine learning technology for the detection and differentiation of various viruses.

WeSYB-31 16:45-17:00

Optical percutaneous needle biopsy to differentiate liver cancer from normal parenchyma

E.V. Potapova[1], E.A. Zherebtsov[1,2], V.V. Dremin[1,3], K.Y. Kandurova[1], V.V. Shupletsov[1], A.V. Mamoshin[1,4], A.V. Dunaev[1]; [1]Research & Development Center of Biomedical Photonics, Orel State Univ., Russia; [2]Optoelectronics and Measurement Techniques unit, Univ. of Oulu, Finland; [3]College of Engineering and Physical Sciences, Aston Univ., UK; [4]Orel Regional Clinical Hospital, Russia

This work presents results of optical percutaneous needle biopsy to differentiate liver cancer from normal parenchyma in vivo and in situ measurements by two developed optical biopsy systems – fluorescence and diffuse reflectance spectroscopy, and fluorescence lifetime one. The accuracy characteristics of optical systems are shown, technology development prospects are described.

Section C. Photonics and nanobiotechnology

Photonics and nanobiotechnology IV

Location: Petrov Vodkin 2 Room, floor 2. 09:00-11:00

WeSYC-16 09:00-09:30

Brillouin imaging: past, present and future. *(Invited paper)*

I. Kabakova; School of Mathematical and Physical Sciences, the Univ. of Technology Sydney, Australia

In this talk I will introduce imaging technology based on Brillouin light scattering for mapping micromechanical properties in tissues, cells and biomaterials. Additionally, I will review recent progress, remaining challenges and future directions in this fascinating field of research.

WeSYC-17 09:30-10:00

Macroscopic time- and spectrally resolved fluorescence imaging *(Invited paper)*

V. Shcheslavskiy[1,2], M. Shirmanova[2], J. Lagarto[3,4], F.S. Pavone[3,4,5], R. Cicchi[3,4], W. Becker[1]; [1]Becker&Hickl GmbH, Germany; [2]Privolzhsky Research Medical Univ., Russia ; [3]National Inst. of Optics, National Research Council (INO-CNR), Italy; [4]European Lab. for Non-linear Spectroscopy (LENS), Italy; [5]Univ. of Florence, Italy

Fluorescence Lifetime Imaging is an optical technique that delivers not only structural, but also molecular specific information about the samples. When it is enhanced with spectral resolution, it becomes even more powerful. This presentation describes a multimodal approach to study biological samples on a macroscale using combined spectroscopic and fluorescence time-resolved methods.

This research was supported by RFBR Grant(s) # RSF: 22-29-01198; 20-65-46018

WeSYC-18 10:00-10:30

How chemotherapy affects microviscosity? *(Invited paper)*

M. Shirmanova[1], L. Shimolina[1,2], A. Gulin[3], N. Ignatova[1], I. Druzhkova[1], A. Khlynova[1], M. Lukina[1], L. Snopova[1], M.K. Kuimova[4], E. Zagaynova[2]; [1]Privolzhsky Research Medical Univ.; [2]Lobachevsky State Univ.; [3]Semenov Inst. of Chemical Physics RAS, Russia; [4]Imperial College London, UK

The plasma membrane of cells is a semi-permeable barrier between the cell and its environment, crucial for cellular homeostasis and survival. In our studies using fluorescence lifetime imaging microscopy (FLIM) and fluorescent molecular rotors we have investigated, in vitro and in vivo, the effects of chemotherapy on membrane viscosity and determined its role in the development of chemoresistance.

This research was supported by RFBR Grant(s) # RSF, Project No. 20-14-00111

WeSYC-19 10:30-10:45

Targeted silver nanoparticles for cancer phototherapy and diagnostics

P.A. Kotelnikova, V.O. Shipunova, S.M. Deyev, A.V. Zvyagin; Shemyakin – Ovchinnikov Inst. of Bioorganic Chemistry RAS, Russia

To obtain targeted nanoagents for phototherapy, we have synthesized silver nanoparticles of various shapes, including spheres, nanorods, nanoprisms, and nanowires. We have developed a number of methods for modifying and stabilizing nanoparticles with polymers and recombinant proteins that can selectively bind cancer cells. We have demonstrated the possibility of silver nanoparticle application as photosensitizers using various light sources.

This research was supported by RFBR Grant(s) # RFBR 20-34-90029, Russian Science Foundation 21-74-30106

WeSYC-20 10:45-11:00

Immunoglobulin -based hybrid targeted nanoagents for in vitro and in vivo multimodal imaging

A.V. Lunin[1], E.S. Korenkov[1], T. Sadan[2], R. Popovtzer[2], E.N. Mochalova[1,3,4], V.R. Cherkasov[1,4]; [1]Moscow Inst. of Physics and Technology, MIPT, Russia; [2]Faculty of Engineering and the Inst. of Nanotechnology and Advanced Materials, Bar-Ilan Univ., Israel; [3]Sirius Univ. of Science and Technology, Russia; [4]Prokhorov General Physics Inst. RAS, Russia

Nanomedicine constantly broadens horizons of modern therapy and diagnostics. However, imaging nanoagents are of especial interest. Here, we report on novel, facile, and sustainable way to fabricate targeted multimodal imaging nanoparticles. Specifically, we synthesize nanoparticles using immunoglobulins and introduce nanoparticles of different nature into immunoglobulin-based matrix. We demonstrate applicability of the nanoparticles both in vitro and in vivo.

This research was supported by RFBR Grant(s) # #19-515-06010, # 19-515-06010

– Break –

Photonics and nanobiotechnology V

Location: Petrov Vodkin 2 Room, floor 2. 11:30-13:15

WeSYC-21 11:30-12:00

Optoacoustic measurement of nanoparticle degradation in physiological media *(Invited paper)*

I.V. Zelepukin[1,2], A.V. Zvyagin[2,3,4], S.M. Deyev[1,2,3]; [1]National Research Nuclear Univ. "MEPhI"; [2]Shemyakin-Ovchinnikov Inst. of Bioorganic Chemistry RAS; [3]Sechenov First Moscow State Medical Univ., Russia; [4]Macquarie Univ., Australia

Here we present method of optoacoustic detection of inorganic nanoparticle degradation. Using optoacoustics we measured kinetics of silicon nanoparticle degradation in various buffers and conditions. It allows to find first known nanoparticle coating with outstanding ability to accelerate silicon material dissolution in buffers.

WeSYC-22 12:00-12:30

Light-activated polymer nanoparticles for image-guided breast cancer treatment *(Invited paper)*

V.O. Shipunova[1], A.A. Sizikov[1], V.R. Cherkasov[1,2]; [1]Moscow Inst. of Physics and Technology; [2]Prokhorov General Physics Inst. RAS, Russia

This report presents a series of works devoted to the creation of biocompatible polymer nanostructures for the therapy and diagnostics of cancer.

This research was supported by RFBR Grant(s) # Ministry of Science and Higher Education of the Russian Federation: agreements # 075-00958-2105 and 075-03-2021-095, project 0714-2020-0004

WeSYC-23 12:30-12:45

Biocompatible with animal cells composite material based on borosiloxane and fullerenes with light-induced bacteriostatic properties

D.E. Burmistrov, M.E. Astashev, A.V. Simakin, R.M. Sarimov, A.D. Kurilov, D.N. Chausov, S.V. Gudkov; Prokhorov General Physics Inst. RAS, Russia

Borosiloxane-fullerene C60 nanocomposites containing various concentrations of fullerene molecules were created. The resulting composite material is capable of self-healing structure. The composite material exhibits photoinduced bacteriostatic properties and is capable of attaching bacterial cells to itself. At the same time, the nanocomposite is biocompatible with mammalian cells; the surface of the nanocomposite is suitable for the colonization of eukaryotic cells.

WeSYC-24 12:45-13:00

Phosphorescent Ir(III) oxygen sensors for bioimaging

I.S. Kritchenkov[1], A.I. Solomatina[1], P.S. Chelushkin[1], M.V. Shirmanova[2], E.S. Kornilova[3], A. Rueck[4], S.P. Tunik[1]; [1]Inst. of Chemistry, St. Petersburg State Univ.; [2]Inst. of Experimental Oncology and Biomedical Technologies, Privolzhsky Research Medical Univ.; [3]Inst. of Cytology RAS, Russia; [4]Core Facility Confocal and Multiphoton Microscopy, Ulm Univ., Germany

This work is devoted to the design, synthesis and implementation of novel iridium(III) O2 sensors in bioimaging.

WeSYC-25 13:00-13:15

Imaging flow cytometry for investigation of extracellular vesicles-magnetic nanoparticles interactions for liquid biopsy

V.A. Bragina[1], S.L. Znoyko[1], N.V. Guteneva[1], V.R. Cherkasov[1], D.O. Novichikhin[1,2], A.G. Burenin[1]; [1]Prokhorov General Physics Inst. RAS; [2]National Research Nuclear Univ. MEPhI, Russia

A novel approach was developed for investigation of interactions between extracellular vesicles (EVs) and magnetic nanoparticles (MNPs). It combines high-resolution imaging flow cytometry (IFC) with fluorescently labeled MNP conjugates. The IFC data verified the optimality of parameters (the amount of MNP conjugates per test, incubation time) for the efficient of magnetic immunochromatographic assay for liquid biopsy EV quantification.

– Break –

Photonics and nanobiotechnology VI

Location: Petrov Vodkin 2 Room, floor 2. 15:00-16:45

WeSYC-26 15:00-15:30

Surface-enhanced Raman scattering from 1D-3D plasmonic Au nanoparticles:the fourth-power law revisited *(Invited paper)*

N.G. Khlebtsov[1,2], B.N. Khlebtsov[1], A.M. Buroc[1], V.A. Khanadeev[1]; [1]Inst. of Biochemistry and Physiology of Plants and Microorganisms, Saratov Scientific Centre RAS; [2]Saratov State Univ., Russia

The electromagnetic theory predicts the four-power scaling of the average SERS enhancement factor as a function of the local field. However, the existing experimental data do not confirm such theoretical predictions. We discuss a reexamination study using well-defined experimental models obtained by controllable etching of Au nanorods, nanotriangles, and nanostars, functionalized with Raman reporters, together with COMSOL and T-matrix simulations.

WeSYC-27 15:30-16:00

Peculiarities of photoluminescence decay for molecules near plasmonic nanostructures *(Invited paper)*

S.M. Safarian[1], Y.V. Rostovtsev[2], V.P. Drachev[1]; [1]Center for Engineering Physics, Skolkovo Inst. of Science and Technology, Russia; [2]Department of Physics, Univ. of North Texas, USA

Plasmonic nanostructures used in the photoluminescence biomolecules monitoring result in bi-exponential decay and affect emitted photon statistics.

WeSYC-28 16:00-16:15

Mode switching of the low-frequency oscillationsof the tobacco mosaic virus when the temperature of its aqueous suspension changes

A.F. Bunkin[1], M.A. Davydov[1], A.N. Fedorov[1], M.V. Arkhipenko[2], V.B. Oshurko[1,2], S.M. Pershin[1]; [1]Prokhorov General Physics Inst. RAS; [2]Faculty of Biology, Moscow State Univ.; [3]Moscow State Technological Univ. STANKIN, Russia

A stimulated low-frequency Raman scattering radiation in suspension of the tobacco mosaic virus with frequencies 31.17 and 43.5 GHz was observed. The virus concentration was varied in the range of about 1012 and 2.0 × 1012 cm–3. The high sensitivity Raman spectrum to the suspension temperature was observed also.

This research was supported by RFBR Grant(s) # 20-02-00172 and Russian Science Foundation (project no. 22-22-001).

WeSYC-29 16:15-16:30

Plasmon resonances of the multilayer nanoparticle

I.A. Pavlichenko; Univ. of Nizhny Novgorod, Russia

Based on the hydrodynamic approach, a physical model of the plasmon response of a spherical metal-dielectric-metal nanoparticle interacting with laser radiation is developed. The frequency dependences of the maximum value of the local field are calculated, and it has been shown that spatial dispersion can have a noticeable effect on the magnitude and position of the main resonance maximum.

WeSYC-30 16:30-16:45

Rapid and easy-to-use method for optimization of lateral flow assay with magnetic separation

A.V. Pushkarev, D.O. Novichikhin, E.N. Mochalova, A.V. Orlov; Prokhorov General Physics Inst. RAS, Russia

Rapid and easy-to-use method has been developed for accurate determining the optimal parameters of a lateral flow assay having a stage of magnetic separation. The method is based on the spectral correlation interferometry joined with a mathematical model describing such test systems. The method demonstrates high correlation with experimental data and can be used without specialized software.

Section D. Photodynamic processes in biology and medicine

Photodynamic processes in biology and medicine I

Location: Petrov Vodkin 3 Room, floor 2. 09:15-11:00

WeSYD-01 09:15-09:45

Absorption spectra of dissolved oxygen molecules in aerated solvents. A review of laser activation experiments *(Invited paper)*

A.A. Krasnovsky, A.S. Benditkis, A.S. Kozlov; Federal Research Center of Biotechnology RAS, Russia

Oxygen activation by laser radiation at 400 – 1300 nm has been studied in aerated organic solvents using chemical trapping and phosphorescence of singlet oxygen under ambient conditions. As a result, the absorption spectra of dissolved oxygen and molar absorption coefficients corresponding to the oxygen absorption peaks have been measured. The biomedical importance of these data will be discussed.

This research was supported by RFBR Grant(s) # No 19-04-00331

WeSYD-02 09:45-10:15

Multifunctional photosensitizer based theranostic agents for imaging-guided photodynamic therapy of cancer *(Invited paper)*

H. Abrahamse; Laser Research Centre, Faculty of Health Sciences, Univ. of Johannesburg, South Africa

We highlight the recent progress in the development of PS-based multifunctional theranostic agents for biomedical applications in multimodal imaging combined with PDT.

WeSYD-03 10:15-10:45

Nano- and picosecond dynamics of excited states of biological coenzymes *(Invited paper)*

O.S. Vasyutinskii; Ioffe Inst. RAS, Russia

The lecture presents the results of experimental and theoretical studies of anisotropic relaxation and energy transfer in excited states of biological coenzymes NADH and FAD in solutions under excitation with pico- and femtosecond laser pulses. Time-resolved transient polarization-modulation and fluorescence anisotropy signals were recorded and analyzed by means of the methods developed by the authors.

WeSYD-04 10:45-11:00

Dependence of Radachlorin fluorescence lifetime on solution pH and localization in Hela cells

A.V. Belashov[1], A.A. Zhikhoreva[1], T.N.Belyaeva[2], I.K. Litvinov[2], A.V. Salova[2], E. S. Kornilova[2], I.V. Semenova[1], O.S. Vasyutinskii[1]; [1]Ioffe Inst.; [2]Inst. of Cytology RAS, Russia

Variations of Radachlorin fluorescence lifetime with pH in PBS solutions have been studied. As shown, an increase in pH resulted in the fluorescence lifetime rise. FLIM-assisted experiments on Radachlorin fluorescence lifetimes in living HeLa cells demonstrated dependence of the lifetime on intracellular localization of Radachlorin molecules. Recorded variations of Radachlorin fluorescence lifetime within intracellular area were about 15-20%.

– Break –

Photodynamic processes in biology and medicine II

Location: Petrov Vodkin 3 Room, floor 2. 11:30-13:30

WeSYD-05 11:30-12:00

Photodynamic theranostics of central lung cancer: capabilities of early diagnosis and minimally invasive therapy *(Invited paper)*

G.V. Papayan[1,2], A.L. Akopov[1]; [1]The Pavlov First Saint Petersburg State Medical Univ.; [2]Almazov National Medical Research Centre, Russia

Bronchoscopic fluorescent diagnostics enable to reveal tumor changes in bronchi mucosa at early stages, and a developed PDT technique performed under fluorescent control helps achieve personalized treatment. Further progress will be determined by the development of new photosensitizers, which should be characterized by a high absorption band in NIR-area.

WeSYD-06 12:00-12:30

Phototoxicity induced in living HeLa cells by focused femtosecond laser pulses: a data-driven approach *(Invited paper)*

B. Talone[1], M. Bazzarelli[2], A. Schirato[1,3], F. Dello Vicario[2], D. Viola[1], E. Jacchetti[4], M. Bregonzio[2], M.T. Raimondi[4], G. Cerullo[1,5], D. Polli[1,5]; [1]Department of Physics, Politecnico di Milano; [2]3rdPlace SRL; [3]Inst. Italiano di Tecnologia; [4]Department of Chemistry, Materials and Chemical Engineering 'G. Natta', Politecnico di Milano; [5]Inst. di Fotonica e Nanotecnologie (IFN), Consiglio Nazionale delle Ricerche (CNR), Italy

We experimentally characterized the survival rate of HeLa cells to sub-200-fs laser pulses at 1040 nm and 80-MHz repetition rate for nonlinear microscopy applications. A data-driven approach could derive the mechanisms of damage as a function of laser power and pixel dwell time in two different light exposure modalities, deepening the photothermal damage with thermodynamic considerations.

WeSYD-07 12:30-13:00

The concept of multimodal prevention and treatment of new coronavirus infection COVID-19 by drug photosensitizers and photodynamic therapy on their basis. *(Invited paper)*

S.D. Nikonov[1,4], V.B. Loktev[2], V.A. Svyatchenko[2], A.P. Mayorov[3], D.A. Bredikhin[1,4]; [1]Novosibirsk State Univ.; [2]State Research Center of Virology and Biotechnology "Vector" Rospotrebnadzor; [3]Inst. of Laser Physics SB RAS; [4]Novosibirsk Scientific Research Inst. of Tuberculosis, Russia

A study of antiviral low-dose photodynamic therapy with pharmacopoeial photosensitizers in the form of methylene blue and chloride E6 (Radachlorin) solutions in vitro demonstrated complete inactivation of SARS-CoV-2 in suspension and protection of Vero E6 cells even 3.5 hours after their infection with coronavirus at concentrations of photosensitizers 100-1000 times lower than the recommended pharmacopoeial forms of these drugs.

WeSYD-08 13:00-13:15

Synthesis of core-shell ternary quantum dots -porphyrin conjugates and its photodynamic therapy application

O.S. Oluwafemi; Department of Chemical Sciences (formerly Applied Chemistry), Univ. of Johannesburg; Centre for Nanomaterials Science Research, Univ. of Johannesburg, South Africa

Porphyrins are photosensitisers used in photodynamic therapy (PDT). However, their limited absorption and aggregation in an aqueous medium affect their effectiveness in PDT. In this presentation, the synthesis of ternary quantum dots (QDs) and their conjugation to porphyrin as an efficient way to overcome photosensitizer shortcoming will be discussed.

WeSYD-09 13:15-13:30

Synthesis and spectroscopic studies of nanostructures based on upconversion nanoparticles coated with a photosensitizer for photodynamic therapy with infrared excitation

D.V. Pominova[1,2], V.Y. Proydakova[1], I.D. Romanishkin[1], A.V. Ryabova[1,2], S.V. Kuznetsov[1], V.B. Loschenov[1,2]; [1]Prokhorov General Physics Inst. RAS; [2]National Research Nuclear Univ. MEPHI, Russia

In this work, we studied the processes of energy transfer from upconversion nanoparticles to photosensitizer molecules. The possibility of photodynamic therapy with infrared excitation using synthesized nanostructures has been demonstrated.

– Lunch Break –

Photodynamic processes in biology and medicine III

Location: Petrov Vodkin 3 Room, floor 2. 15:00-16:30

WeSYD-10 15:00-15:30

Ultrafast relaxations and singlet oxygen generation in solutions of C_{60} in n-methylpyrrolidone *(Invited paper)*

I.M. Kislyakov[1], V.M. Kiselev[2], J. Wang[1];[1]Shanghai Inst. of Optics and Fine Mechanics, CAS, China;[2]Vavilov State Optical Inst., Russia

Photodynamic processes related to the transfer of photoexcitation energy were studied in air-saturated solutions of C60 in NMP. Both excited state kinetics and the efficiency of singlet oxygen photosensibilization are traced. A large quantum yield of the latter which weakly depends on the solution aging was found in the broad range excitation spectrum from UV to the red.

WeSYD-11 15:30-15:45

Photodiagnostics and photodynamic treatment of glioblastoma stem cells with porphyrins and phthalocyanines

L.B. Zaharieva[1,2], D.S. Kyurkchiev[4], K.D. Tumangelova-Yuzeir[4], E.I. Ivanova-Todorova[4], I.A. Angelov[1,5], Ts.I. Genova[1], B.B. Kolev[1], A.I. Gisbrecht[1], L.A. Avramov[1], O.V. Semyachkina-Glushkovskaya[3], P.A. Karazapryanov[6], K.Ts. Minkin[6], E.G. Borisova[1,7]; [1]Inst. of Electronics, BAS, Bulgaria; [2]Sofia Univ., Bulgaria; [3]Saratov State Univ., Russia; [4]Medical Univ. of Sofia, Bulgaria; [5]Inst. of Organic Chemistry with Center of Phytochemistry, BAS Bulgaria; [6]Univ. Hospital "St. Ivan Rilski", Bulgaria; [7]Research National Saratov State Univ., Russia

Investigations into efficacy and mechanisms of impact in photodynamic treatment (PDT) with different photosensitizers, based on porphyrins and phthalocyanines, on stem cells cultures isolated from human glioblastoma were carried out.

WeSYD-12 15:45-16:00

Photodynamic action of polycationic synthetic bacteriochlorin against human lung cancer cells

E.A. Kogan[1], G.A. Meerovich[2,3], S.Sh. Karshieva[4], E.V. Akhlyustina[3], E.A. Makarova[5], N.V. Zharkov[1], I.P. Angelov[6,7], V.B. Loschenov[2,3]; [1]Sechenov First Moscow State Medical Univ.; [2]Prokhorov General Physics Inst. RAS; [3]National Research Nuclear Univ. "MEPHI"; [4]Blokhin National Medical Research Center of Oncology; [5]Organic Intermediates and Dyes Inst., Russia; [6]Inst. of Organic Chemistry with Centre of Phytochemistry; [7]Inst. of Electronics, Bulgaria

The aim of this work is to evaluate the photodynamic effectiveness of photosensitizers based on polycationic derivatives of synthetic bacteriochlorin on human lung cancer cells A549. The results obtained show that these photosensitizers effectively bind to these cells and have very high phototoxicity and low "dark" cytotoxicity

This research was supported by RFBR Grant(s) # 20-52-18008

WeSYD-13 16:00-16:15

Photodynamic therapy for malignant brain tumors

E.I. Kozlikina[1,2], I.S. Trifonov[3], V.V. Krylov[3], V.B. Loschenov[1,2]; [1]Prokhorov General Physics Inst. RAS; [2]National Research Nuclear Univ. MEPhI; [3]Evdokimov Moscow State Univ. of Medicine and Dentistry, Russia

This study presents first results of PDT patients with high grade gliomas in Russian Federation. PDT remains a promising therapeutic approach that requires further study in HGGs to analyze median survival rate. Photodynamic techniques such as photodynamic diagnosis (PDD), fluorescence-guided tumor resection (FGR) and photodynamic therapy (PDT) are currently undergoing intensive clinical investigations as adjuvant treatment for malignant brain tumors

WeSYD-14 16:15-16:30

Photodynamic therapy with 5-ALA induced PpIX effect on macrophages polarization

A.V. Ryabova[1,2], D.V. Pominova[1,2], A.S. Skobeltcin[1,2], I.D. Romanishkin[1], V.B. Loschenov[1,2]; [1]Prokhorov General Physics Inst. RAS; [2]National Research Nuclear Univ. MEPHI, Russia

In this work, we have carried out the assessment of changes in the polarization of macrophages in response to photodynamic treatment according to the changes in the fluorescence lifetime of respiratory chain enzymes. The analysis of the time-resolved fluorescence of metabolic signatures and PpIX makes it possible to determine the cell metabolism types.

This research was supported by RFBR Grant(s) # 20-02-00928

Section B. Laser interaction with cells and tissues: clinical imaging and spectroscopy

Laser interaction with cells and tissues: clinical imaging and spectroscopy VII

Location: Petrov Vodkin 1 Room, floor 2. 09:00-11:00

ThSYB-32 09:00-09:30

Morphological changes of red blood cell trapped in laser tweezers *(Invited paper)*

P.B. Ermolinskiy, A.E. Lugovtsov, A.V. Priezzhev; Lomonosov Moscow State Univ., Russia

The aim of this work was to study the effect of a highly focused laser beam on a red blood cell (RBC) trapped by laser tweezers. The changes of RBC shape in the laser trap were found for different laser beam powers. The results are important for understanding the mechanisms of interaction of laser beams with live cells.

This research was supported by RFBR Grant(s) # This work was supported by the Russian Scientific Foundation (Grant No. 20-45-08004).

ThSYB-33 09:30-10:00

3D scaffolds biodegradation in vivo tracking: current state and prospects *(Invited paper)*

P.S. Timashev; Inst. for Regenerative Medicine, Sechenov Univ.; World-Class Research Center "Digital Biodesign and Personalized Healthcare"; Lomonosov Moscow State Univ., Russia

There is an urgent need to develop strategies for real-time and non-invasively monitoring in vivo degradation. Fluorescence-related imaging, optical coherence tomography, computed tomography, and THz spectroscopy and imaging can be used to achieve this task. We consider the most novel and our own works in the area of in vivo biodegradation and perspectives of the use of the mentioned techniques.

ThSYB-34 10:00-10:30

Comparison of strain ultrasound elastography with compression optical coherence elastography for breast cancer characterization *(Invited paper)*

E.V. Gubarkova[1], A.A. Sovetsky[2], D.A. Vorontsov[3], P.A. Buday[3], M.A. Sirotkina[1], A.A. Plekhanov[1], A.L. Matveyev[2], L.A. Matveev[2], A.Y. Vorontsov[3], V.Y. Zaitsev[2], N.D. Gladkova[1]; [1]Privolzhsky Research Medical Univ.; [2]IAP RAS; [3]Nizhny Novgorod Regional Oncologic Hospital, Russia

The aim of this study is compare the results of ultrasound strain elastography with compression optical coherence elastography (C-OCE) in breast cancer assessment and to evaluate factors that can affect the results of the two elastography techniques. C-OCE has novel capabilities due to its ability to locally control pressure on the tissue and obtain local stress-strain curves.

ThSYB-35 10:30-10:45

Image-guided drug delivery to hair follicles in topical PUVA therapy

Yu.I. Svenskaya[1], E.E. Talnikova[2], E.A. Genina[1], D.A. Gorin[3], G.B. Sukhorukov[4], V.V. Tuchin[1]; [1]Saratov State Univ; [2]Saratov State Medical Univ.; [3]Skolkovo Inst. of Science and Technology, Russia; [4]Queen Mary Univ. of London, UK

Transdermal administration of therapeutic molecules via skin appendages has gained great scientific interest, especially concerning delivery to specific targeted regions and the reduction of systemic toxicity. Here, a novel effective approach towards intrafollicular delivery of psoralen drug is proposed. The impactful effect of topical Psoralen-UVA therapy via targeting to hair follicles is demonstrated in healthy volunteers and a vitiligo patient.

This research was supported by RFBR Grant(s) # The research was supported by RSF (17-73-20172)

ThSYB-36 10:45-11:00

Local atraumatic fixation of the intestinal wall in the real-time artefact-free structural and angiographic transserous OCT imaging

M.G. Ryabkov[1], M.A. Sizov[2], P.A. Shilyagin[3], P.V. Peretyagin[1], E.L. Bederina[1], A.A. Moiseev[3], G.V. Gelikonov[3], N.D. Gladkova[1], E.B. Kiseleva[1]; [1]Privolzhsky Research Medical Univ.; [2]City Clinical Hospital No.30, Nizhny Novgorod; [3]Inst. of Applied Physics RAS, Russia

We develop a method for atraumatic fixation of the intestinal wall to obtain real-time artefact-free structural and angiographic Optical Coherence Tomography images. A special vacuum cap was designed and tested on the wall of the small intestine of minipigs. As a result, the number of motion artifacts in images compared to manual fixation was reduced from 84% to 8%.

This research was supported by RFBR Grant(s) # The study was funded by RSF, grant #19-75-10096.

– Break –

Laser interaction with cells and tissues: clinical imaging and spectroscopy VIII

Location: Petrov Vodkin 1 Room, floor 2. 11:30-14:00

ThSYB-37 11:30-12:00

Rate and degree of platelets aggregation in cardiovascular diseases: studies by light scattering technique *(Invited paper)*

A.E. Lugovtsov, D.A. Umerenkov, P.B. Ermolinskiy, A.V. Priezzhev; Lomonosov Moscow State Univ., Russia

The aim of this work was to measure parameters of platelet aggregation in patients with arterial hypertension and type 2 diabetes mellitus using light scattering technique. The degree and rate of platelets aggregation in patients with these diseases are increased compared to those in healthy people.

ThSYB-38 12:00-12:30

RBC interaction with endothelial cells: study using laser tweezers technique *(Invited paper)*

A.V. Priezzhev[1], P.B. Ermolinskiy[1], A.E. Lugovtsov[1], O.N. Scheglovitova[2]; [1]Lomonosov Moscow State Univ.; [2]Gamaleya National Research Center for Epidemiology and Microbiology, Russia

The aim of this work was to measure the force of interaction between individual red blood cells and endothelial cells using laser tweezers. The changes in the cells interaction forces were found dependent of the content of fibrinogen and other activators in environmental medium. The results are important for understanding the mechanisms of interaction of RBC with vascular endothelium.

ThSYB-39 12:30-13:00

Strain-estimation-based OCT angiography *(Invited paper)*

A.A. Zykov, A.L. Matveyev, L.A. Matveev, D.V. Shabanov, V.Y. Zaitsev; Inst. of Applied Physics RAS, Russia

Optical Coherence Angiography (OCA) discriminates own erythrocytes' motions against the surrounding "solid" tissue. We present a new OCA principle based on local interframe strain estimation. Compared with high-pass filtering of temporal speckle variability, strain-based OCA shows higher tolerance to artifacts induced by strong inhomogeneous strains, which is very promising for realization of contact-mode OCA for practical applications on patients.

ThSYB-40 13:00-13:15

Numerical simulations of phase-amplitude compensation of masking strain-induced motions of scatterers in contact-mode optical coherence angiography

A.A. Zykov, A.L. Matveyev, L.A. Matveev, V.Y. Zaitsev; Inst. of Applied Physics RAS, Russia

Visualization of microvasculature in Optical Coherence Angiography (OCA) is based on discrimination of erythrocytes motion against the surrounding motionless tissue. In practice, surrounding tissue is never still; therefore its motion must be compensated before flow detection. We present a deformation compensation technique for contact-mode OCA in case of big strains when phase-only compensation is insufficient and phase-amplitude compensation is required.

ThSYB-41 13:15-13:30

Fluorescence lifetime measurements for kidney ischemia monitoring in minimally invasive surgery

E.A. Zherebtsov[1,2], S.V. Popov[3], R.G. Guseinov[3], V.V. Shupletsov[1], K.Y. Kandurova[1], V.V. Perepelitsa[3], I.N. Orlov[3], A.S. Katunin[3], E.V. Potapova[1], A.V. Mamoshin[1], A.V. Dunaev[1]; [1]Research & Development Center of Biomedical Photonics, Orel State Univ., Russia; [2]Optoelectronics and Measurement Techniques Unit, Univ. of Oulu, Finland; [3]St. Luka Clinical Hospital, Department of Urology, Russia

The paper demonstrates the results of the application of fluorescent and diffuse reflectance measurements in laparoscopic renal surgeries during warm ischemia. The experimental setup and results of the combined use of optical modalities for cellular metabolism and tissue saturation assessment are described.

– Lunch Break –

Laser interaction with cells and tissues: clinical imaging and spectroscopy IX

Location: Petrov Vodkin 1 Room, floor 2. 15:00-16:15

ThSYB-42 15:00-15:30

Morphological and functional assessment of tumor and non-tumor tissue under therapy using multimodal OCT *(Invited paper)*

M.A. Sirotkina[1], E.V. Gubarkova[1], A.L. Potapov[1], A.A. Moiseev[3], S.S. Kuznetsov[2], E.S. Sedova[2], E.V. Grebenkina[2], S.V. Gamayunov[2], N.D. Gladkova[1]; [1]Privolzhsky Research Medical Univ.; [2]Nizhny Novgorod Regional Oncologic Hospital; [3]Inst. of Applied Physics RAS, Russia

The aim of this study is compare the early (within 24 hours) blood vessels reaction to photodynamic therapy (PDT) by optical coherence angiography (OCA) in case of tumor (basal cell carcinoma) and inflammation lesions (lichen sclerosus). It was shown that the microvascular damages was the primary reaction to PDT. The dynamic of reaction was universal for tumor and inflammation lesions.

ThSYB-43 15:30-16:00

Model of a Photosensitizer for Photodynamic Therapy Based on Upconversion Nanoparticles *(Invited paper)*

V.I. Kochubey[1], I.Yu. Yanina[1,2]; [1]Inst. of Physics, Saratov State Univ.; [2]Lab. of Laser Molecular Imaging and Machine Learning, National Research Tomsk State Univ., Russia

Stable surface coating of the upconversion nanoparticles with human serum albumin (HSA) was carried out to cross-link the photodynamic dye with the particles.

ThSYB-44 16:00-16:15

Iridium cyclometalated complexes as pH probes: synthesis, photophysics, computational study, and cellular imaging

A.I. Solomatina, D.O. Kozina, V.V. Porsev, S.P. Tunik; Inst. of Chemistry, St. Petersburg State Univ., Russia

We report a series of iridium(III) cyclometalated complexes [Ir(N^C)2(X^X)] bearing pH-responsive groups. The compounds were synthesized in good to moderate yields and characterized by mass-spectrometry, NMR-spectroscopy, and XRD analysis. The compounds demonstrate luminescence in solution and pH-dependent photophysical characteristics. Two of the complexes, which display pH-response in a physiologically relevant range in aqueous media, were applied for cellular bioimaging.

Section C. Photonics and nanobiotechnology

Photonics and nanobiotechnology VII

Location: Petrov Vodkin 2 Room, floor 2. 09:00-10:45

ThSYC-32 09:00-09:30

Laser synthesis of colloidal nanomaterials for biomedicine *(Invited paper)*

A.A. Popov; Inst. for Physics and Engineering in Biomedicine, National Research Nuclear Univ. MEPhI, Russia

Pulsed laser ablation in liquids is a "green" physical technique for NPs synthesis, which offers an exceptional purity level of the nanomaterials. Here we present our recent results in synthesis of various inorganic nanomaterials by methods of pulsed laser ablation in liquids for biomedical applications.

This research was supported by RFBR Grant(s) # Russian Science Foundation project no. 19-72-30012

ThSYC-33 09:30-10:00

Modeling of nanoparticles formation process due to pulsed laser ablation in liquids *(Invited paper)*

D.S. Ivanov[1,2], S.M. Klimentov[2], I.N. Zavestovskaya[1], A. Popov[2], P. Shahov[2], A.V. Kabashin[2]; [1]Lebedev Physical Inst. RAS; [2]MEPhI, Inst. of Engineering Physics for Biomedicine, Russia

In this work, we investigate the mechanism of NPs generation in liquids as a function of the pulse duration, the indecent fluence, and the irradiation regime (single- multi-pulse). For that purpose we applied the combined atomistic-continuum model to simulate ultrashort laser pulse interaction with gold sample under water layer confinement.

ThSYC-34 10:00-10:15

Terbium oxide nanoparticle synthesis and the effect of oxidation of nanoparticles on the properties of laser-induced breakdown of aquous colloids

I.V. Baimler, A.V. Simakin, S.V. Gudkov; Prokhorov General Physics Inst. RAS, Russia

The research focuses on the synthesis of Tb nanoparticles with different oxidation degrees by laser ablation in various liquid media. The influence of the oxidation of nanoparticles on the physical and chemical processes during laser-induced breakdown is discussed.

ThSYC-35 10:15-10:30

Laser influence on biopolymer media with carbon nanoparticles for biomedical applications

A.Yu. Gerasimenko[1,2], A.V. Kuksin[1]; [1]Inst. of Biomedical Systems, National Research Univ. of Electronic Technology; [2]Inst. for Bionic Technologies and Engineering, Sechenov First Moscow State Medical Univ., Russia

Laser technology for fabricating composite structures based on biopolymers with single-walled carbon nanotubes has been developed. The structures are intended to recovery of cardiovascular tissues. This is evidenced by the results of the atomic-molecular structure, electrical conductivity studies and biocompatibility. The composites were fabricated due to the phase transition of an aqueous dispersion under the influence of pulsed laser radiation.

ThSYC-36 10:30-10:45

Study of the effect of laser pulse duration in the ultraviolet spectral range on fibroblasts

Y.M. Hamdan[1], E.I. Madirov[1], M.A. Marisov[1], N.I. Shamsutdinov[1], P.V. Zelenikhin[1], A.S. Nizamutdinov[1], A.A. Buglak[2], T.A. Telegina[3]; [1]Kazan Federal Univ.; [2]St. Petersburg State Univ.; [3]Bach Inst. of Biochemistry, Research Center of Biotechnology RAS, Russia

Report the different pulse duration of UVB laser radiation cytotoxic effect on human skin fibroblasts.

This research was supported by RFBR Grant(s) # Russian Science Foundation (RSF)

–Break –

Photonics and nanobiotechnology VIII

Location: Petrov Vodkin 2 Room, floor 2. 11:30-13:30

ThSYC-37 11:30-11:45

Preparation of luminescent nanothermometers based europium(III) complexes embedded in latex nanoparticles

K.M. Kuznetsov, J.R. Shakirova, V.A. Baigildin, S.P. Tunik; St. Petersburg State Univ., Russia

Temperature sensing at macro- and nanoscale levels is one of the challenging tasks in bioimaging. Herein we present the synthesis of a series of thermosensitive europium complexes and an approach to the preparation of luminescent thermosensitive nanospecies containing these complexes, which keep intact europium centered emission and temperature sensitivity in physiological media without crosstalk with other environmental stimuli.

This research was supported by RFBR Grant(s) # 19-13-00132

ThSYC-38 11:45-12:00

Polymer-bound pH-responsive iridium(III) complex as a potential probe in Phosphorescent Lifetime Imaging

Ju. Shakirova, V.A. Baigildin, A.I. Solomatina, S.P. Tunik; St. Petersburg State Univ., Russia

Herein we present the synthesis of the phosphorescent iridium(III) complex with emission lifetime response to variations in pH in the physiologically important range as a potential probe for in vitro/in vivo imaging in PLIM mode. To prevent the oxygen quenching of the phosphorescence and interaction with the biological environment the probe was covalently bonded to biocompatible N-vinylformamide-N-Vinylpyrrolidone block copolymer.

ThSYC-39 12:00-12:15

Physical background of Nd^{3+}, Yb^{3+}:YF_3 temperature sensors for biomedical applications

M.S Pudovkin; Inst. of Physics, Kazan Federal Univ., Russia

The studied Nd3+, Yb3+: YF3 nanoparticles demonstrated high (0.01 K-1) temperature sensitivity in the physiological temperature range. The mechanism of temperature sensitivity includes phonon-assisted energy transfer processes between doping ions, as well as lattice distortion due to thermal expansion phenomenon.

WeSYC-40 12:15-12:30

Down- conversion $LiYF_4$:Tm^{3+}, Yb^{3+} phosphors for optical temperature sensing

A.K. Ginkel, A. R. Khadiev, E.O. Volkova, O.A. Morozov, S.L. Korableva, M.S. Pudovkin; Inst. of Physics, Kazan Federal Univ., Russia

Down-conversion luminescence has been demonstrated in Tm3+ - Yb3+ co-doped LiYF4 upon the 688-nm excitation of Tm3+. For the sake of temperature sensing, luminescence decay time of Tm3+ and luminescent intensity ratios were taken as temperature dependent parameters. The maximum sensitivities were 0.33 μs/K for LiYF4:Tm3+(0,5%),Yb3+(60%) sample.

ThSYC-41 12:30-12:45

Laser-induced switching of the biological activity of phosphonates

D.V. Pankin[1], I.E. Kolesnikov[1], A.G. Pilip[2], A.Egorova[2,3], A.A. Manshina[4]; [1]Center for Optical and Laser Materials Research, St. Petersburg State Univ.; [2]St. Petersburg Federal Research Center RAS, Scientific Research Centre for Ecological Safety RAS; [3]St. Petersburg State Inst. of Technology (Technical Univ.); [4]Inst. of Chemistry, St. Petersburg State Univ., Russia

Butyrylcholinesterase inhibition and its change as a result of laser irradiation are demonstrated for the first time for a series of newly synthesized phosphorylated arylaminomalonates and phosphorus functionalized thiazolotriazoles. The effect of compounds structures on butyrylcholinesterase inhibition and its laser-activated change is revealed experimentally and confirmed by molecular dynamics and docking modelling.

This research was supported by RFBR Grant(s) # This work was supported by RSF project 22-13-00082 and funds within the state assignment of Ministry of Education and Science of the Russian Federation for 2022-2024 (No. FFZF-2022-0012)

ThSYC-42 12:45-13:00

OCT study of cataract simulation in the lens of a porcine eye

E.M. Kasianenko, Y.M. Alexandrovskaya, O.I. Baum; Inst. Photonic Technologies of Federal Scientific Research Centre "Crystallography and Photonics" RAS, Russia

An OCT study of the laser-induced dynamics of the deformation response of the lens structure during cataract modelling using peroxide and formalin at two wavelengths 1,44 and 1,56 μm is presented.

This research was supported by RFBR Grant(s) # No. 20-02-00486a

ThSYC-43 13:00-13:15

The influence of microenvironmental and molecular conformational effects on quantum yield in NADH and FAD in water-alcohol solutions.

I.A. Gorbunova, M.K. Danilova, M.E. Sasin, O.S. Vasutinskii; Ioffe Inst., Russia

We studied quantum yield in biological coenzymes NADH and FAD in water-alcohol solutions. The analysis of the experimental results obtained allowed to separate the factors that influence on the fluorescence quenching in FAD and NADH: the role of molecular conformations in non-radiative relaxation processes in excited states, and solution viscosity and polarity.

ThSYC-44 13:15-13:30

Anti-breast cancer nanorobots for magnetic hyperthermia in vitro and in vivo

M.V. Lomova[1], P.A. Demina[1], Y.I. Svenskaya[1], A.A. Abalymov[1], R.A. Anisimov[1], V.A. Kildisheva[1], A.E. Kalinova[2], A.A. Serdobintsev[2], A.V. Sadovnikov[2], D.V. Voronin[1]; [1]Science Medical Centre, Saratov State Univ.; [2]Inst. of Physics, Saratov State Univ., Russia

The effectiveness of magnetic hyperthermia at high and low frequencies of alternating and constant magnetic fields is determined by the accumulation of drug carriers in the target organ. Adressable delivery of drugs can also be carried out through the usage of magnetic nanorobots.

This research was supported by RFBR Grant(s) # The study was supported by a grant from the Russian Science Foundation (project No. 19-73-10123).

– Lunch Break –

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Photonics and nanobiotechnology IX

Location: Petrov Vodkin 2 Room, floor 2. 15:00-16:30

ThSYC-45 15:00-15:15

The unified approach to simulate absorption spectra of photosynthetic pigments: the combination of artificial intelligence and stochastic theory of optical response

V.A. Kurkov[1], D.D. Chesalin[2], A.P. Razjivin[3], A.A. Ashikhmin[4], R.Y. Pishchalnikov[2]; [1]Moscow Inst. of Physics and Technology (National Research Univ.); [2]Prokhorov General Physics Inst. RAS; [3]Pushchino Scientific Center for Biological Research RAS, Inst. of Basic Biological Problems RAS; [4]Lomonosov Moscow State Univ., Belozersky Research Inst. of Physico-Chemical Biology, Russia

Electronic optical spectra of photosynthetic pigments such as chlorophylls, bacteriochlorophylls, and carotenoids are characterized by the presence of a phonon wing of varying degrees of intensities. Differential evolution - the multiparametric optimizer and the stochastic theory were used together to simulate absorption profiles of pigments and to fit experimental data.

This research was supported by RFBR Grant(s) # RSF # 22-21-00905

ThSYC-46 15:15-15:30

The role of overtones of effective vibronic frequencies in modeling of the linear optical response of carotenoids

D.D. Chesalin[1], E.G. Maksimov[2], R.Y. Pishchalnikov[1]; [1]Prokhorov General Physics Inst. RAS; [2]Lomonosov Moscow State Univ., Department of Biophysics, Faculty of Biology, Russia

Absorption spectra of carotenoids (lutein and zeaxanthin) in two solvents (acetone and methanol) were simulated applying the multimode stochastic theory. Adding overtones of ν1 and ν2 vibronic mode (vibrations of single and double carbon bonds in the carbon chain) to the spectral density allowed obtaining good agreement between the experimental and calculated data in all combinations of carotenoids and solvents.

This research was supported by RFBR Grant(s) # RSF # 22-21-00905, https://rscf.ru/en/project/22-21-00905/

ThSYC-47 15:30-15:45

Molecular dynamics simulation of structural evolution in crystal and amorphous alloys under ultrafast laser irradiation

D. Iabbaden[1], C. Fusco[2], J. Amodeo[2], F. Garrelie[1], JP. Colombier[1]; [1]Univ Lyon, UJM-Saint-Etienne, CNRS, Inst. of Optics Graduate School, Lab. Hubert Curien; [2]Univ Lyon, INSA Lyon, CNRS, MATEIS, UMR5510, France

The main originality of this work is to investigate the ultrafast phenomena and the subsequent structural modifications triggered by femtosecond laser pulses (< 100 fs). In this context, classical molecular dynamics approach is proposed. The challenge is to capture solid-solid phase transformations in both amorphous and crystal matrices.

ThSYC-48 15:45-16:00

Use of evolutionary neural networks to design robust and scalable flat-optics on flexible substrates.

M. Makarenko, Q. Wang, A. Burguete-Lopez, F. Getman, A. Fratalocchi; PRIMALIGHT, Faculty of Electrical Engineering; Applied Mathematics and Computational Science, King Abdullah Univ. of Science and Technology, Saudi Arabia

One of the current challenges in flat-optics is obtaining designs that can withstand the fabrication errors of the manufacturing techniques. We present an inverse design platform that enables the fast design of flexible flat-optics that maintain high performance under deformations. We realize flexible polarizers that maintain a polarization efficiency of 80% over 200nm bandwidths under large mechanical deformations.

ThSYC-49 16:00-16:30

The highly disordered anisotropic media approach to diagnose cancer *(Invited paper)*

T. Gric[1,2,3], E.U. Rafailov[2]; [1]Department of Electronic Systems, Vilnius Gediminas Technical Univ., Lithuania; [2]Aston Inst. of Photonic Technologies, Aston Univ. UK; [3]Semiconductor Physics Inst., Center for Physical Sciences and Technology, Vilnius, Lithuania

We treat biological tissues as the highly disordered anisotropic media by utilizing effective medium approximation. The former allows to account for the system response analytically with no needs of human intervention aiming to detect cancer.

Section D. Photodynamic processes in biology and medicine

Photodynamic processes in biology and medicine IV

Location: Petrov Vodkin 3 Room, floor 2. 09:00-11:00

ThSYD-15 09:00-09:30

Localized and enhanced photodynamic processes through microsphere-assisted microscopy *(Invited paper*

I.S. Ruzankina[1,2], A. Mermoul[1,2], G. Ferrini[1]; [1]1st Interdisciplinary Lab. for Advanced Materials Physics (I-LAMP) and Dept. of Mathematics and Physics, Univ. Cattolica del Sacro Cuore, Italy; [2]Dept. of Chemistry, KU Leuven, Belgium

The principal aim of this work is to give a perspective on the use of a single dielectric microsphere to control light focusing and collection from a substrate, also operating with short laser pulses. The possible advantages in the selective enhancement of surface photodynamic and thermo-mechanical processes on various kinds of substrates are discussed.

ThSYD-16 09:30-10:00

Photodynamic inactivation of influenza virus in biological fluid by fullerene *(Invited paper)*

V.V. Zarubaev[1], I.M. Belousova[2], T.D. Muraviova[2], T.K. Krisko[2], A.M. Starodubtsev[2]; [1]St. Petersburg Pasteur Inst.; [2]Vavilov State Optical Inst., Russia

The purpose of the study was to assess light-mediated virus inactivating properties of fullerene and its effect on the intactness of biological fluids. It was shown that light irradiation in presence of fullerene and oxygen results in complete inactivation of influenza virus in albumin solution.

ThSYD-17 10:00-10:30

Nanostructured and molecular ROS generators for Photo- and Sonodynamic Therapy *(Invited paper)*

A. Dadadzhanova[1], E. Kolesova[1], V. Maslov[1], J. Kost[2], A. Orlova[1]; [1]ITMO Univ., Russia; [2]Ben-Gurion Univ. of the Negev, Israel

Sonodynamic therapy can dramatically enhance the efficiency of non-invasive tumour treatment due to multiple mechanisms initiating cell apoptosis or necrosis under ultrasound action combined with molecule and nanostructured sonosensitizers. Recently, we have demonstrated for the first time the sonodynamic effect of low-intensity 20 kHz ultrasound combined with chlorin e6 on melanoma cells.

This research was supported by RFBR Grant(s) # This work was supported by the Ministry of Science and Higher Education of the Russian Federation, GOSZADANIE No. 2019-1080

ThSYD-18 10:30-10:45

Cell death pathways studied in HMC-1 line after photodynamic treatment with chlorin e6 derivate

D.R. Faizullina[1], T.G. Grishacheva[1], A.S. Trulioff[2], I.V. Kudryavtsev[2], S.V. Shmakov[3], N.N. Petrishchev[1]; [1]Scientific and Educational Inst. of Biomedicine, Pavlov First St. Petersburg State Medical Univ.; [2]Department of Immunology, Inst. of Experimental Medicine; [3]Lab. of Nanobiotechnologies, Alferov Univ., Russia

The cell death mode has been studied in HMC-1 line with flow cytometry after treatment with chlorin e6 derivate Radachlorin used as a photosensitizer. Confocal laser scanning microscopy has been applied to investigate Radachlorin accumulation and distribution. We observed the significant irradiation-dose-dependent difference in apoptosis/necrosis between photodynamic treated HMC-1 line cells and control.

ThSYD-19 10:45-11:00

Photodynamic processes on the surface of copper and copper alloys, causing air sterilization

I.M. Belousova[1], V.M. Kiselev[1], I.V. Bagrov[1], T.D. Murav'eva[1], A.M. Starodubtsev[1], T.K. Krisko[1], O.S. Zhitenev[1], V.V. Zarubaev[2], A.A. Stro[3], I.M. Kislyakov[4]; [1]Vavilov State Optical Inst., Russia; [2]St. Petersburg Research Inst. of Epidemiology and Microbiology named after V.I. Pasteur, Russia; [3]Scientific Research Inst. of Influenza named after A.A. Smorodintsev, Russia; [4]Shanghai Inst. of Optics and Fine Mechanics, China

The developed photodynamic method based on a microporous photocatalytic element made of copper or copper alloy made it possible to completely inactivate influenza viruses in a closed air space and turned out to be promising for the development of equipment for disinfecting and sterilizing air from viruses (influenza, COVID-19 etc.) in enclosed spaces, including medical facilities.

– Break –

Photodynamic processes in biology and medicine V

Location: Petrov Vodkin 3 Room, floor 2. 11:30-13:00

ThSYD-20 11:30-12:00

Colloidal stability and oxidation of shungite carbon nanoparticles in aqueous dispersion mediated by fatty acid *(Invited paper)*

N.N. Rozhkova[1], A.S. Goryunov[2], A.G. Borisova[2], A.A. Kovalchuk[1], S.S. Rozhkov[1]; [1]Inst. of Geology KarRC RAS; [2]Inst. of Biology KarRC RAS, Russia

We studied the interaction of shungite carbon (ShC) nanoparticles and biomolecules using linoleic acid (LA) as an example. The mechanism of interaction of LA with defect-free graphene fragments of ShC is mainly of a hydrophobic nature. Polar sites of nanoparticles can be screened by LA molecules. The results are important for understanding redox effects of ShC on serum albumin.

ThSYD-21 12:00-12:30

Analysis of cells' response to photodynamic treatment with Radachlorin and PpIX by holographic techniques *(Invited paper)*

I.V. Semenova; Ioffe Inst., Russia

An approach is developed for investigation of cellular response to photodynamic treatment by means of digital holographic microscopy and tomography. It allows for noninvasive monitoring of living cell cultures over long time and provides quantitative data on a set of major morphological and optical parameters of cells and their dynamics over time.

ThSYD-22 12:30-13:00

Photoactive Nanomaterials for water remediation and drug delivery *(Invited paper)*

J.M. Nunzi[1,2], S. Atkins[3], A. Chueh[2], T. Barwell[3], L. Seroude[3], A. Laghzizil[4]; [1]Department of Physics, Engineering Physics & Astronomy, Queen's Univ., Kingston K7L3N6; [2]Department of Chemistry, Queen's Univ., Kingston K7L3N6; [3]Department of Biology, Queen's Univ., Kingston, ON, K7L-3N6, Canada; [4]Applied Chemistry of Materials Lab., Mohammed V Univ., Faculty of Sciences, Morocco

Photoactive nanomaterials are investigated for environment protection and sustainability. Azo-benzene polymers self-organize under light into self-structured surface relief gratings. We use them for light triggered drug delivery, which may reduce the damage caused by excess drug released into to the environment. The damage to fresh waters can also be remediated using our newly developed photocatalytic nature-sourced nanomaterials.

This research was supported by RFBR Grant(s) # Natural Sciences and Engineering Research Council of Canada (RGPIN-2020-07016)

ThSYD-23 13:00-13:15

Classification of cell states and lines by machine learning algorithms based on holographic data

A.A. Zhikhoreva[1], A.V. Belashov[1], T.N. Belyaeva[2], A.V. Salova[2], E.S. Kornilova[2], I.V. Semenova[1], O.S. Vasyutinskii[1]; [1]Ioffe Inst.; [2]Inst. of Cytology RAS, Russia

We report the development and validation of machine learning classification algorithms aimed at determination of cell lines and states. Three types of classifiers were used to analyze cellular parameters obtained by digital holographic microscopy. The highest classification accuracy was achieved with the support vector machine learning algorithm. The classification accuracy over 90% was demonstrated.

ThSYD-24 13:15-13:30

Laser osteoperforation in the treatment of the distal tibia osteomyelitis

A.V. Lychagin[1], S.V. Ivannikov[1], N.A. Nabatchikov[1,2], O.D. Podkosov[2]; [1]Sechenov Univ.; [2]Botkin Hospital, Russia

Currently, the treatment of osteomyelitis of the distal tibia remains a hot topic for discussion. Nowadays, the search for an optimal treatment method is relevant. The traditional method involves radical segmental bone resection to the level of healthy tissue, which in turn leads to bone defect, which significantly increases treatment and rehabilitation time.

– Lunch Break –

Photodynamic processes in biology and medicine VI

Location: Petrov Vodkin 3 Room, floor 2. 15:00-16:45

ThSYD-25 15:00-15:30

Lasers in ophthalmology *(Invited paper)*

YU.N. Yusef, D.V. Petrachkov, E.N. Korobov, L. Alharki; Dept. Innovation Vitreoretinal Technology, Research Inst. of Eye Diseases, Russia

Ophthalmology is one of the first areas of medicine to instantly recognize the potential of lasers. There are great prospects for the use of lasers as a "laser scalpel" for the removal of the vitreous body, precision removal of moorings from the surface of the retina, epiretinal fibrosis, and precision retinotomy.

ThSYD-26 15:30-15:45

Experimental characterization of $BaTiO_3$ microspheres to enhance photodynamic and thermal processes in biology and medicine

I.S. Ruzankina[1,2], G. Ferrini[1]; [1]Interdisciplinary Lab. for Advanced Materials Physics (I-LAMP) and Department of Mathematics and Physics, Univ. Cattolica del Sacro Cuore, Italy; [2]Department of Chemistry, KU Leuven, Belgium

This research is aimed at the experimental characterization of large-size BaTiO3 microspheres as intensity enhancers for photodynamic processes on bio-objects with CW light. As a probe we use the surface Raman signal to quantitatively quantify the intensity enhancement and light gathering capability of the dielectric microspheres. The performances of the microspheres lenses are compared to those of standard microscopy objectives.

This research was supported by RFBR Grant(s) # MIUR - PRIN 2017 (aSTAR project (2017RKWTMY 003)). This work has been partially supported by the Universita` Cattolica del Sacro Cuore through D.3.1 and D.2.2 grants.

ThSYD-27 15:45-16:00

Red and near-infrared photobiomodulation of MSCs metabolism in 3D conditions

P.Y. Bikmulina[1], N.V. Kosheleva[1,2,3,4], A.I. Shpichka[1,2], V.I. Yusupov[5], Yu.A. Rochev[2,6], P.S. Timashev[1,2,7,8]; [1]World-Class Research Center "Digital Biodesign and Personalized Healthcare", Sechenov Univ.; [2]Inst. for Regenerative Medicine, Sechenov Univ.; [3]Lab. of Clinical Smart Nanotechnology, Sechenov Univ.; [4]FSBSI Inst. of General Pathology and Pathophysiology; [5]Inst. of Photon Technologies of FSRC "Crystallography and Photonics" RAS, Russia; [6]National Univ. of Ireland, Ireland; [7]Department of Polymers and Composites, Semenov Federal Research Center for Chemical Physics RAS, Russia; [8]Chemistry Department, Lomonosov Moscow State Univ., Russia

The developing field of tissue engineering and 3D-bioprinting requires novel techniques for the stimulation of cell survival, proliferation and differentiation. Photobiomodulation is a perfect candidate here since it is non-invasive, can permeate highly hydrated structures, and was shown to regulate cell physiology in stress conditions. We analyzed the effects of photobiomodulation for the mesenchymal stromal cells in 3D constructs.

This research was supported by RFBR Grant(s) # The study was supported by the Russian Foundation for Basic Research (№ 20-515-56005, hydrogels) and Russian Science Foundation (№18-15-00401)

ThSYD-28 16:00-16:15

Spectral and kinetic characteristics of promising agents for combined PDT based on YF_3-CeF_3:Tb^{3+} nanoparticles conjugated with Radachlorin by means of polyvinylpyrrolidone

A.I. Khusainova, N.I. Shamsutdinov, P.V. Zelenikhin, E.V. Lukinova, S.L. Korableva, A.S. Nizamutdinov; Inst. of Physics, Kazan Federal Univ., Russia

In this work, we studied the spectral and kinetic characteristics of YF_3-CeF3:Tb3+ (15 %) nanoparticles with Radachlorin and polyvinylpyrrolidone. Strong energy transfer from nanoparticles to Radachlrine is shown. To assess the toxicity, we conducted an MTT tests for A549 cells in the presence of nanoparticles with the Radachlorin.

ThSYD-29 16:15-16:30

Age-dependent changes in the functional activity of astrocytes

E.V. Mitroshina[1], T.A. Mishchenko[1], M.I. Krivonosov[2], M.V. Vedunova[1]; [1]Inst. of Biology and Biomedicine, Lobachevsky State Univ. Nizhny Novgorod; [2]Lab Syst Med Hlth Aging, Lobachevsky State Univ. Nizhny Novgorod, Russia

Age-dependent changes in the functional reorganization of neural networks and astrocytes in aging modeling, expressed in a decrease in the number of connections between cells, were shown.

This research was supported by RFBR Grant(s) # This work was supported by the Center of Excellence «Center of Photonics» funded by the Ministry of Science and Higher Education of the Russian Federation, contract No. 075-15-2020-927

ThSYD-30 16:30-16:45

Advanced NADH/FAD/FMN-FLIM and oxygen PLIM

A. Rueck, N. Naskar, K. Reess, S. Kalinina; Univ. Ulm, Core Facility Optical Microscopy N24, Germany

Fluorescence lifetime imaging (FLIM) of metabolic coenzymes, as NAD(P)H and FAD, is now widely accepted to be one of the most important imaging methods for cell metabolism; different algorithms are investigated to get reproducible results.

Section B. Laser interaction with cells and tissues: clinical imaging and spectroscopy

ThSYB-p01 15:00-18:30

Investigation of a combined absorption-fluorescence-Raman spectroscopy approach to brain tumor tissue differentiation ex vivo

I.D. Romanishkin[1], T.A. Savelieva[1,2], I.Yu. Poletaeva[3], S.V. Shugai[3], S.A. Goryaynov[3], D.A. Golbin[3], V.B. Loschenov[1,2]; [1]Prokhorov General Physics Inst. RAS; [2]National Research Nuclear Univ. MEPhI; [3]Burdenko National Medical Research Center of Neurosurgery, Russia

In this work, we used a combined absorption-fluorescence-Raman approach to the optical investigation of brain tissue. The proposed approach allowed taking into account the blood fill, oxygenation, accumulation of fluorescent biomarker, and Raman signal to estimate a degree of malignancy of the tissue.

ThSYB-p02 15:00-18:30

Comparative analysis of TIE imaging and off-axis digital holography for evaluation of cell parameters

A.A. Zhikhoreva[1], A.V. Belashov[1], T.N. Belyaeva[2], A.V. Salova[2], E.S. Kornilova[2], I.V. Semenova[1], O.S.Vasyutinskii[1]; [1]Ioffe Inst.; [2]Inst. of Cytology RAS, Russia

We report comparative analysis of phase imaging of cell specimens performed using transport of intensity equation (TIE) and off-axis digital holography. Optical and morphological parameters of fixed HeLa cells were evaluated from the phase images obtained by these techniques. The accuracy of three TIE solvers under different experimental conditions was estimated by comparison with the data, obtained by holographic microscopy.

ThSYB-p03 15:00-18:30

Combined Monte Carlo and k-Wave simulations of optoacoustic images of blood vessels in tissue-like medium

V.V. Perekatova, A.V. Khilov, D.A. Kurakina, A.A. Getmanskaya, M.Yu. Kirillin; Inst. of Applied Physics RAS, Russia

We simulated set of OA images at dual wavelengths for different vasculature parameters by applying combined Monte Carlo and k-Wave simulations. The obtained set of synthetic OA data revealed high potential as a training set for machine learning technique for blood oxygen saturation mapping based on spectral OA data.

ThSYB-p04 15:00-18:30

Determination of biotissue photodegradation kinetic parameters based on electrical impedance

K.V. Sovin[1], N.V. Kovalenko[1,2], O.A. Ryabushkin[1,2]; [1]Moscow Inst. of Physics and Technology; [2]Fryazino branch of Kotelnikov Inst. of Radio-Engineering and Electronics, Russia

A method for determination of degradation kinetic parameters in laser damage process of biological tissues is proposed. By scattering of laser radiation, homogeneous heating of the sample was created. In this process the temperature dependence of its low-frequency electrical impedance (~1 kHz) was measuring. By processing these kinetics with Arrhenius formulations important parameters of the heating kinetics were obtained.

ThSYB-p05 15:00-18:30

Application and optimization of LCOS spatial light modulator for estimation of optical and physiological parameters of living cells

A.V. Belashov, A.A. Zhikhoreva, I.V. Semenova, O.S. Vasyutinskii; Ioffe Inst. Russia

We report implementation of quantitative phase imaging for evaluation of optical and morphological parameters of living cells using phase-only spatial light modulator. The method accuracy was evaluated under different experimental conditions by comparison with the data, obtained by holographic tomography.

ThSYB-p05 15:00-18:30

The effect of laser radiation on the BSA conformation

E.A. Molkova, V.I. Krasovskii, V.I. Pystovoy; Prokhorov General Physics Inst. RAS, Russia

The effect of laser radiation on the buffer solution of bovine serum albumin (BSA) was studied. In this work, we irradiate aqueous solutions of BSA with a 532 nm laser source with pulse energy 70 μJ and pulse duration 10ns. It has been shown there is a change in the secondary structure of the protein.

ThSYB-p06 15:00-18:30

Homogeneous heating of biological tissues with laser radiation

V.S. Anpilov[1], N.V. Kovalenko[2,3], O.A. Ryabushkin[2,3]; [1]Moscow Engineering Physics Inst.; [2]Moscow Inst. of Physics and Technology; [3]Fryazino branch of Kotelnikov Inst. of Radio-Engineering and Electronics, Russia

In this paper, the heating of biological tissues uniformly illuminated by optical radiation with a penetration depth of the order of the sample size is investigated. The considered method makes it possible to achieve rapid homogeneous heating of the sample volume, as opposed to heating water or air.

ThSYB-p07 15:00-18:30

Frequency-domain lifetime analysis of singlet oxygen luminescence

V.V. Dremin[1,2], E.U. Rafailov[1]; [1]Aston Univ, UK; [2]Orel State Univ, Russia

A system has been developed to measure the intensity and lifetime of singlet oxygen luminescence in the frequency-domain. Test measurements showed the possibility of high-quality analysis of the singlet oxygen concentration in the medium.

ThSYB-p08 15:00-18:30

Light absorption in human tissues for blood flow analysis and diagnostics

E. Nepomnyaschaya, E. Savchenko, I. Kolokolnikov; Peter the Great St. Petersburg Polytechnic Univ., Russia

We suggest to use light absorption methods to realize non-invasive blood flow analysis and diagnostics of liver function based on it. In this research we describe principles of absorbance spectroscopy and results on spectroscopic measurements in medicine.

This research was supported by RFBR Grant(s) # This research was funded by RSF, grant number №21-72-00035. https://rscf.ru/en/project/21-72-00035/.

ThSYB-p09 15:00-18:30

Study of the optical properties of biological tissue depending on temperature

E.A. Gamayunova, V.I. Kochubey; Saratov State Univ., Russia

Measurement of the internal biological tissue temperature is an important parameter for monitoring physiological processes. In our work, we present the results of a study of the optical properties dependence of biological tissues in vitro on temperature changes.

ThSYB-p10 15:00-18:30

Using disk-detector geometry for calculation of optical path length by Monte Carlo simulation of light transport in turbid media

A.P. Tarasov[1,2]; Vladimirsky Moscow Regional Research and Clinical Inst. "MONIKI"; [2]Federal Scientific Research Centre "Crystallography and Photonics" of RAS, Russia

Disk-detector geometry, replacing a conventional square detector with a disk detector, is a technique designed to accelerate Monte Carlo simulations of light transport in turbid media. In this study, we test applicability of using this technique to calculate optical pathlength. It is shown that such calculations are correct, and their accuracy is higher than in the case of square detectors.

Section D. Photodynamic processes in biology and medicine

ThSYD-p01 15:00-18:30

Anisotropic relaxation of Radachlorin photosensitizer in aqueous solution under two-photon excitation

I.A. Gorbunova, M.E. Sasin, A.A. Zhikhoreva, A.V. Belashov, I.V. Semenova, O.S. Vasyutinskii, Ioffe Inst., Russia

The fluorescence decay of Radachlorin photosensitizer in aqueous solution under two-photon excitation by femtosecond laser pulses at 810 nm has been studied. The major fluorescence parameters of the molecule including fluorescence decay time, rotational diffusion time and anisotropy have been determined.

ThSYD-p02 15:00-18:30

Conformational relaxation and molecular oxygen rebinding in alpha and beta subunits within valency hybrids of human hemoglobin

S.V. Lepeshkevich[1], I.V. Sazanovich[2], M.V. Parkhats[1], S.N. Gilevich[3], B.M. Dzhagarov[1]; [1]Stepanov Inst. of Physics NASB, Belarus; [2]Central Laser Facility, Research Complex at Harwell, STFC Rutherford Appleton Lab., UK; [3]Inst. of Bioorganic Chemistry NASB, Belarus

Picosecond to millisecond laser time-resolved transient absorption spectroscopy was used to study O2 rebinding and conformational relaxation following O2 photodissociation in the alpha and beta subunits within human hemoglobin. Oxy-cyanomet valency hybrids were used as models for oxygenated hemoglobin. Significant functional non-equivalence of the alpha and beta subunits in both the geminate O2 rebinding and concomitant structural relaxation was revealed.

ThSYD-p03 15:00-18:30

Efficacy of photoactivated medicinal plant extracts

A.V. Mikulich[1], A.I. Tretyakova[1], R.K. Nahorny[1], N.V. Dudchik[2], O.A. Emeliyanova[2], A.I. Zhabrouskaya[2], A.N. Sobchuk[1], T.S. Ananich[1], L.G. Plavskaya[1], O.N. Dudinova[1], I.A. Leusenka[1], S.V. Yakimchuk[1], V.Yu. Plavskii[1], T.Q. Tien[3], Q.C. Tong[3], Th.-Ph. Nguyen[4]; [1]Inst. of Physics NASB; [2]Scientific Practical Centre of Hygiene, Belarus; [3]IMS, VAST, Vietnam; [4]SEP, Hanoi Univ. of Science and Technology, Vietnam

We present study on spectral-luminescent characteristics medicinal plant extracts (extract from a mixture of flowers of Matricaria chamomilla and Calendula officinalis, Achilléa millefólium herb (commercial name "Rotatit"); preparation from Hypéricum perforátum; preparation from Eucalypti viminalis folia), their ability to generate of singlet oxygen upon photoexcitation and photodynamic effects of extracts on mammalian cell culture and different taxonomic groups of bacteria.

ThSYD-p04 15:00-18:30

Increasing the chlorine E6 concentration in tumor tissues by preliminary laser irradiation

K.T. Efendiev[1,2], P.M. Alekseeva[1,2], A.A. Shiryaev[3], V.B. Loschenov[1,2]; [1]Prokhorov General Physics Inst. RAS; [2]Department of Laser Micro-, Nano-, and Biotechnology, Inst. of Engineering Physics for Biomedicine, National Research Nuclear Univ. "MEPhI"; [3]Univ. Clinical Hospital no.1, Levshin Inst. of Cluster Oncology, Sechenov First Moscow State Medical Univ., Ministry of Health of the Russian Federation, Russia

This paper presents a method for increasing the chlorin e6 concentration in tumors. Different dynamics in fluorescence indices were observed in tumors and their border. After preliminary irradiation of tissues, an increase in the fluorescence indices of tumors was observed in 70% of cases. In 60% of cases, a decrease in photosensitizer fluorescence was observed in the tumor border.

ThSYD-p05 15:00-18:30

Oxidation of biopterins under exposure to UV light from LED

D.A. Makarova[1], A.S. Nizamutdinov[1], E.I. Madirov[1], E.V. Lukinova[1], Y.L. Vechtomova[2], A.A. Buglak[3], T.A. Telegina[2]; [1]Inst. of Physics, Kazan Federal Univ.; [2]Bach Inst. of Biochemistry, Research Center of Biotechnology RAS; [3]St. Petersburg State Univ., Russia

Here we report the study of processes of tetrahydrobiopterin oxidation upon irradiation with UV light form LED source. We have detected the dihydropterin dimers formation initiated by UV light.

ThSYD-p06 15:00-18:30

Photobleaching control of chlorin e6 in the cervical tissues by the phototheranostics method

P.M. Alekseeva[1,2], K.T Efendiev[1,2], A.V. Gilyadova[3,4], A.A. Shiryaev[3,4], V.B. Loschenov[1,2]; [1]Prokhorov General Physics Inst. RAS; [2]National Research Nuclear Univ. "MEPhI"; [3]Sechenov First Moscow State Medical Univ., Levshin Inst. of Cluster Oncology, Univ. Clinical Hospital No.1; [4]National Medical Research Center - Treatment and Rehabilitation Center of the Ministry of Health of the Russian Federation, Russia

Photodynamic therapy with intravenous administration of the chlorin e6 shows high efficiency in the treatment of cervical neoplasms with complete eradication of the human papillomavirus. This method can reduce deaths from cervical cancer and preserve fertility in patients. Spectral and video fluorescence diagnostics allows intraoperatively assessing the degree of photosensitizer accumulation and photobleaching and visualizing the boundaries of neoplasms.

ThSYD-p07 15:00-18:30

Photonics of oxygen-saturated microemulsions based on extracts of spruce cone from picea abies for photodynamic therapy

A.V. Tcibulnikova[1], E.S. Zemlyakova[1,2], V.A. Slezhkin[1,2], I.G. Samusev[1], V.V. Bryukhanov[1], D.A. Artamonov[1]; [1]Immanuel Kant Baltic Federal Univ., Russia; [2]Kaliningrad State Technical Univ., Russia.

A spectral study of the microemulsion solution based on Spruce Cone (Picea abies) extract containing of polyphenols and phenolic acids was carried out in the visible and IR spectral regions. The microemulsion solution has an absorption spectrum and luminescence. Based on the time-resolved spectroscopy, the possibility of reactive oxygen species generation in the microemulsion with the extract was proved.

ThSYD-p08 15:00-18:30

Singlet oxygen generation by a pH-responsive photosensitizer based on porphyrin and hydroxyapatite nanoparticles

M.V. Parkhats[1], S.V. Lepeshkevich[1], A.V. Petkevich[2], A.A. Rogachev[2], S.N. Terekhov[1], B.M. Dzhagarov[1]; [1]Stepanov Inst. of Physics NASB; [2]Inst. of Chemistry of New Materials NASB, Belarus

The efficiency of photosensitized singlet oxygen generation was found to be decreased up to 10 times upon the porphyrin-hydroxyapatite complex formation at pH 7.6. The drop of pH to 5.0 leads to increasing in singlet oxygen luminescence. The obtained data indicate that at low pH value the porphyrin is released from the complex and its photodynamic activity is restored.

ThSYD-p09 15:00-18:30

Study of microcirculation parameters using wearable Doppler monitors in pregnant patients with type 1 diabetes mellitus

E. Zharkikh[1], Yu. Loktionova[1], A. Zherebtsova[1], M. Tsyganova[2], A. Tiselko[3], E. Zherebtsov[1,4]; [1]Research and Development Center of Biomedical Photonics, Turgenev Orel State Univ.; [2]St. Petersburg State Univ.; [3]The Research Inst. of Obstetrics, Gynecology and Reproductology named after D.O. Ott, Russia; [4]Optoelectronics and Measurement Techniques, Univ. of Oulu, Finland

The study is devoted to investigating the parameters of blood microcirculation and oxidative metabolism in pregnant women with diabetes mellitus using the new portable devices for monitoring blood microcirculation and metabolic processes. The peculiarities of regulation of microcirculation and tissue metabolic parameters in 1st trimester of pregnancy were investigated in women with diabetes mellitus.

This research was supported by RFBR Grant(s) # The study was supported by the Russian Foundation for Basic Research (research project No. 20-08-01153)

ThSYD-p10 15:00-18:30

Using genetically engineered calcium indicator to identify the role of astrocytes in the development of Alzheimer's disease

M.S. Gavrish, E.V. Mitroshina, M.O. Savyuk, M.V. Vedunova; Inst. of Biology and Biomedicine, Lobachevsky State Univ. of Nizhny Novgorod, Russia

A new calcium sensor has been developed to determine the functional activity of astrocytes in Alzheimer's disease an in vitro modeling

This research was supported by RFBR Grant(s) # This work was supported by the Center of Excellence «Center of Photonics» funded by the Ministry of Science and Higher Education of the Russian Federation, contract No. 075-15-2020-927