

**Sample topics for the summer-2020 scientific practice of students within ITMO University,
RUSSIA, SAINT-PETERSBURG**

INTERNATIONAL INSTITUTE "PHOTONICS AND OPTICAL INFORMATION TECHNOLOGY"

Femtosecond optics and femtotechnologies

- Numerical and experimental study of the spread of high-intensity femtosecond pulses in optical media.
- Practical application of the experimental data communication systems and other applications.
- Spectral supercontinuum generation in photonic crystal fibers and study the dispersion of such fibers.
- Terahertz application in non-destructive quality control and diagnostics

Development of new methods to analyse food quality by THz radiation. Development of new methods to visualise hidden objects. Development of new THz diagnostic methods in art restoration.

- Nonlinear optics of femtosecond pulses
- Nonlinear THz optics

Investigation of peculiarities of self-phase modulation and spectrum superbroadening of single-cycle paraxial optical waves in homogeneous isotropic dielectric media with instantaneous cubic nonlinearity

- Photon echo experimental research in nanodimension films

Experiments were performed in two-photon excitation of the femtosecond signal of the primary photon echo. We registered the primary photon echo in the semiconductor layer of zinc oxide with a nanodimension thickness of (100, 600, and 800 nm). This phenomenon was displayed on the quantum transition, which corresponded to 400 nm under a room temperature. Photon echo was observed on the free exciton. Registration of the partially weakened energy echo signal, by the scattering on the optical phonons was carried out at a wavelength of 800-840 nm. Nano-optical effect of the account reducing of time of the irreversible transverse relaxation of the environment T₂ with the decreasing of the layer thickness was detected.

- Stimulated Raman scattering

Numerical and experimental research of stimulated Raman scattering in compressed gases and crystals. Application of SRS for spectral and time optical gating of signals.

- THz imaging and holography

New methods of terahertz imaging and its scientific and technical applications

Terahertz Biomedicine

Research Directions:

- Terahertz spectroscopy
- Terahertz imaging
- Terahertz tomography
- Development of methods for medical diagnostics:

The main area of focus – diagnostics of socially important human diseases using ultrashort pulse optical methods (femtosecond lasers and terahertz radiation).

The tasks for the group comprise achievement of world class scientific and innovative results, research for development of new techniques and methods in the field of ultrashort pulse optics for non-invasive monitoring

and early diagnostics of structural and functional changes in human hard and soft tissues, as well as in cell cultures, testing of physiologically active biomolecules for presence of endogenous risk factors for disease development, pathological processes in a broad spectrum of tissues (epithelial tissues, intravascular disorders and bone tissues), and for evaluation of therapy effectiveness.

- Development of THz metamaterials devices
- Transformation optics
- Materials and technology of holography

INTERNATIONAL SCIENTIFIC AND RESEARCH INSTITUTE OF BIOENGINEERING

The main research topics are

- The creation of polymer-based materials for biomedical application is one of the main topics in modern science, which is devoted to solve problems with human health and national safety. One of the key topics is focused on working out of new materials for medical application, intended for contacting between nature media with living organism, which is quite necessary for regenerative medicine. The more interesting point is directed on creation of biocompatible, resorbable materials for development of new directions in medicine - cellular and fabric engineering, creation of artificial implants etc.
- Tissue Engineering;
- Simulation of macromolecules and biosystems;
- Biodestructed and resorbable materials;
- Drug delivery;
- Cellular engineering;
- Creation of materials for sanitary-and-hygienic application;
- Nanomedicine;
- Biosensors;
- Biotechnology;
- BioChemical Engineering;
- Creation of artificial organ

ADAPTIVE AND NONLINEAR CONTROL SYSTEMS LAB

- Development of new methods of adaptive control of linear and nonlinear dynamical systems under external disturbances and unrecorded dynamics. Formally, the study can be divided into three main sections :
 - analysis of the problem of managing complex dynamic systems
 - development of methods of nonlinear and adaptive control of complex systems ,
 - experimental research and testing methods obtained
- Synthesis methods of investigation and control of oscillatory processes in nonlinear dynamical systems
- Adaptive compensation of sinusoidal perturbations in mechatronic systems
- Biotechnology research development and management system robotic systems
- Identification of the parameters of the harmonic signal under external perturbations
- Development of control algorithms for mechatronic and robotic systems under conditions of incomplete information about the parameters of the object and operational environment
- Trajectory control of robotic systems under constraints and uncertainties

- Qualitative methodology for applying sustainability in the design of digital systems with concentrated and distributed parameters
- Experimental studies of nonlinear phenomena of hysteresis and intermittency in the dynamics of pulsed DC converters
- Experimental studies of zones of uncertainty state pulsed DC converters in the vicinity of the bifurcation point
- Control and evaluation of distributed systems with information constraints
- Nonlinear and adaptive control of dynamic objects with restricted control input