Approved by the decision
of the MIPT Academic Council
dated June 29, 2023
(protocol No. 01/06/2023)

Federal State Autonomous Educational Institution of Higher Education "Moscow Institute of Physics and Technology (National Research University)"

THE MAIN EDUCATIONAL PROGRAM OF HIGHER EDUCATION

Level of higher education
MASTER

Domain of study
03.04.01 APPLIED MATHEMATICS AND PHYSICS

Orientation (specialty)
GENERAL AND APPLIED PHYSICS/ОБЩАЯ И ПРИКЛАДНАЯ ФИЗИКА

Starting year of the educational program
2023 y.

Update of the educational program:
decision of MIPT Academic Council dated May 30, 2024 (protocol No. 01/05/2024)

The main educational program of higher education in the field domain of study 03.04.01 Applied Mathematics and Physics, orientation (specialty) General and Applied Physics/Общая и прикладная физика, implemented at MIPT, is a set of basic characteristics of education (volume, content, planned results), organizational and pedagogical conditions, forms of certification, which is presented as a general characteristic of the educational program, curriculum, academic calendar schedule, work programs of disciplines (modules), training programs, evaluation and methodological materials. The main educational program of higher education has been created on the basis of the educational standard domain of study 03.04.01 Applied Mathematics and Physics, independently developed and approved by MIPT.

1. General characteristics of the educational program

Qualifications awarded to graduate: master.

Form of education: full-time

Education period: 2 years.

The educational program consists of: 120 credits and includes all types of student's classroom and independent work, training, time, allotted for quality control of the mastering of the educational program by the student.

The contact work of students with teachers consists of, at least, 840 hours.

Program implementation language: english.

Using a network form of educational program implementation: yes.

Program goal:

The program is aimed at training highly professional specialists capable of making scientific discoveries at the most advanced frontiers of physics and High-Tech. Students and graduates are eager to study problems of the global scientific agenda in conditions of fierce competition and international integration on the front edge of knowledge of physical laws in the field of biophysics, physics of aging and age-related diseases, physiology and neurobiology, bioinformatics and theoretical biophysics. Graduates continue their research careers either at MIPT or at other leading world universities.

The educational program is implemented in a network form together with the University of Groningen.

2. Characteristics of the professional activity of graduates:

Fields of professional activity and areas of professional activity,

in which graduates, who have mastered the master's program, can carry out professional activities:

01 Science (including scientific research in various fields of fundamental science, technology, and national economy, that use approaches, models and methods of mathematics, physics, chemistry, biology, other natural and socio-economic sciences, as well as modern information technologies);

40 Cross-cutting types of professional activities in industry (in the field of fundamental and applied research, innovation and development, as well as in the development and implementation of new technological processes for the production of promising materials (including biological and those used in medicine), as well as in the monitoring of parameters of the state of complex technical and living systems and environmental conditions, including development and use to solve the tasks).

Graduates can carry out professional activities in other fields of professional activity and (or) areas of professional activity, provided that their level of education and acquired competencies meet the requirements of the employee's qualification.

Types of tasks of professional activity of graduates:

research.

Tasks of professional activity of graduates:

planning and conducting scientific work and analytical research in accordance with the approved direction of research in the subject area of specialization;

planning and independent conduct of observations and measurements, planning, setting up and optimizing experiments in the subject area of research, selection of effective data processing methods and their implementation;

planning and conducting theoretical research, development of new physical and mathematical, including computer, models of the processes and phenomena under study, analysis and synthesis of analytical research data in the subject area;

consolidation of the obtained data, independent formation of conclusions and preparation of scientific and analytical reports, publications and presentations of the results of scientific and analytical research, qualified transfer of the results of scientific and analytical research to related subject areas;

planning and development of new methods and technical means for fundamental research and innovative developments;

planning and development of new algorithms and computer programs for research and applied purposes;

definition of promising directions of scientific research and information sources for analytical search in the subject area chosen for specialization, effective collection and processing of scientific and analytical information using modern programs, tools and methods of computer and information technologies and computational mathematics.

Objects of professional activity of graduates, mastered the program Master's:

models, methods and means of fundamental and applied research and development in the field of mathematics, physics and other natural and social economic sciences according to the training profile in science, engineering, technology, as well as in the areas of knowledge-based industries, management and business;

natural and social phenomena and processes.

3. List of professional standard, corresponding to the professional activities of graduates:

40.011 Research and Development Specialist;

40.008 Specialist in organization and management of research and development work;

01.003 Teacher of supplementary education for children and adults.

Code and name of the professional standard	Generalized labor functions			Labor functions		
	code	name	level of qualification	name	code	level of qualification
40.011 Professional standard "Research and Development Specialist"	B	Conducting research and development in the study of independent topics	6	Leading a group of workers in the study of independent topics	B/03.6	6
				Conducting work on the processing and analysis of scientific and technical information and research results	B/02.6	6
	C	Conducting R&D work on the subject of the organization	6	Implementation of scientific management of research on individual tasks	C/01.6	6
				Management of the results of R&D work	C/02.6	6
	D	Implementation of scientific leadership in the relevant field of knowledge	7	Formation of new areas of R&D work	D/01.7	7
				Coordination of the activities of co-executors involved in the performance of work with other organizations	D/03.7	7
				Defining the scope of application of the results of R&D work	D/04.7	7
40.008 Professional standard "Specialist in organization and management of research and development work"	B	Organization of work on the implementation of R&D work	6	Organization of the implementation of research work on the problems provided for by the thematic plan of the sector (laboratory)	B/01.6	6
				Resource management of the relevant structural unit of the organization	B/02.6	6
				Organization of analysis and optimization of life cycle management processes for R&D work	B/03.6	6

01.003 Professional standard "Teacher of supplementary education for children and adults"	A	Teaching in additional general education programs	6	Organization of students' activities aimed at mastering an additional general educational program	A/01.6	6.1
				Pedagogical control and assessment of the development of an additional general education program	A/04.6	6.1
				Development of software and methodological support for the implementation of an additional general educational program	A/05.6	6.2
	B	Organizational and methodological support for the implementation of additional general educational programs	6	Organization and conduct of market research of additional education services for children and adults	B/01.6	6.3
				Organizational and pedagogical support of the methodological activities of teachers of additional education	B/02.6	6.3
	C	Organizational and pedagogical support for the implementation of additional general education programs	6	Organizational and pedagogical support for the development of social partnership and promotion of additional education services for children and adults	C/02.6	6.3
				Organization of additional education for children and adults in one or more areas of activity	C/03.6	6.3

4. Requirements for the results of mastering the educational program

As a result of mastering the main educational program, the graduate should form universal, general professional and professional competencies.

Universal competencies of graduates and indicators of their achievement:

Code and name of competence	Code and name of the indicator of competence achievement

UC-1 Use a systematic approach to critically analyze a problem,and develop an action plan	UC-1.1 Systematically analyze the problem situation, identify its components and the relations between them UC-1.2 Search for solutions by using available sources UC-1.3 Develop a step-by-step strategy for achieving a goal, foresee the result of each step, evaluate the overall impact on the planned activity and its participants
UC-2 Able to manage the project through all stages of implementation	UC-2.1 Set an objective within a defined scientific problem; formulate the agenda, relevance, significance (scientific, practical, methodological, or other depending on the project type), forecast the expected results and possible areas of their application UC-2.2 Forecast the project outcomes, plan necessary steps to achieve the outcomes, chart the project schedule and monitoring plan UC-2.3 Organize and coordinate the work of project stakeholders, provide the team with necessary resources UC-2.4 Publicly present the project results (or results of its stages) via reports, articles, presentations at scientific conferences, seminars, and similar events
UC-3 Organize and manage a team, and develop the team strategy to achieve the objectives	UC-3.1 Organize and coordinate the work of the project stakeholders and help resolve disputes and conflicts UC-3.2 Consider the interests, specific behavior, and diversity of opinions of team members/colleagues/counterparties UC-3.3 Foresee the results (consequences) of both individual and collective actions UC-3.4 Plan teamwork, distribute tasks to team members, hold discussions of different ideas and opinions
UC-4 Use modern communication tools in the academic and professional fields, including those in a foreign language	UC-4.1 Exchange business information in oral and written forms in Russian and at least one foreign language UC-4.2 Use the acquired skills to write, translate, and edit various academic texts (abstracts, essays, reviews, articles, etc.) UC-4.3 Present the results of academic and professional activities at various academic events, including international conferences UC-4.4 Use modern ICT tools for academic and professional collaboration
UC-5.1 Analyze and consider cultural diversity in intercultural interactions	UC-5.1 Identify specific philosophical and scientific traditions in major world cultures UC-5.2 Define the theoretical and practical significance of cultural and linguistic factors within various interrelated philosophical and scientific traditions
UC-6 Determine priorities and ways to improve performance through self-assessment	UC-6.1 Achieve personal growth and professional development, determine priorities and ways to improve performance UC-6.2 Evaluate performance results in correlation with the set objectives and applied methods

General professional competencies of graduates and indicators of their achievement:

Code and name of competence	Code and name of the indicator of competence achievement
Gen.Pro.C-1 Gain fundamental scientific knowledge in the field of physical and mathematical sciences	Gen.Pro.C-1.1 Apply fundamental scientific knowledge in the field of physical and mathematical sciences Gen.Pro.C-1.2 Consolidate and critically assess professional experience and research findings Gen.Pro.C-1.3 Understand interdisciplinary relations in applied mathematics and computer science and apply them in professional settings
Gen.Pro.C-2 Acquire an understanding of current scientific and technological challenges in professional settings, and scientifically formulate professional objectives	Gen.Pro.C-2.1 Assess the current state of mathematical research within professional settings Gen.Pro.C-2.2 Assess the relevance and practical importance of research in professional settings Gen.Pro.C-2.3 Understand professional terminology used in modern scientific and technical literature and present scientific results in oral and written form within professional communication

Gen.Pro.C-3 Select and/or develop approaches to professional problem-solving with consideration to the limitations and specifics of different solution methods	Gen.Pro.C-3.1 Analyze problems, plan research strategy to achieve solution(s), propose, and combine solution approaches Gen.Pro.C-3.2 Employ research methods to solve new problems and apply knowledge from various fields of science (technology) Gen.Pro.C-3.3 Gain knowledge of analytical and computational methods of problem-solving, understand the limitations of the implementation of the obtained solutions in practice
Gen.Pro.C-4 Successfully perform a task, analyze the results, and present conclusions, apply knowledge and skills in the field of physical and mathematical sciences and ICTs	Gen.Pro.C-4.1 Apply ICT knowledge and skills to find and study scientific literature and use software products Gen.Pro.C-4.2 Apply knowledge in the field of physical and mathematical sciences to solve problems, make conclusions, and evaluate the obtained results Gen.Pro.C-4.3 Justify the chosen method of scientific research
Gen.Pro.C-5 Undertake professional training, achieve professional growth, and become a team leader in a professional sphere, tolerant of social, ethnic, religious, and cultural differences	Gen.Pro.C-5.1 Tolerate social, ethnic, religious, and cultural differences in teamwork Gen.Pro.C-5.2 Manage a small professional team Gen.Pro.C-5.3 Apply new knowledge and achieve personal and professional growth

Professional competencies of graduates and indicators of their achievement:

Code and name of competence	Code and name of the indicator of competence achievement	Basis (professional standarts, analysis of other requirements for graduates)
type of professional activity tasks: research		
Pro.C-1 Assign, formalize, and solve tasks, develop and research mathematical models of the studied phenomena and processes, systematically analyze scientific problems and obtain new scientific results	Pro.C-1.1 Locate, analyze, and summarize information on current research findings within the subject area Pro.C-1.2 Make hypotheses, build mathematical models of the studied phenomena and processes, evaluate the quality of the developed model Pro.C-1.3 Apply theoretical and/or experimental research methods to a specific scientific task and interpret the obtained results	analysis of employers' requirements for graduates
Pro.C-2 Organize and conduct scientific research and testing independently or as a member (leader) of a small research team	Pro.C-2.1 Plan and conduct scientific research independently or as part of a research team Pro.C-2.2 Test research results through scientific publications and participation in conferences	analysis of employers' requirements for graduates
Pro.C-3 Use research and testing equipment (devices and installations, specialized software) in a selected subject field	Pro.C-3.1 Understand the operating principles of the equipment and specialized software Pro.C-3.2 Conduct an experiment (simulation) using research equipment (software) Pro.C-3.3 Evaluate the accuracy of the experimental (numerical) results	analysis of employers' requirements for graduates

5. Curriculum

The curriculum (Appendix 1) determines the list, labor input, sequence and distribution by periods of study of academic disciplines (modules), trainings, other types of educational activities, forms of intermediate and final certification of students. The labor input of the educational program is set in credit units.

The volume of compulsory part, excluding the volume of the state final attestation, is 75,83 persents percent of the total volume of the program.

The matrix of compliance of competencies with the disciplines of the curriculum is given in Appendix 2.

6. Academic calendar schedule

Academic calendar schedule (Appendix 3) shows the distribution of types of educational activities, periods of attestation of students and vacations by year of study (courses) and within each academic year. The academic calendar schedule of the educational program of higher education includes 96 5/6 weeks, of which there are 58 4/6 weeks of theoretical and practical training, 19 5/6 weeks of the credit-examination period, 3 4/6weeks of the state final certification and 14 4/6 weeks of holidays.

7. Work programs of disciplines (modules)

Work programs of disciplines (modules), including evaluation materials for ongoing monitoring of progress and intermediate certification, are presented in Appendix 4.

8. Practice programs

The educational program provides for the following trainings:

Personal Research Project/Научно-исследовательская работа: practical training.

Work programs of trainings, including assessment materials for ongoing monitoring of progress and intermediate certification are presented in Appendix 5.

9. Program of the state final certification

As part of the state final certification, the following are provided:

Performance of and Defence of Graduation Thesis/Выполнение и защита выпускной квалификационной работы.

The program of the state final certification (Appendix 6) includes requirements for final qualifying works (volume, structure, design, presentation), the procedure for their implementation, the procedure for defending the final qualifying work, criteria for evaluating the results.

10. Material and technical, educational and methodological support of the educational program

The work programs of disciplines (modules), practices determine the material and technical and educational and methodological support of the educational program, including a list of licensed and freely distributed software, a list of electronic educational publications and (or) printed publications, electronic educational resources, a list and composition of modern professional databases and information reference systems.

Classrooms for conducting training sessions provided for by the educational program are equipped with equipment and technical means of training, the composition of which is determined in the work programs of disciplines (modules) and practices.

The premises for independent work of students are equipped with computer equipment with the ability to connect to the Internet and are provided with access to the electronic information and educational environment of MIPT.

MIPT's electronic information and educational environment provides access to:
– to EBS:
EBS "University Library online";
"Book on Lime" by the publishing house "University Book House";
EBS of "Lan" publishing house;
EBS of "Yurait" publishing house;
EBS of "IBooks.ru" publishing house;
EBS Books.mipt.ru;
EBS ZNANIUM.COM;
access to the collections of the National Electronic Library.

- scientific foreign and Russian journals and electronic databases:
database “Uspekhi Fizicheskikh Nauk” Autonomous non-profit organization Editorial Office of the journal “Uspekhi Fizicheskikh Nauk”;
journals of the Russian Academy of Sciences;
journals of the Steklov Mathematical Institute of the Russian Academy of Sciences: Mathematical journals (mathnet.ru): Izvestia of the Russian Academy of Sciences. Series mathematical, Mathematical Collection, Uspekhi matematicheskikh nauk;
electronic version of the journal "Quantum Electronics" Lebedev Physical Institute of the Russian Academy of Science;
Russian journals on the East View platform of IVIS;
Full-text journal Science Online (American Association for the Advancement of Science);
Journals database (Bentham Science Publishers);
EBSCO eBooks database (EBSCO Information Services GmbH);
Wiley Journal Database;
archival journal collection Wiley Journal Backfiles (2005-2013);
archival collection of journals Wiley Journal Backfiles (2014 -2022);
journals of the Russian Academy of Sciences;
World Scientific Complete eJournal Collection database (World Scientific Publishing Co Pte Ltd.;
Academic Reference Database (China Academic Journals (CD Edition) Electronic Publishing House Co., Ltd);
The Cochrane Library database (John Wiley & Sons, Inc.);
CSD-Enterprise database (The Cambridge Crystallographic Data Centre).

Students undergo theoretical and practical training using the MIPT classroom fund and technical means, electronic and (or) printed educational publications provided by the MIPT library, as well as educational and scientific equipment and specialized software provided by the laboratories of The Research Center for Molecular Mechanisms of Aging and Age-Related Diseases and a partner organization.

11.Features of the educational program implementation for the disabled and persons with special needs

If there are persons with disabilities or persons with special needs among students, the educational program is adapted taking into account the special educational needs of such students.
When teaching according to an individual curriculum for people with disabilities, the period for mastering the educational program can be extended at their request by no more than one year compared to the period for obtaining education for the corresponding form of education.

12. Staff conditions for the implementation of the educational program

Leading Russian and foreign scientists – specialists in the field of methods of modern biophysics and their applications, representing MIPT, MSU, NSU, the University of Groningen (Netherlands), INSERM (France), the University of South Florida (USA), etc., are involved in lectures. Some of the classes are held online.

The share of scientific and pedagogical staff (in teaching loads reduced to integer values) with an education corresponding to the profile of the discipline (module) being taught, in the total number of scientific and pedagogical staff implementing the Master's program is more than 70 persents.

The share of scientific and pedagogical staff (in teaching loads reduced to integer values) who have an academic degree (including an academic degree awarded abroad and recognized in the Russian Federation) and (or) an academic title (including an academic title obtained abroad and recognized in the Russian Federation), in the total number of scientific and pedagogical staff implementing the Master's program, is more than 60 persents.

The share of scientific and pedagogical staff (in teaching loads reduced to integer values) from the number of managers and employees whose activities are related to the orientation (specialty) of the ongoing Master's program (having work experience in this professional field for more than 3 years) in the total number of employees implementing the master's program is more than 5 persents.

The general management of the scientific content of the master's program is carried out by the Doctor of Physics and Mathematical Sciences, Kolachevskiy Nikolay Nikolaevich, who carries out independent research projects and participates in the implementation of such projects in the field of study, who has annual publications based on the results of this research activity in leading Russian and international peer-reviewed scientific journals and publications, as well as carrying out annual approbation of the results of this research activity at national and international conferences.

Nikolay Nikolaevich Kolachevsky, Corresponding Member of the Russian Academy of Sciences, Doctor of Physics and Mathematics.
Place of work and position: The Lebedev Physical Institute of the Russian Academy of Sciences (LPI), Director (since 2015).
Education – MIPT (Department of General and Applied Physics, 1994), diploma qualification "Engineer-physicist", specialty "Automation and electronics", training area "Applied Mathematics and Physics"
Academic degree – Doctor of Sciences in Physical and Mathematical Sciences ("Coherent laser spectroscopy of hydrogen and rubidium atoms")
Academic title – Professor (according to the Department No. 78 of the NRNU MEPhI – "Physical and technical problems of metrology")
Honorary title – Corresponding Member of the Russian Academy of Sciences (Specialist in the field of precision laser spectroscopy, X-ray, nonlinear and quantum optics, laser cooling.)
The type of activity of the institution is a wide range of research topics covering almost all areas of modern physics.
Area of scientific interests:
Precise frequency measurements, ultra-high resolution spectroscopy, ultra-stable lasers, optical clocks, laser cooling, research of exotic atoms (antihydrogen), measurements of fundamental constants, experimental testing of fundamental theories.
Publications:
author of 211 publications indexed in WOS (Researcher ID: D-2448-2013), including collective monographs. Scientific editor and translator of the monograph “Frequency Standards. Principles and Applications” (Fizmatlit, 2006). More than 20 invited talks at conferences. Awards, grants, projects: three times winner of the competition for outstanding young scientists – candidates and doctors of sciences of the President of the Russian Federation. Fellow of the Alexander von Humboldt Foundation, Max Planck Society. Head of grants of the RFBR, the German Physical Society, projects of the Russian Academy of Sciences. Since 2012 Head and responsible executor of contracts (R&D, ROC) within the framework of the Federal Target Program “GLONASS 2012-2020”, member of the GBAR collaboration (CERN), head of the joint laboratory of LPI and Russian Quantum Center (Skolkovo).
Teaching activities:
Scientific supervisor of students and postgraduates (Lebedev Physical Institute), teaching of courses of lectures on modern fields of quantum physics at MEPhI and MIPT.
h-index: 21 (WOS), 27 (Google scholar).
Participation in scientific and public organizations:
Member of the Scientific Coordinating Council of the FANO, member of the Scientific Council of the LPI, Scientific and Technical Council of the Main Metrological Center of the State Service of Time and Frequency of VNIIFTRI. Member of the editorial board of the journal "Physics-Uspekhi (Advances in Physical Sciences)". Member of the organizational international conferences ICONO/LAT, CLEO, ICOLS. Expert of funds: RFBR (Russian Federation), GACR (Czech Republic).
Participation in joint research projects:
JINR (Dubna), VNIIFTRI (Mendeleevo), Russian Quantum Center (Skolkovo), Max-Planck Institute for

Quantum Optics (Garching, Germany), Max-Planck Institute for Nuclear Physics (Heidelberg, Germany), ETH (Zuerich, Switzerland), CERN (Switzerland).
Interaction with the industry:
Joint projects with "Lens-Optics" (Russian-German manufacturer of optical components), "Avesta" (Russian manufacturer of laser systems), "Menlo Systems" (German manufacturer of optical frequency synthesizers).
Main scientific achievements:
- performed advanced experimental studies of optical micro- and nanostructures in the soft X-ray range, developed new methods for studying components of X-ray optics. The results of work were used in the creation of spectrometers and spectrogeliographs (the CORONAS-F space project) and in laser plasma studies.
- developed a new laser method for creating a thermal neutron polarizer. He implemented a polarizing helium cell, which was used in preparations of an experiment on search of violations of T-invariance in the neutron beam of the IBR-30 reactor (JINR, Dubna).
- developed a new optical method for determining energy of hyperfine splitting in hydrogen-like atoms, which enabled frequency measurements of the hyperfine splitting of level 2S in hydrogen and deuterium with record accuracy. Based on the obtained results, a detailed study of the corrections of quantum electrodynamics of bound states was carried out.
- proposed and developed a method of model-independent estimation of the upper limit of the drift of a fine structure constant. Measured the absolute frequency of the 1S-2S transition in a hydrogen atom, which allowed scientists to impose a limit on the drift of the fine structure constant at the level of 10-15 per year.
- implemented deep laser cooling of a rare-earth thulium atom to temperatures of 10 microns for the first time to solve the problem of creating a high-precision optical clock. For the first time, he implemented secondary cooling, as well as the capture of thulium in magnetic and optical traps.
- implemented new principles of laser frequency stabilization, which make it possible to obtain compact tunable laser radiation sources with a spectral line width of less than 1 Hz.
Applied research:
Creation of optical clocks on laser-cooled atoms and ions, creation of unique laser systems for optical clocks on strontium atoms within the framework of the Federal Target Program “GLONASS” for FSUE VNIIFTRI, Rosstandart.
Since 2021, leader of a project of creation of an ion-based quantum processor, which is supervised by Rosatom as part of the Quantum Technologies roadmap.

13. Information about the departments involved in the implementation of the educational program

Chair of Biophysics: head of Chair, Doctor of Chemical Sciences, Associate Professor, Chupin Vladimir Viktorovich, chief Researcher of CMM, MIPT. The mission of the department is to train highly qualified physicists who will be able to work at the intersection of physics and biological sciences and will have both an extensive theoretical background and basic skills and knowledge of the latest methods used in modern structural biology, molecular biology and biophysics. The department is based at the Research Center for Molecular Mechanisms of Aging and Age-Related Diseases of MIPT. The researchers of the Center read specialized courses for students and provide scientific guidance for their research projects. The Department of Biophysics actively cooperates with numerous Russian and foreign scientific organizations. Students of the department participate in Russian and international conferences, as well as internships in the best research centers in Europe and the USA. Graduates continue their research careers either at MIPT or in other leading universities of the world.

Basic organisations:

, The Research Center for Molecular Mechanisms of Aging and Age-Related Diseases, founded in 2015, is now an actively developing cluster of ten laboratories (the last of which was established in December 2022) conducting research in the field of membrane physics, molecular cell biology and optogenetics, electron microscopy of biological systems, and aging problems. In 2020-2022, the Center has attracted several large grants from the Ministry of Education and Science, including as a co-executor together with the

Federal State University of Biotechnology of the Russian Academy of Sciences; it participates in the federal program for the creation and development of a world-class genomic research center. In the 2022 competition, the researchers of the Center won 5 RSF grants, two more large grants were supported in the first half of 2023..