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Passport of the field of science "Physics"

Physics includes the following fields:

- ***Mechanics of liquids, gases, and plasmas;***
- ***Astrophysics and stellar astronomy;***
- ***Physics of the Sun;***
- ***Planetary investigations;***
- ***Theoretical physics;***
- ***Radiophysics;***
- ***Optics;***
- ***Condensed matter physics;***
- ***Plasma physics;***
- ***Low temperature physics;***
- ***Physics of semiconductors;***
- ***Physics of magnetic phenomena;***
- ***Physics and technology of nanostructures, atomic and molecular physics;***
- ***Physics of the atomic nucleus and elementary particles;***
- ***Chemical physics, combustion and explosion, physics of extreme states of matter;***
- ***Crystallography, physics of crystals;***
- ***Laser physics;***
- ***High energy physics;***
- ***Biophysics;***
- ***Computational physics.***

Mechanics of liquids, gases, and plasmas

Research areas:

1. Rheological laws of behavior of fluid homogeneous and multiphase media under mechanical and other influences.
2. Hydraulic models and approximate methods for calculating flows in water, technological devices and power plants.
3. Laminar and turbulent flows.
4. Compressible flows and shock waves.
5. Dynamics of rarefied gases and molecular gas dynamics.

6. Multiphase media flows (gas-liquid flows, bubble media, gas suspensions, aerosols, suspensions and emulsions).
7. Filtration of liquids and gases in porous media.
8. Physical and chemical hydromechanics (flows with chemical reactions, combustion, detonation, phase transitions, in the presence of radiation, etc.).
9. Aerodynamics and heat transfer in aircraft.
10. Hydromechanics of floating bodies.
11. Boundary layers, mixing layers, currents in the wake.
12. Jet currents. Cavitation in dropping liquids.
13. Hydrodynamic stability.
14. Linear and nonlinear waves in liquids and gases.
15. Heat and mass transfer in gases and liquids.
16. Hydromechanics of media interacting with an electromagnetic field. Plasma dynamics.
17. Experimental methods for studying dynamic processes in liquids and gases.
18. Analytical, asymptotic and numerical methods for studying the equations of kinetic and continuum models of homogeneous and multiphase media.
19. Hydrodynamic models of natural processes and ecosystems.

Astrophysics and stellar astronomy

Research areas:

1. Investigation of physical processes associated with the generation of radiation (electromagnetic, neutrino, gravitational), propagation and absorption of radiation in space environments; development of methods for the analysis of electromagnetic radiation in various spectral ranges as applied to astronomical observations.
2. Investigation of the physical properties of space objects (planets, stars, galaxies and their systems) of the interplanetary, circumstellar, interstellar and intergalactic environment, based on astronomical observations.
3. Study the origin, movement and evolution of space objects based on fundamental physical theories and astronomical observations.
4. Investigation of the large-scale structure and cosmological evolution of the Universe as a whole, including the early stages of its expansion, an explanation of the origin of galaxies, stars, planets and their systems.
5. Investigation of cosmic factors that determine the conditions for the life emergence and existence on Earth and other planets.

Physics of the Sun

Research areas:

1. Sun internal structure and physical processes occurring in Sun bowels.
2. Solar activity and its cycles at different time scales.
3. Structure and dynamics of solar atmosphere (convection zone, photosphere, chromosphere, corona).
4. Formations in the solar atmosphere (active areas, spots, prominences, etc.).

5. Magnetic fields and active phenomena (flashes, emissions, etc.).
6. Solar radiation of all ranges - from radio emission to gamma and neutrino radiation.
7. Solar cosmic rays.
8. Solar wind and heliosphere.
9. Solar-terrestrial physics and solar-terrestrial relations.
10. Scientific instruments and complexes, experimental methods and data processing algorithms for the above mentioned areas of research.

Planetary investigations

Research areas:

1. Experimental studies (including measurements on spacecraft and ground-based observations using telescopes) of the chemical composition, vertical structure, aerosol component and dynamics of planet atmospheres, their satellites and comets. Theoretical studies of physical and chemical processes in planetary atmospheres, dynamics of planetary atmospheres, interaction of atmospheres with the surface, processes of their formation and evolution. Development of planets atmospheric models, their satellites and comets.
2. Development of methods and geophysical sounding of planet bowels, their satellites, comets and asteroids. Theoretical studies of tplanets internal structure, their satellites, comets, and asteroids. Development of planet internal structure models and satellites.
3. Experimental studies of solar system body surface structure, physical characteristics, chemical and mineral composition of the surface layer. Theoretical studies of geological and geochemical processes on the surface of solar system bodies, development of models for the evolution of planetary body surface.
4. Experimental and theoretical studies of planet magnetic fields, planetary magnetospheres, interaction of solar system bodies with the solar wind.
5. Theoretical research in the field of planetary cosmogony (problems of the origin and evolution of the solar system, as well as extrasolar planetary systems).

Theoretical physics

Research areas:

1. Condensed matter theory of classical and quantum, macroscopic and microscopic systems. Study of various states of matter and physical phenomena in them. Statistical physics and kinetic theory of equilibrium and non-equilibrium systems.
2. General theory of relativity and relativistic astrophysics. Physical properties of matter and space-time in the Universe. Classical and quantum cosmology and gravity.
3. Theory of fundamental interactions and quantum field theory. Study of phenomena at small scales and at high energies. Development of mathematical methods of field theory.

4. General questions of quantum mechanics: fundamentals, measurement theory, general theory of scattering. Quantum theory of physical phenomena in nuclei, atoms and molecules.
5. Development of the theory of mesoscopic systems. Quantum information theory and quantum computing.
6. Development of the theory and study of the general properties and laws of nonlinear dynamics of highly non-equilibrium systems. Development of the theory of chaos and turbulence.

Radiophysics

Research areas:

1. Development of physical foundations of the generation, amplification and conversion of oscillations and waves of various nature (electromagnetic, acoustic, plasma, mechanical), as well as autowaves in non-equilibrium chemical and biological systems. Searching the methods to create highly efficient sources of coherent radiation of millimeter, submillimeter and optical ranges, technical mastering of new frequency ranges and powers.
2. Study of radiation linear and nonlinear processes, propagation, diffraction, scattering, interaction and transformation of waves in natural and artificial environments.
3. Development and research of new electrodynamic systems and devices for the formation and transmission of radio signals: resonators, waveguides, filters and antenna systems in the radio, optical and infrared ranges.
4. Investigation of fluctuations, noise, random processes and fields in concentrated and distributed stochastic systems (statistical radiophysics). Development of new methods of signal analysis and statistical processing in the presence of interference. Development of statistical framework for the information transfer. Study of nonlinear dynamics, space-time chaos and self-organization in non-equilibrium physical, biological, chemical and economic systems.
5. Development of scientific foundations and principles of active and passive remote environmental diagnostics based on modern methods of solving inverse problems. Creation of remote monitoring systems for the geo-, hydrosphere, ionosphere, magnetosphere and atmosphere. Radio astronomy research of near and far outer space.

Optics

Research areas:

1. Wave (physical) optics. Interference, diffraction, polarization, light coherence. Formation of light beams. Optics of anisotropic, moving and non-stationary media, metal optics. Formation and processing of optical images, topography. Optics of optical fibers.
2. Geometric (beam) optics. Propagation and conversion of light beams. New principles for building optical systems and tools. Phenomena at the boundaries of environments. Photometry.
3. Molecular optics. Dispersion, absorption, scattering of light. Optical activity of media and structures. Optics of media under external influences. Optical

investigations of the fundamental properties of matter. Quantum nature of light. Spontaneous and forced processes. Photon statistics. Optical methods for information transmitting and processing, physical foundations of quantum computing.

4. Luminescence. Radiation and absorption of light by isolated and interacting atoms and molecules. Light sources. Physical foundations of spectroscopy methods and techniques. Laser spectroscopy, optical precision measurements and standards, single atom spectroscopy.
5. Action of light. Energy-momentum transfer, dynamic processes during the interaction of light with matter, processes of energy release by matter during light exposure. Light control of atom motion and quantum state. Photoelectric phenomena. Photochemical processes. Radiation detection. Self-action of light in the environment. Nonlinear optics. Propagation of ultrahigh-power and ultra-small durations optical pulses.

Condensed matter physics

Research areas:

1. Theoretical and experimental study of the physical nature of metals and alloys properties, inorganic and organic compounds, dielectrics, including fiber materials in both solid and amorphous states, depending on their chemical, isotopic composition, temperature and pressure.
2. Theoretical and experimental study of the physical properties of disordered inorganic and organic systems, including classical and quantum liquids, glasses of various nature and dispersed systems.
3. Investigation of the experimental state of condensed matter (strong compression, impact, change in gravitational fields, low temperatures), phase transitions in them and their phase state diagrams.
4. Theoretical and experimental study of radiation effects of various types, high-temperature plasma on the nature of changes in physical properties of condensed matter.
5. Development of mathematical models for building phase state diagrams and predicting changes in physical properties of condensed matter depending on the external conditions of their location.
6. Development of experimental methods for studying physical properties and creation the physical foundations for industrial technology for producing materials with given properties.
7. Technological applications of condensed matter physics.

Plasma physics

Research areas:

1. Controlled thermonuclear fusion with magnetic and inertial confinement, pinches, etc.
2. Thermodynamics, kinetics (including transport phenomena), optics, elementary processes in plasma (ionization, radiation, collisions, etc.).
3. Plasma dynamics: waves, instabilities, flows, nonlinear phenomena (self-

organization, structures, turbulence, etc.), abnormal transport, electromagnetism, etc.
4. Plasma diagnostics.
5. Sources and plasma generation.
6. Charged plasma, particle beams in plasma, plasma electronics.
7. Plasma in space and astrophysics.
8. Processes on the Sun and in the stars.
9. Plasma phenomena in the atmospheres, ionospheres and magnetospheres of planets.
10. Interaction of plasma with matter in other aggregate states (with the surface of solids, dust particles, clusters, aerosols, liquids, etc.).
11. Plasma phenomena in condensed matter (solids, electrolytes, etc.).
12. Plasma technologies and devices.
13. Plasma chemistry and reactions in plasma.

Low temperature physics

Research areas:

1. Quantum liquids and crystals.
2. Superconducting systems, including high temperature superconductors.
3. Quantum gases, Bose-Einstein condensates.
4. Strongly correlated electronic and phonon systems.
5. Low-temperature magnetism: magnetic structures, phase transitions, magnetic resonance.
6. Low-dimensional quantum systems and disordered systems.
7. Mesoscopic systems.
8. Investigation of mechanical, electrical, magnetic, optical, thermal and other physical properties of a substance at low temperatures.
9. Development of methods for obtaining and measuring low and ultra-low temperatures.

Physics of semiconductors

Research areas:

1. Physical foundations of technological methods for producing semiconductor materials, composite structures, structures of reduced dimension and semiconductor devices and integrated devices based on them.
2. Structural and morphological properties of semiconductor materials and composite structures based on them.
3. Impurities and defects in semiconductors and composite structures.
4. Surface and interface of semiconductors, semiconductor hetero-structures, contact phenomena.
5. Electronic spectra of semiconductor materials and composite compounds based on them.
6. Electronic transport in semiconductors and composite semiconductor structures.
7. Optical and photoelectric phenomena in semiconductors and composite

semiconductor structures.
8. Spontaneous and stimulated luminescence in semiconductor materials and composite structures, semiconductor lasers and light-emitting devices.
9. Non-equilibrium phenomena in semiconductors and structures. Electron plasma.
10. Acoustic and mechanical properties of semiconductors and composite semiconductor structures.
11. Dynamics of crystal lattice. Electron-phonon interaction.
12. Many-particle interactions in semiconductors and composite structures.
13. Transport and optical phenomena in structures of reduced dimension.
14. Mesoscopic phenomena in semiconductors and composite structures.
15. Non-crystalline semiconductors. Organic semiconductors.
16. Magnetic semiconductors.
17. Modeling of properties and physical phenomena in semiconductors and structures, technological processes and semiconductor devices.
18. Development of physical principles of functioning and design of devices based on semiconductor materials and composite semiconductor structures.
19. Development of investigation methods for semiconductors and composite semiconductor structures.

Physics of magnetic phenomena

Research areas:

1. Development of theoretical models explaining the relationship of substances magnetic properties with their electronic and atomic structure, nature of their magnetic state, nature of atomic and domain magnetic structures, changes in magnetic state and magnetic properties under various external influences.
2. Experimental studies of substances magnetic properties and states by various methods, establishing the relationship of these properties and states with chemical composition and structural state, revealing the laws of their change under various external influences.
3. Investigation of changes in various substance physical properties related with the change in their magnetic states and magnetic properties.
4. Investigation of phenomena related with the interaction of various kinds of electromagnetic radiation and fluxes of elementary particles with substance magnetic moments or its structural components: atoms, atomic nuclei, electrons (paramagnetic, ferromagnetic, nuclear magnetic, nuclear gamma resonances, etc.).
5. Development of various magnetic materials, technological methods aimed at improving their characteristics, instruments and devices based on application of magnetic phenomena and materials.

Physics and technology of nanostructures, atomic and molecular

physics

Research areas:

1. Technological methods for producing nanomaterials, composite structures, structures of reduced dimension, devices and integrated devices based on them.
2. Structural, morphological and mechanical properties of nanomaterials and composite structures based on them.
3. Atomic-molecular design, self-organization, topologically oriented, biomimetic, biofunctionalized, energy-collecting and adaptive (self-adaptive) nanostructures and nanomaterials.
4. Atomic clusters and nanostructures on the surface. Interface boundaries in nanomaterials and composite structures.
5. Electronic transport in nanomaterials and composite structures.
6. Optical and photoelectric phenomena in nanomaterials and composite structures.
7. Magnetic properties of nanomaterials and composite structures.
8. Modeling of properties, physical phenomena and technological processes in nanomaterials and composite structures.
9. Physical principles of functioning and design of devices based on nanomaterials and composite structures.
10. Diagnostics of nanomaterials and nanostructures.
11. Investigation methods for nanomaterials and composite structures.

Physics of the atomic nucleus and elementary particles

Research areas:

1. Spectroscopy of atomic nuclei.
2. Neutron physics.
3. Relativistic nuclear physics and heavy ion physics.
4. Weak and electromagnetic processes in nuclear physics, nuclear neutrino physics.
5. Physics of fission and nuclear fusion, in particular, the synthesis of superheavy elements.
6. Theory of atomic nucleus and nuclear reactions, physics of low-particle systems.
7. Mesoatomic and mesomolecular physics, muon catalysis physics.
8. Nuclear astrophysics, physics of supernovae, the origin of elements in the Universe.
9. Cosmic ray physics.
10. Design of experimental facilities and instruments for research on nuclei structure and nuclei interaction with nuclei beams and elementary particles.
11. Development and implementation of new technical methods for nuclear phenomena detecting.
12. Design of new experimental facilities and equipment for research in nuclear physics and cosmic ray physics.

Chemical physics, combustion and explosion, physics of extreme states of

matter

Research areas:

1. Atomic-molecular structure of chemical particles and substances, mechanisms of chemical transformation, molecular, energy, chemical and spin dynamics of elementary processes, physics and physical theories of chemical reactions, and experimental methods for studying the chemical structure and dynamics of chemical transformations.
2. Spatial and electronic structure, atomic-molecular parameters of isolated atoms, ions, molecules; structure and properties of van der Waals molecules, complexes, Rydberg molecules, clusters, associates, films, adsorption layers, intercalates, interfaces, micelles, defects; structure and properties of crystals, amorphous bodies, liquids; the behavior of substances and structural-phase transitions under extreme conditions - in electric and magnetic fields, under conditions of static and dynamic compression, in laser radiation fields, in plasma and in gravitational fields, at extremely low temperatures and in other conditions.
3. Molecular dynamics, intermolecular potentials and molecular organization of substances; computer molecular dynamics as a method for diagnosing substance structure and dynamics; dynamic theories in description of elasticity, relaxation, plastic deformation, thermal conductivity, rheology; dynamics of phase transitions.
4. Energy dynamics and selective population of electronic, vibrational and rotational states; energy exchange and transfer between different states within the molecule and intermolecular energy exchange; relaxation of internal energy into kinetic and lattice energy; energy dynamics characteristics in gases, clusters, liquids, solids and interfaces; energetics of chemical reactions and mechanisms of energy storage in molecules.
5. Potential energy surfaces of chemical reactions and quantum methods for their calculation; dynamics of reagents movement on a potential surface; methods of dynamic trajectories and static theories of reactions; tunnel effects in chemical dynamics; energy conversion in elementary processes and chemical lasers; chemical reaction mechanisms and reactivity control; coherent processes in chemistry, coherent chemistry - quantum and classical; spin dynamics and spin chemistry; spectroscopy and chemistry of single molecules and clusters; experimental methods for studying chemical, energy, and spin dynamics.
6. Structure and reactivity of chemical reactions intermediates; chemical mechanisms and physics of catalytic processes; dynamics, structure and spectroscopy of catalytically active surfaces.
7. Laws and mechanisms of propagation, structure, parameters and stability of combustion waves, detonation, explosive and impact waves; relationship of the chemical and physical nature of substances and systems with their thermochemical parameters, characteristics of thermal decomposition, combustion, explosive transformation; thermodynamics, thermochemistry and macro-kinetics of combustion processes and explosive transformation.
8. Processes analogues of combustion, detonation and explosion; interaction of combustion waves and explosive transformation with the environment, objects and substances; phenomena generated by combustion and explosive

transformation; combustion and explosive transformation processes in devices and apparatuses for energy and substances production; combustion and explosive transformation control.

9. Problems of fire and explosion safety of substances, materials, processes.

Crystallography, physics of crystals

Research areas:

1. Theory of symmetry.
2. Atomic and electronic structure of the crystal lattice.
3. Lattice dynamics and phase transitions.
4. Structural analysis methods (X-ray, electron and neutron diffraction, theory and experiment).
5. Crystal chemistry.
6. Crystallization physics and methods of growing crystals and films.
7. Mechanical properties of crystals (elasticity, plastic deformation, theory of dislocations, twinning, fracture).
8. Electrical properties of crystals (polarization; pyro-, piezoelectric, and ferroelectrics; domain structure and phase transitions in ferroelectrics).
9. Optical properties of crystals (birefringence, interference, absorption and scattering of light in crystals; electro-, piezoelectric, and magneto-optical properties of crystals; nonlinear optical properties; laser crystals).
10. Transport phenomena in crystals (electrical and thermal conductivity; thermoelectric, galvanic, and thermomagnetic effects).
11. structure and properties of real crystals.
12. Crystals of polymers and proteins.
13. Liquid crystals.

Laser physics

Research areas:

1. Physics of interaction of coherent optical radiation with matter.
2. Processes of generation and transformation of coherent optical radiation, physical methods for controlling laser radiation properties and parameters, including the development of radiation sources with non-classical properties.
3. Investigation of matter fundamental properties by means of coherent radiation using nonlinear optics and laser spectroscopy.
4. Laser methods and means of nature studying and determining the properties and characteristics of physical, chemical and biological objects and processes.
5. Physical aspects of fiber optic communications, integrated optics, optical processing and transmission of information.
6. Physical and technical foundations of laser technologies and devices for various fields of science and technology, including high-precision optical measurements, modification and processing of materials, location, laser medicine, etc.

High energy physics

Research areas:

1. Physics of strong interactions in accelerators.
2. Physics of electroweak interactions in accelerators.
3. Structure and decay properties of hadrons, leptons and other elementary particles.
4. Hadron spectroscopy.
5. Investigation of collisions of light and heavy ions with nuclei at high energy.
6. Non-accelerator experiments of electroweak interactions; search for particle interactions and their theoretical interpretation.
7. Cosmophysics and its relations with elementary particle physics.
8. Design of experimental facilities for research in high-energy physics and development of new physical methods for particles detecting.
9. Development of mathematical methods and systems for processing and analysis of experimental accelerator data.

Biophysics

Research areas:

1. Molecular biophysics: nucleic acid biophysics; protein biophysics.
2. Cell biophysics: membrane biophysics; biophysics of ion channels; bioenergy; muscle contraction biophysics.
3. Biophysics of complex systems: mathematical biophysics; environmental biophysics; radiation biophysics; medical biophysics; technical biophysics.

Computational physics

Research areas:

1. Characteristics of numerical methods and related software systems, reflecting the growth of modern computers performance and computing efficiency increase.
2. Implementation of numerical methods in solving applied problems arising in the mathematical modeling of scientific and technical problems, correspondence of selected algorithms to the problem specifics.