Special courses

1. Computing methods

The aim of the course is to learn intellectual systems of computer algebra (program systems of symbolic mathematics).

2. Modern computing technologies and computer methods of research

Special course contents: visual programming, data bases, elements of work with Internet, system of computer calculations Mathematica; symbolic, numerical and graphic method; modeling of physical phenomena; method of computer animation; computer experiments.

3. Modern geometry and tensor analysis

Geometry of Euclidean, Minkovskiy, Riemannian spaces, their groups of transformations. Tensor analysis in these spaces. Stratifications and manifolds theory.

4. Mechanics of Continuous media

Equation of gas motion, flow equation, equations of solid and liquid crystals motion. Diffusion, heat conduction, acoustic waves in these media.

5. Theory of gravitation

Motion of a particle in gravitational field, Einstein equation for gravitational field, fields of bodies, three effects of the general theory of relativity, gravitational waves, model and evolution of Universe, relativistic cosmology.

6. Non-linear physics

Non-linear oscillations of mechanical systems. Qualitative, approximate and exact methods of research of non-linear systems. Non-linear waves in elastic and magnetoordered media. Solitons. Vortices.

7. Crystal theory

Geometry of crystal lattices, dynamics of atom there, thermodynamics of crystals, their heat conduction, lattice imperfection, dispersion of light and neutrons by crystals.

8. Theory of metals

Electron in periodical fields, theory of zone, thermodynamics of conduction electrons in electric and magnetic fields, scattering of electrons, statistic mechanics of conduction electrons, kinetics of electrons and phonons, high-frequency characteristics of metals, absorption of sound in them.

9. Theory of magnetism

The aim of this special course is the acquaintance of students with basics of modern quantum physics of magnetism as one of the examples of strongly correlative electronic systems’ theory, to learn basic models of strong magnetism: Heisenberg spin model, Hubbard model, s-d model. The main attention is paid to exact and approximate methods of building of energetic spectrum and to thermodynamics of Heisenberg isotropic and anisotropic models for different proportionalities of accessory and magnetic spin lattices.

10. Quantum statistics and kinetics

Methods of modern theory of condensed state of aggregation of matter: secondary quantization, statistic operator, Green temperature functions, functional methods, Keldysh method.

11. Many-particles system theory

Functional methods in theory of classical systems. Green quantum functions. Fermi liquids theory. Electron-electron, electron-photon, electron-impurity interaction in metals and continual integrals. Electron gas in magnetic field. Interacting bosons.

12. Mezoscopic physics

Quantum theory of ensemble of disordered small systems, that are in similar macrostate but differ by realization of degree of disorder.

13. Theory of superconduction

Macroscopic and microscopic theories of superconduction of metals, theory of Ginzburg-Landau, two types of superconductors, kinetics of superconductors, superconductor in high-frequency field. Josephson effect. Methods of Gorkov and Eliashberg in the theory of superconduction, high-temperature superconduction.

14. Quantum field theory

Lectures are the introduction to quantum field theory, on the whole to quantum electrodynamics. The basic features of relativistic wave equation, Dirac equation for electron and Maxwell’s equation for electromagnetic field and their canonical quantization are taught. The interaction of electrons and photons is also examined. Feinmann laws for calculations of probabilities of physical processes are deduced and discussed. The lectures are for students with the degree of master, who are specialized in theoretical physics and who knows quantum mechanics and classical electrodynamics on the level of university courses.

15. Theory of calibrating fields

Lectures are the introduction to theory of calibrating fields. Basic principles, spontaneous symmetry faults, Hibbs mechanism, Weinberg-Salam model as the example of the electroweak interactions of leptons theory, generalization of this model into physics of adrons. Lectures are for students with the degree of master, who are specialized in theoretical physics and know quantum field theory in its canonical formulation. The aim of the lectures is to study theoretical and field methods that can be used in modern researches in the theory of fundamental interactions.