ITMO

Level of education: **Master**
Field of study: **16.04.01 Technical Physics**

Advanced Quantum and Nanophotonic Systems

SPINTRONICS

Credits: 6 ECTS		
Semester		Assessment
2nd semester	6 ECTS	Exam

Course developers: **Valery M. Uzdin**

The course involves the study of the current state of rapidly developing areas of physics and technology related to the magnetism of nano and microsystems. On the one hand, modern methods for studying nanostructures will be discussed, including synchrotron and X-ray spectroscopy, neutron scattering, tunneling microscopy, etc., and on the other hand, it is planned to study theoretical approaches used to describe physical properties, the ordering and dynamics of magnetic nanosystems as well as for the interpretation of experimental data. It is also planned to implement individual projects related to the modeling of magnetic micro and nanosystems.

Requirements

Course prerequisites: General Physics, Electrodynamics, Quantum Mechanics, Statistical Physics.

Course structure

1. Magnetism at different spatial scales. Exploring of spin degrees of freedom. New magnetic states and structures: magnetics superlattices, exchange magnetic springs, skyrmions etc.
2. Hierarchy of physical models. Dimensionless parameters. Ideal gas – gas of solid balls – classical plasma – quantum plasma.
3. The nature of magnetism. Dia, para and ferromagnetism. Localized and itinerant models of magnetism.
4. Antiferromagnetic exchange coupling in magnetic superlattices. Giant magnetoresistance.
5. Ising model. Absence of phase transition in 1-dimensional Ising model. Goldstone modes.
6. Generalized Heisenberg model. Exchange, anisotropy, Dzyaloshinskii-Moriya interaction.
7. Mean field approximation. Landau theory of phase transitions.
8. Models of itinerant magnetism. Habbard, Anderson, Alexander-Anderson Models.

9. Green function for Anderson model. Density of states and magnetic moment calculations.
10. Non-collinear magnetism within the framework of itinerant models. Non-collinear magnetic structures.
11. Topological magnetic structures. Racetrack memory.
12. Stability of magnetic states. Transition state theory
13. Dynamics of magnetic states. Landau–Lifshitz–Gilbert equation.
14. Perspectives of spintronics.

Assessment

To pass exam successfully in addition to mastering the basic terms and concepts of the course student have to prepare an oral presentation according to the topics of spintronics and complete an individual project that involves independent computer modeling and the performance of appropriate analytical and numerical calculations.

Faculty: **Faculty of Physics**

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Tags: **Magnetic systems modeling, Giant magnetoresistance, Topological magnetic systems, Skyrmions, Stability of magnetic states**