Level: PhD
Course title: Strongly correlated systems
Status: elective
ECTS: 30
Requirements: none

Learning objectives

Acquiring theoretical knowledge in magnetism. Getting familiar with basic theoretical magnetic models (magnetic dielectric, magnetic semiconductors and conductors), Heisenberg model, Ising model and XY and XXZ models-isotropic and unisotropic, Hubbard model and s/d exchange model and Anderson model.

Learning outcomes

After taking the course, the students should have developed:

General abilities: deeper knowledge of this field, following the literature, analysis of various solutions and the choice of the most adequate solution, application in practice and other subjects.

Subject-specific abilities: knowing the basic theoretical magnetic models, calculating some basics quantities (magnetization, magnetic susceptibility, critical temperature) in the frame of stated theoretical models in the Mean-field approximation and Random phase approximation, calculating basic results for superconductors- in the frame of BCS and Ginzburg-Landau theory.

Syllabus

Theoretical instruction

Magnetic ions in crystals. Electron states of free magnetic ions. Exchange interaction. Magnetism of spin systems. Molecular field theory. Heisenberg model, Ising model, XY model. Mean field approximation. Tyablikov's (RPA) approximation. Molecular field for antiferromagnets. Ground state of ferromagnet and antiferromagnet. Spin waves in ferromagnets and antiferromagnets. 1D and 2D Heisenberg model – exact solution. Exact solution of 1D Hubbard model. Magnetism of metals and alloys. Magnetism of free electrons. Theory of strongly correlated electrons. Hubbard and t-J model. RPA theory of ferromagnetism in metals. s-(p)d model and Anderson Hamiltonian. Superconductivity. Ginzburg-Landau theory. Microscopic BCS theory. Superconductors of I and II kind. Vortices. Josephson's effect and quantum interferometers. High-temperature superconductivity.

Practical instruction

Weekly teaching load				Other:
Lectures: 5	Exercises:	Other forms of teaching:	Student research: 15	