Level: bachelor

Course title: Quantum statistical physics

Status: elective

ECTS: 6

Requirements: Quantum mechanics, Statistical physics

Learning objectives

Introduction to modern methods of quantum statistical physics as well as their applications in some fields of physics of condensed matter.

Learning outcomes

After taking the course, the students should have developed:

General abilities: basic 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: Upon completion of the course, the student should master some modern methods of statistical physics (Green's functions, the second quantization method for interacting particle systems). The knowledge is sufficient to monitor other advanced courses.

Syllabus

Theoretical instruction

Nonrelativistic many-particle systems, Second quantization for systems of identical particles. Many particle states, Examples. States and opservables of identical particles - bosons and fermions. General single- and many-particle operators. Field operators. Small oscillations and phonons in 1d and 3d. Nonequilibrum statistical operator. Basics of Quantum kinetic theory, Fluctuation-disipation theorem. Linear response of the system and Greens function. Double-time Green's functions, Equation pof motion. Spectral representation of Green's and correlation functions. Exact expressions, The Kramers-Kroning relation. Wick's theorem for boson and fermi systems. Application of Greens methods in the theory of magnetism. Magnetism: the quantum nature of magnetism; exchange interaction; Heisenbergs model: ground state and spin wave; concept of quasiparticels - magnons. Exactly solvable models, Izing model. Phenomenon superfluidity, Landau superfluid condition. Non ideal Bose gas at low temperatures. Effective Hamiltonian, Microtheory of Bogolyubova. Phonons and rotons. Superfluidity He4. A Phenomenological theory of superconductivity: The Ginzburg–Landau theory and the Josephson effects. Superconductivity. Cooper's phenomenon, Cooper's pairs. Electron-phonon interaction and superconductivity. Frohlich's ttransformation and effective electron-electron interactions. BCS theory. Unitary u-v transformation, spectrum and energy superconductors.

Practical instruction

Problem solving. Homework.

Weekly teaching load

Lectures:	Exercises:	Other forms of teaching:	Student research:	Other:
3	1	1		