Special courses of the Chair of Low-Temperature Physics

1. Structure of solids. Basis of geometrical crystollography. Inverse lattice, properties of its radius-vector, Brilluen zone. Methods of study of clistalline structure. Main structural types of substance with various type of interatomic connections.

2. Basis of cryogenic material knowledge. Mechanical and physical properties of metals in the field of low temperatures. Types of alloys and its phase diagrams. Chemical structure, physical and mechanical, tecnology of production, utilization in modern industry of metals and their alloys, polymers and composites, amorphous alloys, liquid crystals and other constructial materials.

3. Thermal and physical properties of metals in low temperatures. Quantum features of thermal oscillations in solids and their influence on the thermal and physical properties of solids. Anharmonizm of thermal oscillations and thermal expansion, Gruneisen law. Thermal conductivity of matals and alloys, impact of electrons and phonons, low-temperature maximum of thermal conductivity.

4. Methods of physical experiment in low temperatures (Associate Professor V.S. Krylovskii). Study of properties of normal metals and superconductors in low temperatures; physical properties and methods of receiving low and ultralow temperatures; physical properties of refrigerants and kryostats for receiving and keeping low temperatures; principle of construction of kryostats; low-temperature thermometry.

5. Electronic phenomena in metals (Associate Professor V.I. Biletskii). Modern ideas of the structure of electronic and energetic spectrum of metals and experimental phenomena, which are observed in metals in low temperatures in electric subsystem and help to get information of thermodynamic and kinetic properties of metals and characteristics of energetic state of electrons.

6. Methods of low-temperature experiment (Associate Professor V.I. Biletskii). Examined methods of receiving low temperatures, low-temperature experimental equipment, principles of measuring of physical properties of metals in low temperatures, research in low temperatures.

7. Introduction to high-temperature superconductivity (ITSC) (Professor M.O. Obolenskii) Structure, synthesis and physical properties of ITSC. Comparative analysis of physical properties of low-temperature materials in normal and superconductive states.

8. Electronic properties of metals in low temperatures (Professor M.O, Obelenskii) Main provisions of theory of electronic spectrum of metals, conception of Fermi-surface, kinetic and thermodynamic properties of electronic subsystem. Main experimental methods of study of electronic spectrum of metals.

9. Pining and dynamics of vortices in superconductors (Professor V.O. Shklovskii). Traditional and new aspects of physics of spining and dynamics of vortices in superconductors of second type. Ductile stream and Holl's effect without pining and also microscopic sense of coefficients of dissipative and Holl ductility; anizotropy of pining, oriented motion of vortices and new Holl tensions when there are oriented in one way planar defects. Collective and individual pining of vortices in the chaotic whetting defects (theory of Lanin-Ovchinnikov and the results of Labush) and also interpretation of scenario of collective spinning in terms of the picture of strong spining.

10. Localization and mezoscopic effects in metals in low temperatures (Professor V.O. Shklovskii). New aspects of physics of low-temperature electic conductivity of metals. Weak localization, Anderson localization, leaping conductivity of Anderson isulator, scale theory of strong localization, percolation electric conductivity of macrodisordered composites of fractal ideas, mezoscopic effects of low-temperature conductivity, universal fluctuations of conductance i 1/f.

11. Fundamentals of physics of superconductivity. Fundamentals of physics of superconductivity. Main properties of superconductors and their thermodynamic description, and also phenomenological theories of brothers London and Ginsburg-Landau and microscopic theory of Bardin-Cooper-Shriffer. Main ideas of weak superconductivity and tunnel effects in superconductors. Physical interpretation of phenomena is the centre of attention.

12. Superconduction metals and alloys. Main properties of superconductors of the first and second type, their thermodynamics, linear electrodynamics, based on the phenomenological equations of brothers London. Phenomenological theory of Ginsburg-Landau and microscopic theory of Bardin-Cooper-Shriffer. While studying superconductors of the second type, questions of phase state, spining and dynamics of rotational substance are examined. Interconnection of the structure and defection of superconduction materials with the features of superconduction state.

13. Applied aspects of superproductivity. The first part of the course is about fundamentals of weak superproductivity, stationary and nonstationary effects of Josephson, respond of Josephson transition on the external magnetic field, fluctuational effects and macroscopic quantum tunneling. Then go applied aspects (quantum interpherometers, bolometers and so on). The second part includes interaction of apricot vortices with defects of crystalline structure and vortical lattice and also effects which are typical for high-temperature superconductors. Utilization of superconductors for production of wire with high current ability and creation of high magnetic fields.

14. Fundamentals of physics of quantum liquids. Main properties of helium-4, caused of quantum effects in low temperatures, phenomenological theory of superfluid of Landau, hydrodynamics of quantum liquids and expansion of waves in quantum liquids. Superfluid of

thin pellicles of helium-4, condensation of Bose-Einstein, phenomenological theories of superfluid and vortical states in superfluid helium.

15. Computer modelling. Fundamentals of computer processing of experimental information and also calculations of physical characteristics and parameters of research objects on the basis of received information. Main possibilities of standart program “Origin”.