

Condensed Matter Physics
Description of the course
Spring 2007

Instructor V.L. Pokrovsky

This course intends to represent the basic ideas and experimental developments in the condensed matter physics. The basic states of condensed matter are liquids, liquid crystals, crystals, quasicrystals and glasses. The notion of the long-range order (LRO) allows to avoid microscopic details and focus on the long and intermediate scale phenomena (hydrodynamic and mesoscopic description). Long-wave low-energy excitations in media with violated continuous symmetry have the gapless energy spectrum. These so-called Goldstone modes are of paramount importance since they are responsible for long-wave dynamic processes: hydrodynamic flows, elastic waves, spin waves, diffusion, heat and charge conduction. They also lead to singularities in linear responses of these media.

Topological defects in these media, such as vortices, dislocations, disclinations, skyrmions, domain walls and kinks are localized excitations of ordered media. Their appearance changes drastically the static and dynamic behavior of the system. The topological phase transitions were observed in thin films of liquid ^4He and in two-dimensional crystals. Vortices in superconductors placed into magnetic field form a lattice. Their motion produces dissipation and transfer the superconductor into a resistive state. Therefore, in good superconductors the vortices are pinned by impurities or lattice defects.

The Quantum Hall effect also is based on a deep change in topology of the quantum state. A consequent explanation of this effect as well as consideration of the vortex pinning belongs to another part of Condensed Matter Physics: Physics of systems with quenched disorder.

The knowledge of Quantum Mechanics and Statistical Physics in the limits of first courses is presumed.

The principal textbook is “Principle of Condensed Matter Physics” by Chaikin and Lubensky, Cambridge University Press, 1995.

This course has mainly the purpose of information for interested people. No exams are planned. The listeners will be supplied by problems mainly for self-control, in total 6 assignments. The grade A will be given for solution of more than 70% of assignments and the grade B for solution from 50 to 70% of problems.