Condensed Matter Physics.

Syllabus of the course 689, 2007

Instructor Valery Pokrovsky

1. Introduction. Mesoscopic description of condensed matter. Ordered and disordered states. Experimental tools of studying condensed matter..
2. Simple models displaying long-range orders: Ising model, the Lattice gas model, XY-model, Heisenberg model.
3. Order as the violation of symmetry. Landau theory. Groups and their representations. Initial and residual symmetry. Degeneration orbits. Thermodynamic fields and linear responses (susceptibilities). Goldstone modes.
4. Phase transitions. Mean field theory. Scaling. Wilson renormalization group.
5. Liquid crystals and crystals. Weak and strong order. Elasticity of crystals. Frank moduli of liquid crystals.
6. Magnets and ferroelectrics.
7. Superfluids and Superconductors.
8. Long-wave-length dynamics. Propagating and relaxational modes. Conservation laws and dissipation. Hydrodynamics. Sound excitations. Landau-Lifshitz equation and spin waves. Diffusion. Nucleation.
9. Topological excitations.
10. Two-dimensional ordered systems.
11. Incommensurate crystals and quasicrystals.
12. Ginzburg-Landau-Chern-Simons theory of the Quantum Hall effect.

Topics for presentations:

1. Quasicrystals.
2. Fredericks transition.
3. Blue phases of cholesteric liquid crystals.
4. Vortices in superconductors and superfluids.
5. Order parameter in ^{3}He and exotic superconductors.
6. Condensate in cooled gases of alkali metals.
7. High-T_c superconductors.
8. Charge and spin density waves.
9. Modulated magnetic structures (Cr).
10. Metal-insulator transition.
11. Giant and colossal magneto-resistance.
12. . Soft matter: colloids and polymers.