Physics of Bose-Systems (lecturer: Dr. Andrij Rovenchak)

[4 ECTS credits]

Lectures

1. Introduction: History of Bose-system studies
2. Ideal quantum gases: Derivation of the distribution functions
3. Thermodynamics of the ideal Bose-gas
4. Ideal Bose-gas in an external field
5. Bose-systems with a finite number of particles
6. Gross–Pitaevskii equation
7. Bogoliubov's method of approximate second quantization
8. Bose-systems with strong interactions
9. Physical grounds of experimental techniques for cooling and trapping atoms

Seminars

1. Bose's original paper on the derivation of Planck's distribution
2. Ideal D-dimensional Bose-gas: density of states, phase transition temperature T_c, thermodynamic functions in the vicinity of T_c for different D values
3. Ideal Bose-gas in spherically-symmetric traps $U = U(|\mathbf{r}|)$. Two-dimensional ideal gas in the oscillator trap. Ideal gas with a power dispersion law in traps of different shapes
4. Finite systems in spaces with dimensionality $D > 2$ and $D = 1$. Integer partitions and microcanonical treatment of the harmonic oscillator system
5. Gross–Pitaevskii equation: ground state of the homogeneous hard-sphere system; excitation spectrum of a weakly-interacting Bose-gas
6. Bogoliubov's approach to the calculation of the excitation spectrum of a weakly-interacting Bose-gas: homogeneous systems and harmonic traps
7. Collective variables: Hamiltonian of and interacting Bose-system; ground state wave-function; interacomic potentials and structure functions
8. Two-time temperature Green's functions. Calculations of thermodynamic functions. Excitation spectrum of a two-component bosonic mixture
9. Physical grounds of cooling techniques: laser cooling; Sisyphus cooling; evaporative cooling. Physical principles of trapping techniques for magnetic and magneto-optical traps

Grading plan:

Work during seminars:	10%
Seminar reports (average):	20%
Mid-term and final tests (2 × 10%) =	20%
Final exam:	50%
Total:	**100%**

Grading scale: 90–100 = A; 81–90 = B; 71–80 = C; 61–70 = D; 51–60 = E