Advanced Statistical Physics

Identification number	Workload	Credits	Term of studying	Frequency of occurrence	Duration
MN-P-PN-StatPhysII	270 h	9 CP	1st Semester	Every winter term	1 Semester

1	Type of lessons	Contact times	Self-study times	Intended group size
	a) Lecture	56 h	84 h	15–20 Students per problem class
	b) Problem Class	28 h	84 h	
	c) Preparation for exam	---	18 h	

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Aims of the module and acquired skills

This course introduces a wide range of concepts used to describe many-particle systems: Stochastic dynamics in and out of equilibrium, exact solutions of lattice models, mean-field theory, the renormalization group, and disordered systems. In particular, the renormalization group provides a unifying language across a wide range of theoretical physics: from quantum field theory and particle physics to statistical physics and condensed matter. Stochastic dynamics is a key concept to describe systems out of equilibrium, for instance transport and traffic phenomena, the dynamics of biomolecules, neural systems, or biological evolution. The course is a recommended prerequisite for the area of specialization (AoS) "Statistical and Biological Physics" and requires participation in the lecture course and in the exercise sessions.

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Contents of the module

1. Macroscopic and microscopic degrees of freedom
   - conservation laws
   - fast and slow variables
   - elementary continuum mechanics and hydrodynamics
2. Phase transitions and critical phenomena
   - Universality
   - Landau theory
   - relevance of fluctuations
   - field-theoretic approach
3. Scaling and renormalization
4. Dynamics
   - Correlation- and response functions
   - Langevin- and Fokker-Planck equations
   - the Wiener integral
   - nonequilibrium stationary states
5. Disordered systems and glasses

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Teaching/Learning methods

The module consists of a lecture course, supplemented by a problem class.

5	Requirements for participation Classical theoretical physics; elementary thermodynamics and statistical physics.
6	Type of module examinations The module is passed by passing a written exam, which is held during the semester and is offered again at the beginning of the following semester. To be accepted for the written exam, students must actively participate in the problem class, solve the homework problems and register for the exam.
7	Requisites for the allocation of credits The module is passed by passing a written exam. The grade given for the module is equal to the grade of the written exam.
8	Compatibility with other Curricula As elective subject in other M.Sc. programs
9	Significance of the module mark for the overall grade The weight of the module is 9/111 ≈ 8.1 %.
10	Module coordinator J. Krug, J. Berg
11	Additional information Literature: Plischke and Bergersen, Equilibrium statistical physics (World Scientific) Goldenfeld, Lectures on phase transitions and the renormalization group (Westview Press) Chaikin and Lubensky, Principles of condensed matter physics (Cambridge University Press) Version: 24.10.2017 JB