DIRECTORY OF MODULES OFFERED IN ENGLISH LANGUAGE

COURSES OFFERED IN ENGLISH AT THE UNIVERSITY OF GÖTTINGEN
ACADEMIC YEAR 2017/2018

FACULTY OF PHYSICS

GEORG-AUGUST-UNIVERSITÄT
GÖTTINGEN

A very warm welcome!

The University of Göttingen features an outstanding study environment for both exchange and full-degree students. All courses of study benefit from an excellent research-oriented environment formed by a broad network including five Max Planck Institutes, the German Primate Centre, the German Aerospace Centre and the Academy of Science and Humanities: the Göttingen Campus. An increasing number of lectures and courses are taught in the English language attracting more and more international students. This catalogue provides an impression of what is available.

This catalogue of courses taught in English varies from faculty to faculty and the courses available to you depend on whether you are an exchange student coming to Göttingen for a semester or an academic year, or whether you are a full degree student coming to Göttingen to complete an entire degree programme. You may take most courses in the programme you are enrolled in, however in a few cases restrictions may apply. Selecting courses from other subjects or other departments might require negotiations. If you have any questions, please contact the study advisor in charge of your subject.

Prior to their arrival in Göttingen exchange students have to set up a learning agreement. In some cases restrictions will apply, e.g. signing up for certain laboratory courses may not be possible. Generally exchange students are required to take at least half of the lectures and courses within their chosen subject.

Full degree students must first apply for a study place. Links to websites with application guidelines and deadlines are provided by some subjects/faculties. If not stated otherwise please visit:

http://www.uni-goettingen.de/en/3811.html

In any case, you are very welcome to browse through this catalogue to find/check out courses that suit your interests! For the complete course catalogue of the University of Göttingen see:

https://univz.uni-goettingen.de/qisserver/

We look forward to welcoming you in Göttingen!

Index by areas of study

I. Faculty of Physics

1. Bachelor modules

2. Master modules

Georg-August-Universität Göttingen **Module B.Phy.1512: Particle physics II - of and with quarks**	6 C 6 WLH

Learning outcome, core skills: After successful completion of this module, students should be familiar with the properties and interactions of quarks as well as with experimental methods and experiments which lead to their discovery and are used for precise studies.	**Workload:** Attendance time: 84 h Self-study time: 96 h

Courses:	
1. Particle physics II - of and with quarks (Lecture)	4 WLH
2. Particle physics II - of and with quarks (Exercise)	2 WLH

Examination: Oral examination (approx. 30 minutes) **Examination requirements:** Concepts and methods along with specific implementations of statistical methods in data analysis. Properties and discovery of quarks, discovery of W and Z bosons at hadron colliders, the top-quark, CKM mixing matrix, decays of heavy quarks, quark mixing and oscillations, CP-violation, jets, gluons and fragmentation, deep-inelastic scattering, QCD tests and measurement of the strong coupling alpha_s.	6 C

Admission requirements: none	**Recommended previous knowledge:** Introduction to Nuclear/Particle Physics
Language: German, English	**Person responsible for module:** Prof. Dr. Arnulf Quadt
Course frequency: each summer semester	**Duration:** 1 semester[s]
Number of repeat examinations permitted: 3 times	**Recommended semester:** Bachelor: 6; Master: 1 - 2
Maximum number of students: 30	

Georg-August-Universität Göttingen **Module B.Phy.1522: Solid State Physics II**	6 C 4 WLH

Learning outcome, core skills: After successful completion of this Module students will be able to work with advanced concepts, phenomena and models of solid state physics.	**Workload:** Attendance time: 56 h Self-study time: 124 h

Course: Solid State Physics II	
Examination: Oral examination (approx. 30 minutes) **Examination requirements:** Examination topics: Basics, phenomena and models for electrons and lattice dynamics in solids. Concepts of quasi-particle interaction: Transport phenomena incl. electrical and thermal conductivity, dielectric properties. Semiconductors, magnetic properties of solids, superconductivity.	6 C

Admission requirements: none	**Recommended previous knowledge:** Introduction to solid state physics
Language: German, English	**Person responsible for module:** StudiendekanIn der Fakultät für Physik
Course frequency: each summer semester	**Duration:** 1 semester[s]
Number of repeat examinations permitted: 3 times	**Recommended semester:** Bachelor: 6; Master: 1 - 2
Maximum number of students: 120	

Georg-August-Universität Göttingen **Module B.Phy.1551: Introduction to Astrophysics**	8 C 6 WLH

Learning outcome, core skills: After successful completion of the modul students should be familiar with the basic concepts of astrophysics in observation and theory.	**Workload:** Attendance time: 84 h Self-study time: 156 h

Course: Lecture and exercises for introduction to astrophysics	
Examination: Written examination (120 minutes) **Examination prerequisites:** At least 50% of the homework of the excercises have to be solved successfully. **Examination requirements:** Observational techniques, Planets and exoplanets, planet formation, stellar formation, structure and evolution, galaxies, AGN and quasars, cosmology, structure formation	8 C

Admission requirements: none	**Recommended previous knowledge:** none
Language: English, German	**Person responsible for module:** Prof. Dr. Wolfram Kollatschny
Course frequency: each winter semester	**Duration:** 1 semester[s]
Number of repeat examinations permitted: 3 times	**Recommended semester:** Bachelor: 5 - 6; Master: 1
Maximum number of students: 120	

Additional notes and regulations:

Special Regulations for students of Master of Education:

- Exercises will take place in German.
- Exam will be in German.

Georg-August-Universität Göttingen **Module B.Phy.1561: Introduction to Physics of Complex Systems**	8 C 6 WLH

Learning outcome, core skills: Sound knowledge of essential methods and concepts from Nonlinear Dynamics and Complex Systems Theory, including practical skills for analysis and simulation (using, for example, the programming language python) of dynamical systems.	**Workload:** Attendance time: 84 h Self-study time: 156 h

Courses:	
1. Introduction to Physics of Complex Systems (Lecture)	4 WLH
2. Introduction to Physics of Complex Systems (Exercise)	2 WLH

Examination: written examination (120 Min.) or oral examination (approx. 30 Min.) **Examination requirements:** • Knowledge of fundamental principles and methods of Nonlinear Physics • Modern experimental techniques and theoretical models of Complex Systems theory.	8 C

Admission requirements: none	**Recommended previous knowledge:** Basic programming skills (for the exercises)
Language: English, German	**Person responsible for module:** apl. Prof. Dr. Ulrich Parlitz
Course frequency: each winter semester	**Duration:** 1 semester[s]
Number of repeat examinations permitted: 3 times	**Recommended semester:** Bachelor: 5 - 6; Master: 1 - 2
Maximum number of students: 120	

Georg-August-Universität Göttingen **Module B.Phy.1571: Introduction to Biophysics**	8 C 6 WLH

Learning outcome, core skills: After attending this course, students will be familiar with basic concepts and phenomena, theoretical descriptions, and experimental methods in biophysics.	**Workload:** Attendance time: 84 h Self-study time: 156 h

Courses:	
1. Introduction to Biophysics (Lecture) *Contents*: components of the cell; diffusion, Brownian motion and random walks; low Reynolds number hydrodynamics; chemical reactions, cooperativity and enzymes; biomolecular interaction forces and self-assembly; membranes; polymer physics and mechanics of the cytoskeleton; neurobiophysics; experimental methods and microscopy	4 WLH
2. Introduction to Biophysics (Exercise)	2 WLH

Examination: Written exam (120 min.) or oral exam (ca. 30 min.) **Examination prerequisites:** At least 50% of the homework of the excercises have to be solved successfully. **Examination requirements:** Knowledge of the fundamental principles, theoretical descriptions and experimental methods of biophysics.	8 C

Admission requirements: none	**Recommended previous knowledge:** none
Language: English	**Person responsible for module:** Prof. Dr. Jörg Enderlein
Course frequency: each winter semester	**Duration:** 1 semester[s]
Number of repeat examinations permitted: 3 times	**Recommended semester:** Bachelor: 5 - 6; Master: 1 - 2
Maximum number of students: 100	

Georg-August-Universität Göttingen **Module B.Phy.5503: Astrophysical Spectroscopy**	3 C 2 WLH

Learning outcome, core skills: After successful completion of the modul the students should ... • know astronomial telescopes and measurement techniques • have an understanding of spectroscopic observation techniques • know principles of spectroscopy and design of astronomical spectrographs • know planning and execution of astronomical observations • data reduction and analysis	**Workload:** Attendance time: 28 h Self-study time: 62 h

Course: Lecture (Lecture) *Contents*: Astrophysical Spectroscopy	

Examination: Written examination (120 Min.) or oral examination (approx. 30 Min.) **Examination requirements:** Knowledge of astronomical spectroscopy, telescopes, image errors, instrumentation; observation, reduction and analysis of spectroscopic data.	3 C

Admission requirements: none	**Recommended previous knowledge:** Introduction to Astrophysics
Language: German, English	**Person responsible for module:** Prof. Dr. Ansgar Reiners
Course frequency: each summer semester	**Duration:** 1 semester[s]
Number of repeat examinations permitted: 3 times	**Recommended semester:** Bachelor: 6; Master: 1 - 2
Maximum number of students: 40	

Georg-August-Universität Göttingen **Module B.Phy.5505: Data Analysis in Astrophysics**	3 C 2 WLH

Learning outcome, core skills: After successful completion of the modul students are able to model noise and signal.	**Workload:** Attendance time: 28 h Self-study time: 62 h

Course: Vorlesung (Lecture)	

Examination: Oral examination (approx. 30 minutes)	3 C

Examination requirements: Demonstrate an understanding of concepts developed in lecture: Introduction to methods of data analysis in astrophysics: Random signal and noise; correlation analysis; model fitting by least squares and maximum likelihood; Monte Carlo simulations; Fourier analysis; filtering; signal and image processing; Hilbert transform; mapping; applications to problems of astrophysical relevance.	

Admission requirements: none	**Recommended previous knowledge:** none
Language: English	**Person responsible for module:** StudiendekanIn der Fakultät für Physik
Course frequency: each summer semester	**Duration:** 1 semester[s]
Number of repeat examinations permitted: 3 times	**Recommended semester:** Bachelor: 6; Master: 1
Maximum number of students: 40	

Georg-August-Universität Göttingen **Module B.Phy.5511: Magnetohydrodynamics**	3 C 2 WLH

Learning outcome, core skills: After successful comletion of this module, students should be able to apply the fundamental concepts and methods of magnetohydrodynamics to geo- and astrophysical problems.	**Workload:** Attendance time: 28 h Self-study time: 62 h

Course: Lecture (Lecture)	

Examination: Written examination (120 Min.) or oral examination (approx. 30 Min.) **Examination requirements:** Demonstrate an understanding of the most important subjects treated during the lecture: The induction equation, the dynamo effect, mean field magnetohydrodynamics, Alfven-waves	

Admission requirements: none	**Recommended previous knowledge:** none
Language: German, English	**Person responsible for module:** Prof. Dr. Andreas Tilgner
Course frequency: every 4th semester	**Duration:** 1 semester[s]
Number of repeat examinations permitted: 3 times	**Recommended semester:** Bachelor: 5 - 6; Master: 1 - 4
Maximum number of students: 20	

Georg-August-Universität Göttingen **Module B.Phy.5512: Low-mass stars, brown dwarfs, and planets**	3 C 2 WLH

Learning outcome, core skills: After successful completion of the modul students should be familiar with concepts of stellar and planetary astrophysics and should know how to applicate physical concepts in an astrophysical context.	**Workload:** Attendance time: 28 h Self-study time: 62 h

Course: Lecture (Lecture)	

Examination: Written examination (120 Min.) or oral examination (approx. 30 Min.) **Examination requirements:** Formation, evolution, structure, and atmospheres of low-mass stars and sub-stellar objects; detection and characterization methods	3 C

Admission requirements: none	**Recommended previous knowledge:** Introduction to astrophysics.
Language: German, English	**Person responsible for module:** Prof. Dr. Stefan Dreizler
Course frequency: each summer semester	**Duration:** 1 semester[s]
Number of repeat examinations permitted: 3 times	**Recommended semester:** Bachelor: 6; Master: 1 - 3
Maximum number of students: 40	

Georg-August-Universität Göttingen **Module B.Phy.5513: Numerical fluid dynamics**	6 C 4 WLH

Learning outcome, core skills: After completion of this module students should ... • know the basic methods for solving partial differential equations • be able to program and analyze numerical methods for the solution of partial differential equations.	**Workload:** Attendance time: 56 h Self-study time: 124 h

Course: Lecture with exercises	

Examination: Written report (max. 15 S.) or oral examination (approx. 30 Min.) **Examination requirements:** Basic programming skills. Finite difference, finite volume, finite element and spectral methods. Explicit and implicit time steps. Stability analysis.	

Admission requirements: none	**Recommended previous knowledge:** none
Language: German, English	**Person responsible for module:** Prof. Dr. Andreas Tilgner
Course frequency: every 4th semester	**Duration:** 1 semester[s]
Number of repeat examinations permitted: 3 times	**Recommended semester:** Bachelor: 5 - 6; Master: 1 - 4
Maximum number of students: 20	

Georg-August-Universität Göttingen **Module B.Phy.5514: Physics of the Interior of the Sun and Stars**	3 C 2 WLH

Learning outcome, core skills: After successful completion of the modul students should be able ... • to understand the equations of stellar structure, • to understand current questions about the physics of solar/stellar interiors and magnetism, • to understand the physics of solar/stellar oscillations and their diagnostic potential.	**Workload:** Attendance time: 28 h Self-study time: 62 h

Course: Vorlesung (Lecture)	

Examination: Oral examination (approx. 30 minutes)	3 C

Examination requirements: Demonstrate an understanding of concepts developed in lecture: Introduction to stellar structure, evolution, and dynamics; rotation; convection; dynamos; observations of solar and stellar oscillations; introduction to stellar pulsations; normal modes; weak perturbation theory; numerical forward modeling	

Admission requirements: none	**Recommended previous knowledge:** none
Language: English	**Person responsible for module:** StudiendekanIn der Fakultät für Physik
Course frequency: each winter semester	**Duration:** 1 semester[s]
Number of repeat examinations permitted: 3 times	**Recommended semester:** Bachelor: 5 - 6; Master: 1 - 3
Maximum number of students: 40	

Georg-August-Universität Göttingen **Module B.Phy.5517: Physics of the Sun, Heliosphere and Space Weather: Key Knowledge**	3 C 2 WLH

Learning outcome, core skills: Introduction into the basics concepts of solar and heliospheric physics	**Workload:** Attendance time: 28 h Self-study time: 62 h

Course: Vorlesung (Lecture)	

Examination: Written examination (120 Min.) or oral examination (approx. 30 Min.) **Examination requirements:** Basic processes in solar and heliospheric physics	

Admission requirements: none	**Recommended previous knowledge:** none
Language: German, English	**Person responsible for module:** Prof. Dr. Ansgar Reiners Contact Person: Dr. Bothmer
Course frequency: each winter semester	**Duration:** 1 semester[s]
Number of repeat examinations permitted: 3 times	**Recommended semester:** Bachelor: 4 - 6; Master: 1
Maximum number of students: 30	

Georg-August-Universität Göttingen **Module B.Phy.5518: Physics of the Sun, Heliosphere and Space Weather: Space Weather Applications**	3 C 2 WLH

Learning outcome, core skills: Learning outcome: Introduction into the physics processes of space weather based on applied study cases. Core skills: Knowledge about physical processes of space weather and its applications. Ability in self-organised solving of case studies.	**Workload:** Attendance time: 28 h Self-study time: 62 h

Course: Vorlesung (Lecture)	

Examination: Oral examination (approx. 30 Min.) or written examination (120 Min.) **Examination requirements:** Knowledge about physical processes of space weather.	

Admission requirements: none	**Recommended previous knowledge:** none
Language: German, English	**Person responsible for module:** Prof. Dr. Ansgar Reiners Contact person: Dr. Bothmer
Course frequency: each summer semester	**Duration:** 1 semester[s]
Number of repeat examinations permitted: 3 times	**Recommended semester:** Bachelor: 4 - 6; Master: 1
Maximum number of students: 30	

Georg-August-Universität Göttingen **Module B.Phy.5522: Solar Eclipses and Physics of the Corona**	3 C 2 WLH

Learning outcome, core skills: After successfully completed the modul students should understand the basic processes on how a cool star can heat and sustain its million Kelvin hot outer atmosphere, the corona. Using basic concepts of magnetohydrodynamics they should also be able to explain the structure and dynamics of the corona.	**Workload:** Attendance time: 28 h Self-study time: 62 h

Course: Lecture (Lecture)	

Examination: Written examination (120 Min.) or oral examination (approx. 30 Min.) **Examination requirements:** Understanding of basic physical process in the corona of a star. The exam will be based on excecises distributed during the lecture course. Phenomenology of solar eclipses, timing of eclipses; Physics of hot gases; interaction of gas and magnetic field in the outer atmosphere of the Sun and other stars; phyiscal processes for plasma heating („coronal heating“); wave and Ohmic heating, acceleration of plasma to form a solar wind, solar-terrestrial relations	3 C

Admission requirements: none	**Recommended previous knowledge:** -Introduction to astrophysics - Electrodynamics
Language: German, English	**Person responsible for module:** apl. Prof. Dr. Hardi Peter
Course frequency: every 4th semester; summer semester	**Duration:** 1 semester[s]
Number of repeat examinations permitted: 3 times	**Recommended semester:** Bachelor: 4 - 6; Master: 1 - 3
Maximum number of students: not limited	

Georg-August-Universität Göttingen **Module B.Phy.5523: General Relativity**	6 C 6 WLH

Learning outcome, core skills: **Learning outcome:** Basic structures of Differential Geometry, Einstein's equation and underlying principles, Schwarzschild space-time and classical tests of General Relativity, black holes, gravitational waves, foundations of cosmology **Core skills:** The students shall master the foundations of General Relativity mathematically and physically. They shall be able to perform corresponding computations in simple models.	**Workload:** Attendance time: 84 h Self-study time: 96 h

Courses:	
1. Lecture (Lecture)	4 WLH
2. Excercises	2 WLH

Examination: Written examination (120 minutes) **Examination requirements:** Basic structures of Differential geometry, simple examles of computations, Einstein's equation, underlying principles, Schwarzschild space-time, classical tests of General Relativity, foundations of cosmology.	6 C

Examination requirements:	

Admission requirements: none	**Recommended previous knowledge:** Basic knowledge of Mechanics, Electrodynamics and special Relativity, Analysis of several real variables
Language: German, English	**Person responsible for module:** apl. Prof. Folkert Müller-Hoissen
Course frequency: Two-year as required / Winter semester	**Duration:** 1 semester[s]
Number of repeat examinations permitted: 3 times	**Recommended semester:** Bachelor: 5 - 6; Master: 1 - 4
Maximum number of students: 60	

Georg-August-Universität Göttingen **Module B.Phy.5525: Seminar on Integrable Systems and Solitons**	4 C 2 WLH

Learning outcome, core skills: **Learning outcome:** Special topics of the mathematics and physics of integrable systems and solitons, using original articles or advanced text books. **Core skills:** Ability to get acquainted with an advanced topic from this area of mathematics and physics, using original articles or advanced text book material, and to present a professional talk about this material.	**Workload:** Attendance time: 28 h Self-study time: 92 h

Course: Seminar	

Examination: Presentation with discussion (approx. 75 minutes) and written elaboration (max. 10 pages) **Examination prerequisites:** Active participation	

Admission requirements: none	**Recommended previous knowledge:** Basic knowledge of the mathematics and physics of integrable systems and solitons.
Language: German, English	**Person responsible for module:** apl. Prof. Folkert Müller-Hoissen
Course frequency: every 4th semester; Two-year as required / Summer semester	**Duration:** 1 semester[s]
Number of repeat examinations permitted: 3 times	**Recommended semester:** Bachelor: 5 - 6; Master: 1 - 4
Maximum number of students: 10	

Georg-August-Universität Göttingen **Module B.Phy.5530: Introduction to Cosmology**	3 C 2 WLH

Learning outcome, core skills: Learning outcome: Newtonian cosmology, relativistic homogeneous isotropic cosmology, horizons and distances, the hot universe, Newtonian inhomogeneous cosmology, inflation. This course will be based on video lectures and short quizzes that will be discussed in class. Core skills: Understanding the evolution of the universe on very large scales, knowledge of current questions in physical cosmology.	**Workload:** Attendance time: 28 h Self-study time: 62 h

Course: Introduction to Cosmology (Lecture) *Course frequency:* jedes Sommersemester	2 WLH

Examination: written (120 Min.) or oral exam (ca. 30 Min.) **Examination prerequisites:** keine **Examination requirements:** Physikalisches Verständnis der Entwicklung des Universums auf sehr großen Skalen, Kenntnis der aktuellen Fragen der Kosmologie	3 C

Admission requirements: none	**Recommended previous knowledge:** none
Language: English	**Person responsible for module:** Prof. Dr. Jens Niemeyer
Course frequency: every 4th semester; vorraussichtlich SoSe	**Duration:** 1 semester[s]
Number of repeat examinations permitted: 3 times	**Recommended semester:** from 5
Maximum number of students: 20	

Additional notes and regulations: Study Foci: AG, KT

Georg-August-Universität Göttingen **Module B.Phy.5531: Origin of solar systems**	3 C 2 WLH

Learning outcome, core skills: After finishing the module the students should be able to apply the fundamental knowledge about the structure and the formation of planetary systems to geophysical and astrophysical problems.	**Workload:** Attendance time: 28 h Self-study time: 62 h

Course: Lecture (Lecture)	

Examination: Oral examination (approx. 30 minutes) **Examination requirements:** Theory and observation of early phases of stars and planetary systems, including extrasolar planets and our own solar system. In particular: Early phases of formation of stars and protoplanetary disks, models of the condensation of molecules and minerals during formation of planetary systems, chemistry and radiation in low-density astrophysical environments, formation of planets and their migration, small solar system bodies as source of information on the early solar system.	3 C

Admission requirements: none	**Recommended previous knowledge:** Introduction to Astropyhsics
Language: German, English	**Person responsible for module:** Prof. Dr. Stefan Dreizler Ansprechpartner: Dr. Jockers, Dr. Krüger
Course frequency: each winter semester	**Duration:** 1 semester[s]
Number of repeat examinations permitted: 3 times	**Recommended semester:** from 4
Maximum number of students: not limited	

Georg-August-Universität Göttingen **Module B.Phy.5533: Solar and Stellar Activity**	6 C 4 WLH

Learning outcome, core skills: Fundamental knowledge of solar and stellar structure, sun-like stars, generation of magnetic fields and magnetic activity, physics of the chromosphere and corona, dynamo mechanisms, evolution of stellar activity and other stellar parameters, star-planet interaction.	**Workload:** Attendance time: 56 h Self-study time: 124 h

Course: Lecture (Lecture)	

Examination: Written examination (ca. 120 Min.) or oral examination (approx. 30 Min.) **Examination requirements:** Knowledge of the structure of the sun and solar-like stars; generation of magnetic fields and magnetic activity; physics of the chromosphere and the corona; dynamo mechanisms; evolution of stellar activity; star-planet interaction	6 C

Admission requirements: none	**Recommended previous knowledge:** Introduction to Astrophysics
Language: German, English	**Person responsible for module:** Prof. Dr. Ansgar Reiners
Course frequency: unregular	**Duration:** 1 semester[s]
Number of repeat examinations permitted: 3 times	**Recommended semester:** Bachelor: 6; Master: 1 - 4
Maximum number of students: 40	

Georg-August-Universität Göttingen **Module B.Phy.5538: Stellar Atmospheres**	6 C 4 WLH

Learning outcome, core skills: After successful completion of the modul students should know how to applicate physical concepts (such as atomic and molecular physics, thermodynamics, and statistical physics) in an astrophysical context, and know their implementation in numerical simulations.	**Workload:** Attendance time: 56 h Self-study time: 124 h

Courses:	
1. Physics of stellar atmospheres (Vorlesung)	2 WLH
2. Stellar atmosphere modelling (Computerpraktikum)	2 WLH
Examination: Oral Exam (ca. 30 Min.)	6 C

Examination requirements: Oral account of the context and concepts learned during the two courses on the topics of interaction of radiation and matter; radiative transfer; structure of stellar atmospheres; and theoretical foundations of spectral analysis; answering of specific questions on all the aspects in this field.	

Admission requirements: none	**Recommended previous knowledge:** none
Language: English	**Person responsible for module:** Prof. Dr. Stefan Dreizler
Course frequency: each winter semester	**Duration:** 1 semester[s]
Number of repeat examinations permitted: 3 times	**Recommended semester:** Bachelor: 5 - 6; Master: 1 - 4
Maximum number of students: 20	

Additional notes and regulations: Schwerpunkt: Astro-/Geophysik

Georg-August-Universität Göttingen **Module B.Phy.5539: Physics of Stellar Atmospheres**	3 C 2 WLH

Learning outcome, core skills: After successful completion of the modul students should understand the interaction of radiation and matter, radiative transfer, structure of stellar atmospheres; thorough understand the theoretical foundations of spectral analysis and know how to applicate physical concepts (such as atomic and molecular physics, thermodynamics, and statistical physics) in an astrophysical context.	**Workload:** Attendance time: 28 h Self-study time: 62 h

Course: Physics of stellar atmospheres (Vorlesung)	
Examination: Oral Exam (ca. 30 Min.)	3 C

Examination requirements: Oral account of the context and concepts of radiative transfer and structure of stellar atmospheres.	

Admission requirements: none	**Recommended previous knowledge:** none
Language: English	**Person responsible for module:** Prof. Dr. Stefan Dreizler
Course frequency: each winter semester	**Duration:** 1 semester[s]
Number of repeat examinations permitted: 3 times	**Recommended semester:** Bachelor: 5 - 6; Master: 1 - 4
Maximum number of students: 20	

Additional notes and regulations: Schwerpunkt: Astro-/Geophysik

Georg-August-Universität Göttingen **Module B.Phy.5540: Introduction to Cosmology**	3 C 2 WLH

Learning outcome, core skills: After successful completion of the modul students should understand the evolution of the universe on very large scales, knowledge of current questions in physical cosmology.	**Workload:** Attendance time: 28 h Self-study time: 62 h

Course: Lecture Introduction to Cosmology	

Examination: written (120 min.) or oral (ca. 30 min.) exam **Examination requirements:** Key concepts and calculations from homogeneous cosmology: Newtonian cosmology; relativistic homogeneous isotropic cosmology; horizons and distances; the hot universe; Newtonian inhomogeneous cosmology; inflation. This course will be based on video lectures and short quizzes that will be discussed in class.	3 C

Admission requirements: none	**Recommended previous knowledge:** none
Language: English	**Person responsible for module:** Prof. Dr. Jens Niemeyer
Course frequency: each winter semester	**Duration:** 1 semester[s]
Number of repeat examinations permitted: 3 times	**Recommended semester:** Bachelor: 4 - 6; Master: 1 - 3
Maximum number of students: 20	

Additional notes and regulations: Schwerpunkt: Astro-/Geophysik; Kern-/Teilchenphysik

Georg-August-Universität Göttingen **Module B.Phy.5543: Black Holes**	3 C 2 WLH

Learning outcome, core skills: After successfully completing the module, students are expected to understand the basic mathematical properties of black holes as solutions of Einstein's equations of General Relativity and to know the scenarios of astrophysical black hole formation.	**Workload:** Attendance time: 28 h Self-study time: 62 h

Course: Black Holes (Lecture)	

Examination: Written examination (120 Min.) or oral examination (approx. 30 Min.) **Examination requirements:** Gravitational collapse, Schwarzschild black holes, charged black holes, rotating black holes, horizon properties, black hole mechanics, black hole thermodynamics	3 C

Admission requirements: none	**Recommended previous knowledge:** Basic knowledge of General Relativity
Language: German, English	**Person responsible for module:** Prof. Dr. Jens Niemeyer
Course frequency: at irregular intervals	**Duration:** 1 semester[s]
Number of repeat examinations permitted: 3 times	**Recommended semester:** Bachelor: 6; Master: 1 - 4
Maximum number of students: not limited	

Georg-August-Universität Göttingen **Module B.Phy.5544: Introduction to Turbulence**	3 C 2 WLH

Learning outcome, core skills: **Learning objectives:** In this course, the students will be introduced to the phenomenon of turbulence as a complex system that can be treated with methods from non-equilibrium statistical mechanics. The necessary statistical tools will be introduced and applied to obtain classical and recent results from turbulence theory. Furthermore, current numerical and experimental techniques will be discussed. **Competencies:** The students shall gain a fundamental understanding of turbulent flows as a problem of non-equilibrium statistical mechanics. Part of the course will be held in tutorial style in which textbook problems will be discussed in detail. The course shall also strengthen the students' ability to perform interdisciplinary work by stressing the interdisciplinary aspects of the field with connections to pure and applied math as well as engineering sciences.	**Workload:** Attendance time: 28 h Self-study time: 62 h

Course: Introduction to Turbulence (Lecture)	

Examination: Written exam (90 min.) or oral exam (approx. 30 min.) **Examination requirements:** Basic knowledge and understanding of the material covered in the course such as: continuum description of fluids (Navier-Stokes equations), non-dimensionalization & dimensional analysis, Kolmogorov phenomenology, intermittency, exact statistical approaches & the closure problem, soluble models of turbulence.	3 C

Admission requirements: none	**Recommended previous knowledge:** Basic Knowledge in continuum mechanics or electrodynamics
Language: English, German	**Person responsible for module:** Prof. Dr. Eberhard Bodenschatz
Course frequency: each winter semester	**Duration:** 1 semester[s]
Number of repeat examinations permitted: 3 times	**Recommended semester:** Bachelor: 5 - 6; Master: 1 - 4
Maximum number of students: 25	

Georg-August-Universität Göttingen **Module B.Phy.5604: Foundations of Nonequilibrium Statistical Physics**	3 C 2 WLH

Learning outcome, core skills: **Lernziele**: Invariant densities of phase-space flows with local and global conservation of phase-space volume; reduction of a microscopic dynamics to a stochastic description, to kinetic theory and to hydrodynamic transport equations; fluctuation theorems; Green-Kubo relations; local equilibrium; entropy balance and entropy production; the second law; statistical physics of equilibrium processes as a limit of a non-equilibrium processes; applications in nanotechnology and biology: small systems far from thermodynamic equilibrium. **Kompetenzen**: After successful completion of the modul the students should know modeling approaches for a statistical-physics description of small systems far from thermodynamic equilibrium: in homework problems, that will be presented in a subsequent symposium, this will be highlighted by explicitly working out examples in nanotechnology and biology.	**Workload:** Attendance time: 28 h Self-study time: 62 h

Course: lecture	

Examination: Presentation (approx. 30 min) and handout (max. 4 pages)	3 C

Examination requirements: Modeling of an experimental system by a Master equation, kinetic theory or Non-Equilibrium Molecular Dyanamics with discussion of the appropriate fluctuation relations and/or the relation of models on different levels of coarse graining.	

Admission requirements: none	**Recommended previous knowledge:** Statistische Physik
Language: English	**Person responsible for module:** StudiendekanIn der Fakultät für Physik
Course frequency: unregelmäßig	**Duration:** 1 semester[s]
Number of repeat examinations permitted: 3 times	**Recommended semester:** Bachelor: 4 - 6; Master: 1
Maximum number of students: 20	

Georg-August-Universität Göttingen **Module B.Phy.5605: Computational Neuroscience: Basics**	3 C 2 WLH

Learning outcome, core skills: **Goals:** Introduction to the different fields of Computational Neuroscience: • Models of single neurons, • Small networks, • Implementation of all simple as well as more complex numerical computations with few neurons. • Aspects of sensory signal processing (neurons as ‚filters'), • Development of topographic maps of sensory modalities (e.g. visual, auditory) in the brain, • First models of brain development, • Basics of adaptivity and learning, • Basic models of cognitive processing. **Kompetenzen/Competences:** On completion the students will have gained… • …overview over the different sub-fields of Computational Neuroscience; • …first insights and comprehension of the complexity of brain function ranging across all sub-fields; • …knowledge of the interrelations between mathematical/modelling methods and the to-be-modelled substrate (synapse, neuron, network, etc.); • …access to the different possible model level in Computational Neuroscience.	**Workload:** Attendance time: 28 h Self-study time: 62 h

Course: Vorlesung	

Examination: Written examination (45 minutes) **Examination requirements:** Actual examination requirements: Having gained overview across the different sub-fields of Computational Neuroscience; Having acquired first insights into the complexity of across the whole bandwidth of brain function; Having learned the interrelations between mathematical/modelling methods and the to-be-modelled substrate (synapse, neuron, network, etc.) Being able to realize different level of modelling in Computational Neuroscience.	3 C

Admission requirements: none	**Recommended previous knowledge:** none
Language: English	**Person responsible for module:** Prof. Dr. Florentin Andreas Wörgötter
Course frequency: each summer semester	**Duration:** 1 semester[s]
Number of repeat examinations permitted: twice	**Recommended semester:** Bachelor: 2 - 6; Master: 1 - 4

Georg-August-Universität Göttingen **Module B.Phy.5606: Mechanics of the cell**	3 C 2 WLH

Learning outcome, core skills: After successfully finishing this course, students will be familiar with fundamental concepts of cellular mechanics and will be able to apply them independently to specific questions.	**Workload:** Attendance time: 28 h Self-study time: 62 h

Course: Lecture	

Examination: oral exam (ca. 15 min.) or written exam (60 Min.) **Examination requirements:** Polymer physics and polymer networks, membranes, physics on small scales, cell mechanics, molecular motors, cell motility, dynamics in the cell	3 C

Admission requirements: none	**Recommended previous knowledge:** Introduction to Biophysics and/or Physics of Complex Systems
Language: English, German	**Person responsible for module:** Prof. Dr. Sarah Köster
Course frequency: sporadic	**Duration:** 1 semester[s]
Number of repeat examinations permitted: 3 times	**Recommended semester:** Bachelor: 5 - 6; Master: 1 - 4
Maximum number of students: not limited	

Georg-August-Universität Göttingen **Module B.Phy.5607: Mechanics and dynamics of the cytoskeleton**	4 C 2 WLH

Learning outcome, core skills: After successfully finishing this course, students will be able to work on specific questions with the help of book chapters or journal publications and to present the topic in a seminar talk.	**Workload:** Attendance time: 28 h Self-study time: 92 h

Course: Seminar	

Examination: Presentation with discussion (Bachelor approx. 30 min., Master approx. 60 min.) **Examination prerequisites:** Active participation **Examination requirements:** Polymer physics and polymer networks; membranes; physics on small scales; cell mechanics; molecular motors; cell motility; dynamics in the cell.	4 C

Admission requirements: none	**Recommended previous knowledge:** Introduction to Biophysics and/or Physics of Complex Systems
Language: German, English	**Person responsible for module:** Prof. Dr. Sarah Köster
Course frequency: sporadic	**Duration:** 1 semester[s]
Number of repeat examinations permitted: 3 times	**Recommended semester:** Bachelor: 5 - 6; Master: 1 - 4
Maximum number of students: 14	

Georg-August-Universität Göttingen **Module B.Phy.5608: Micro- and Nanofluidics**	3 C 2 WLH

Learning outcome, core skills: After successfully finishing this course, students will be familiar with basic hydrodynamics and their applications in biology, biophysics, material sciences and biotechnology. They should know the fundamentals of fluid dynamics on small scales and be able to apply them independently to specific questions.	**Workload:** Attendance time: 28 h Self-study time: 62 h

Course: Lecture	

Examination: Oral exam (ca. 30 min.) or written exam (60 min.) **Examination requirements:** Fluid dynamics, hydrodynamics on the micro- and nanoscale and its applications in biology, biophysics, material sciences and biotechnology; wetting and capillarity; “life” at low Reynolds numbers; soft lithography; fluidics in biology and biophysics, “lab-on-a-chip” applications; Navier-Stokes-Equation	3 C

Admission requirements: none	**Recommended previous knowledge:** Introduction to Biophysics and/or Physics of Complex Systems
Language: German, English	**Person responsible for module:** Prof. Dr. Sarah Köster
Course frequency: sporadic	**Duration:** 1 semester[s]
Number of repeat examinations permitted: 3 times	**Recommended semester:** Bachelor: 5 - 6; Master: 1 - 4
Maximum number of students: not limited	

Georg-August-Universität Göttingen **Module B.Phy.5611: Optical spectroscopy and microscopy**	3 C 2 WLH

Learning outcome, core skills: **Learning outcome**: Physical basics of fluorescence and fluorescence spectroscopy, fluorescence anisotropy, fluorescence lifetime, fluorescence correlation spectroscopy, basics of optical microscopy, resolution limit of optical microscopy, wide field and confocal microscopy, super-resolution microscopy. **Core skills:**The students shall learn the basics and applications of advanced fluorescence spectroscopy and microscopy, including single-molecule spectroscopy and all variants of super-resolution fluorescence microscopy.	**Workload:** Attendance time: 28 h Self-study time: 62 h

Course: Lecture	

Examination: Oral examination (approx. 30 minutes) **Examination requirements:** Fundamental understanding oft he physics of fluorescence and the applications of fluorescence in spectroscopy and microscopy.	3 C

Admission requirements: none	**Recommended previous knowledge:** none
Language: English, German	**Person responsible for module:** StudiendekanIn der Fakultät für Physik
Course frequency: every 4th semester	**Duration:** 1 semester[s]
Number of repeat examinations permitted: 3 times	**Recommended semester:** Bachelor: 4 - 6; Master: 1
Maximum number of students: 20	

Georg-August-Universität Göttingen **Module B.Phy.5613: Physics of soft condensed matter**	6 C 4 WLH

Learning outcome, core skills: After successfully finishing this course, students will be familiar with fundamental concepts of soft condensed matter physics and will be able to apply them independently to specific questions.	**Workload:** Attendance time: 56 h Self-study time: 124 h

Courses:	
1. Lecture	3 WLH
2. Homework/Excercises	1 WLH

Examination: Written exam (120 min.) or oral exam (ca. 30 min.) **Examination prerequisites:** 50% of problem sets (homework) have to be solved **Examination requirements:** Intermolecular interactions; phase transitions; interface physics; amphiphilic molecules; colloids; polymers; polymer networks; gels; fluid dynamics; self-organization.	6 C

Admission requirements: none	**Recommended previous knowledge:** Introduction to…Biophysics or/and Physics of complex systems or/and Solid State Physics or/and Materials Physics
Language: German, English	**Person responsible for module:** Prof. Dr. Sarah Köster
Course frequency: sporadic	**Duration:** 1 semester[s]
Number of repeat examinations permitted: 3 times	**Recommended semester:** Bachelor: 5 - 6; Master: 1 - 4
Maximum number of students: not limited	

Georg-August-Universität Göttingen **Module B.Phy.5614: Proseminar Computational Neuroscience**	4 C 2 WLH

Learning outcome, core skills: After successful completion of the module, students have deepened their knowledge in computational neuroscience / neuroinformatics by independent preparation of a topic. They should... - know and be able to apply methods of presentation of topics from computer science; - be able to deal with (English-language) literature; - be able to present a topic of computer science; - be able to lead a scientific discussion.	**Workload:** Attendance time: 28 h Self-study time: 92 h

Course: Proseminar	

Examination: Talk (approx. 45 Min.) with written report (max. 7 S.) **Examination requirements:** Proof of the acquired knowledge and skills to deal with scientific literature from the field of computational neuroscience / neuroinformatics under guidance by presentation and preparation.	4 C

Admission requirements: none	**Recommended previous knowledge:** B.Phy.5605
Language: English	**Person responsible for module:** StudiendekanIn der Fakultät für Physik
Course frequency: each semester	**Duration:** 1 semester[s]
Number of repeat examinations permitted: 3 times	**Recommended semester:** Bachelor: 4 - 6; Master: 1 - 3
Maximum number of students: 14	

Georg-August-Universität Göttingen **Module B.Phy.5616: Biophysics of the cell - physics on small scales**	6 C 4 WLH

Learning outcome, core skills: After successfully finishing this course, students will be familiar with fundamental concepts of cellular biophysics and will be able to apply them independently to specific questions.	**Workload:** Attendance time: 56 h Self-study time: 124 h

Courses:	
1. Lecture (Lecture)	3 WLH
2. Homework/Excercises	1 WLH

Examination: Written exam (120 min.) or oral exam (ca. 30 min.) **Examination prerequisites:** 50% of homework/problem sets have to be solved **Examination requirements:** Physical principles in cells; adhesion; motility; cellular communication; signal transduction; biopolymers and networks; nerve cinduction; extracellular matrix; experimental methods; current research.	6 C

Admission requirements: none	**Recommended previous knowledge:** Introduction to Biophyiscs and/or Physics of Complex Systems
Language: German, English	**Person responsible for module:** Prof. Dr. Sarah Köster
Course frequency: sporadic	**Duration:** 1 semester[s]
Number of repeat examinations permitted: 3 times	**Recommended semester:** Bachelor: 5 - 6; Master: 1 - 4
Maximum number of students: not limited	

Georg-August-Universität Göttingen **Module B.Phy.5620: Physics of Sports**	4 C 2 WLH

Learning outcome, core skills:	**Workload:**
After completing this module a student should be able to: • Research a topic in the scientific literature and analyse it critically. • Show fundamental skills in model building and, for example, in the discussion of nonlinear differential equations or other complex physical models.	Attendance time: 28 h Self-study time: 92 h

Course: Seminar	

Examination: Presentation with discussion (approx. 45 minutes) and supplementary report (max. 4 pages) **Examination prerequisites:** Active participation	

Examination requirements: The student should: Present a summary of the key physics underlying a particular sport; Explain the topic from intuition to a deep description of the relevant physical facts or foundation; Set up an appropriate model and discuss the solution. Where appropriate, the student must take into account a critical discussion of the relevant literature.	

Admission requirements: none	**Recommended previous knowledge:** Basic analytical mechanics and fluid dynamics.
Language: English, German	**Person responsible for module:** Prof. Dr. Stephan Herminghaus Contact persons: Dr. O. Bäumchen, Dr. M. Mazza
Course frequency: unegular, two year as required	**Duration:** 1 semester[s]
Number of repeat examinations permitted: 3 times	**Recommended semester:** Bachelor: 5 - 6; Master: 1 - 4
Maximum number of students: 25	

Georg-August-Universität Göttingen **Module B.Phy.5621: Stochastic Processes**	4 C 2 WLH

Learning outcome, core skills: After successful completion of this course, students should, when asked, be able to employ the fundamental concepts of stochastic processes, that lie on the boundary between biology, physics and economics.	**Workload:** Attendance time: 28 h Self-study time: 92 h

Course: Seminar	

Examination: Presentation with discussion (approx. 60 minutes) **Examination prerequisites:** Active Participation **Examination requirements:** Random walks, space-time propagation models (of information and epidemics); entropy concepts; Information theory for stochastic processes, Markov chains, Fokker-Planck formalism. The given presentation time includes time for the discussion.	

Examination requirements:	

Admission requirements: none	**Recommended previous knowledge:** none
Language: English	**Person responsible for module:** Prof. Dr. Theo Geisel
Course frequency: every 4th semester; two-year as required, summer semester or winter semester	**Duration:** 1 semester[s]
Number of repeat examinations permitted: 3 times	**Recommended semester:** Bachelor: 4 - 6; Master: 1 - 4
Maximum number of students: 20	

Georg-August-Universität Göttingen **Module B.Phy.5623: Theoretical Biophysics**	6 C 4 WLH

Learning outcome, core skills: **Learning outcome:** Basics of probability theory, Bayes Theorem, Brownian motion, stochastic differential equations, Langevin equation, path integrals, Fokker-Planck equation, Ornstein-Uhlenbeck processes, thermophoresis, chemotaxis, Fluctuation Dissipation Theorems, Stochastic Resonance, Thermal Ratchet, motor proteins, hydrodynamics at the nanoscale, population dynamics, Jarzynski relations, non-equilibrium thermodynamics, neural networks. **Core skills:** The core coal is to teach students fundamental theoretical concepts about stochastic systems in the widest sense, an the application of these concepts the biophysics of biomolecules, cells and populations.	**Workload:** Attendance time: 56 h Self-study time: 124 h

Course: Vorlesung mit Selbststudium Literatur	

Examination: Oral examination (approx. 30 minutes) **Examination requirements:** Derivation of fundamental relations describing stochastic systems, derivation, handling and explanation of differential equations, derivation of analytical and approximative solutions for the various considered problems.	6 C

Admission requirements: none	**Recommended previous knowledge:** none
Language: English, German	**Person responsible for module:** Prof. Dr. Jörg Enderlein
Course frequency: every 4th semester	**Duration:** 1 semester[s]
Number of repeat examinations permitted: 3 times	**Recommended semester:** Bachelor: 4 - 6; Master: 1 - 4
Maximum number of students: 20	

Georg-August-Universität Göttingen **Module B.Phy.5624: Introduction to Theoretical Neuroscience**	4 C 2 WLH

Learning outcome, core skills: After successfully completing this course, students should understand and be able to employ the fundamental concepts, model representations and mathematical methods of the theoretical physics of neuronal systems.	**Workload:** Attendance time: 28 h Self-study time: 92 h

Course: Seminar	

Examination: Lecture (approx. 60 minutes) **Examination prerequisites:** Active Participation **Examination requirements:** Elementary knowledge of the construction, biophysics and function of nerve cells; probabilistic analysis of sensory encoding; simple models of the dynamics and information processing in networks of biological neurons; modelling of the biophysical foundations of learning processes.	

Admission requirements: none	**Recommended previous knowledge:** none
Language: English	**Person responsible for module:** Prof. Dr. Fred Wolf
Course frequency: each summer semester	**Duration:** 1 semester[s]
Number of repeat examinations permitted: 3 times	**Recommended semester:** Bachelor: 4 - 6; Master: 1 - 4
Maximum number of students: 25	

Georg-August-Universität Göttingen **Module B.Phy.5628: Pattern Formation**	6 C 4 WLH

Learning outcome, core skills: **Learning outcome**: Spatial patterns such as stripes or spots emerge in many physical systems, biology and beyond. This course will cover the mechanisms and most common examples of such patterns. We shall show how broad classes of nonlinear dynamical systems are related in terms of non-dimensional groups, and symmetries. Linear stability theory will be introduced to demonstrate the onset of emergent features, and amplitude equations will be derived around these instabilities to describe the rules of pattern selection (like spots or stripes). Finally, the significance of defects and their dynamics will be explored. Model systems such as convection cells, waves in excitable tissue, wrinkling, reaction-diffusion patterns and beyond will be introduced. Additional context and related questions of current research will be covered in talks by members of the Göttingen Research Campus. **Core skills:** After successful completion of the modul, the students should... • know, how to approach the study of natural patterns in nonlinear systems from a rigorous physical perspective; • know, how to identify the conditions for the onset of a pattern, and to analyse pattern selection and stability; • be able to develop a familiarity with the principles of pattern formation, and apply these to a broad range of situations, from the large-scale structure of the universe, to a leopard's spots and flux tubes in superconductors; • be able to perform an in-depth investigation on a particular topic of their choice, and present this topic during class.	**Workload:** Attendance time: 56 h Self-study time: 124 h

Courses:	
1. lecture	2 WLH
2. tutorium	2 WLH

Examination: presentation (approx. 45 min) and handout (max. 4 pages)	6 C

Examination requirements: Modeling of an experimental system by identifying appropriate dimensionless variables; determining the stability threshold; deriving appropriate amplitude equations and discussing the pattern selection beyond the threshold of linear stability.	

Admission requirements: none	**Recommended previous knowledge:** Analytical Mechanics, basic knowledge on Partial Differential Equations.
Language: English	**Person responsible for module:** apl. Prof. Dr. Jürgen Vollmer
Course frequency: two year as required, summer or winter term	**Duration:** 1 semester[s]
Number of repeat examinations permitted:	**Recommended semester:**

3 times	Bachelor: 5 - 6; Master: 1 - 4
Maximum number of students: 50	

Georg-August-Universität Göttingen **Module B.Phy.5629: Nonlinear dynamics and time series analysis**	6 C 4 WLH

Learning outcome, core skills: Sound knowledge and practical experience with methods and concepts from Nonlinear Dynamics and Time Series Analysis, mainly obtained by devising, implementing, and running algorithms and simulation programs.	**Workload:** Attendance time: 56 h Self-study time: 124 h

Course: Blockpraktikum	

Examination: Presentation with discussion (approx. 45 minutes) and written elaboration (max. 10 pages) **Examination requirements:** • Presentation of a specific topic • Report about own (simulation) results obtained for the specific topic	6 C

Admission requirements: none	**Recommended previous knowledge:** Basic programming skills (for the exercises)
Language: German, English	**Person responsible for module:** apl. Prof. Dr. Ulrich Parlitz
Course frequency: sporadic	**Duration:** 1 semester[s]
Number of repeat examinations permitted: 3 times	**Recommended semester:** Bachelor: 5 - 6; Master: 1 - 4
Maximum number of students: 12	

Additional notes and regulations: (Duration: 2 weeks with 8h per day)

Georg-August-Universität Göttingen **Module B.Phy.5631: Self-organization in physics and biology**	4 C 2 WLH

Learning outcome, core skills: **Learning outcome**: Non-linear dynamics, instabilities, basics of self-organisation, bifurcations, non-equilibrium thermodynamics: **Core skills:** Upon successful seminar participation, the students should be capable of - accomplish literature research autonomously and therefore understand and analyse scientifc articles in the corresponding scientific context - create a presentation including physical and biological basics relevant to the scientific article and give the oral presentation	**Workload:** Attendance time: 28 h Self-study time: 92 h

Course: Seminar	

Examination: Presentation (approx. 45 Min.) **Examination prerequisites:** Active Participation **Examination requirements:** Elaborated presentation, which includes an introduction to the necessary basics	

Admission requirements: none	**Recommended previous knowledge:** -Introduction to biophysics -Introduction to physics of complex systems
Language: English, German	**Person responsible for module:** Prof. Dr. Eberhard Bodenschatz Further contact person: Dr. M. Tarantola
Course frequency: each semester	**Duration:** 1 semester[s]
Number of repeat examinations permitted: 3 times	**Recommended semester:** Bachelor: 5 - 6; Master: 1 - 4
Maximum number of students: 10	

Georg-August-Universität Göttingen **Module B.Phy.5632: Current topics in turbulence research**	4 C 2 WLH

Learning outcome, core skills: **Learning outcome:** Based on a selected topic the students shall develop a basic understanding of turbulent flows. **Core skills**: The goal of this course is to enable the students to present their research in the context of the international state of the art of the field.	**Workload:** Attendance time: 28 h Self-study time: 92 h

Course: Seminar	WLH

Examination: Presentation (approx. 45 Min.) **Examination prerequisites:** Active Participation **Examination requirements:** Basic understanding of turbulence; instabilities, scaling, models of turbulence, turbulence in rotating and stratified systems, turbulent heat transport, particles in turbulence	

Admission requirements: none	**Recommended previous knowledge:** Basic knowledge of advanced continuum mechanics or electrodynamics.
Language: English, German	**Person responsible for module:** Prof. Dr. Eberhard Bodenschatz
Course frequency: each semester	**Duration:** 1 semester[s]
Number of repeat examinations permitted: 3 times	**Recommended semester:** Bachelor: 5 - 6; Master: 1 - 4
Maximum number of students: 15	

Georg-August-Universität Göttingen **Module B.Phy.5636: Introduction to Chaotic Behavior II: Hamiltonian Systems**	3 C 2 WLH

Learning outcome, core skills: On successful completion of this course, students shall have a command of the analytical methods of non-linear dynamics.	**Workload:** Attendance time: 28 h Self-study time: 62 h

Course: Lecture	

Examination: Written examination (90 minutes) **Examination prerequisites:** none **Examination requirements:** Arnold's cat map; Hartmann-Grobmann theory; homoclinic slices; Melnikov methods; homoclinic tangles; Smale's horseshoe map; ergodicity; Kolmogrov-Sinai entropy.	

Admission requirements: none	**Recommended previous knowledge:** none
Language: English	**Person responsible for module:** Prof. Dr. Theo Geisel
Course frequency: Two year as required / summer or winter semester	**Duration:** 1 semester[s]
Number of repeat examinations permitted: 3 times	**Recommended semester:** Bachelor: 4 - 6; Master: 1 - 4
Maximum number of students: 30	

Georg-August-Universität Göttingen **Module B.Phy.5639: Optical measurement techniques**	3 C 2 WLH

Learning outcome, core skills: After successful completion of the module, students should ... - be able to apply light models - have understood basic optical principles of measurement - have gained an overview of optical measurement method for measuring different physical quantities at different scales	**Workload:** Attendance time: 28 h Self-study time: 62 h

Course: Optical Measurement Techniques (Lecture)	

Examination: Presentation with discussion (approx. 30 min.) or oral examination (approx. 30 Min.) **Examination requirements:** Understanding optical measurement principles and methods	

Admission requirements: none	**Recommended previous knowledge:** none
Language: German, English	**Person responsible for module:** StudiendekanIn der Fakultät für Physik / Ansprechpartner: Dr. Nobach
Course frequency: each winter semester	**Duration:** 1 semester[s]
Number of repeat examinations permitted: 3 times	**Recommended semester:** Bachelor: 5 - 6; Master: 1 - 4
Maximum number of students: 30	

Georg-August-Universität Göttingen **Module B.Phy.5645: Nanooptics and Plasmonics**	3 C 2 WLH

Learning outcome, core skills: After the course, the students should have a profound knowledge about the rapidly evolving field nanooptics and plasmonics, both experimentally as well as theoretically.	**Workload:** Attendance time: 28 h Self-study time: 62 h

Course: Nanooptics and Plasmonics (Lecture)	

Examination: Written examination (90 min.) or oral examination (approx. 30 Min.) **Examination prerequisites:** keine **Examination requirements:** Electrodynamics of single particle/molecule emission, electrodynamic interaction of nano-emitters and molecules with light, interaction of light with nanoscale dielectric and plasmonic structures, and with optical metamaterials. Theory of light-matter interaction at the nanometer length scale. Fundamentals of optical microscopy and spectroscopy, applied to optical quantum emitters.	

Admission requirements: none	**Recommended previous knowledge:** Experimental Physics I-IV
Language: German, English	**Person responsible for module:** Prof. Dr. Jörg Enderlein
Course frequency: each winter semester	**Duration:** 1 semester[s]
Number of repeat examinations permitted: 3 times	**Recommended semester:** Bachelor: 4 - 6; Master: 1 - 4
Maximum number of students: 20	

Georg-August-Universität Göttingen **Module B.Phy.5646: Climate Physics**	6 C 4 WLH

Learning outcome, core skills: **Learning outcome:** This course will introduce the physical principles of the Earth's climate, and the dynamics of our atmosphere and oceans. We will show how the basic features of a climate system can be understood through a detailed energy balance. A momentum balance, in the form of the Navier-Stokes equations, and mass balance, give rise to many of the additional behaviours of a real climate system. The main features of atmospheric and ocean circulation, mixing, and transport will be discussed in this context, including such topics as the thermohaline circulation; turbulent mixing; atmospheric waves; and Coriolis effects. We will then return to the global energy budget, and discuss physically grounded models of climate prediction and climate sensitivity (e.g. Milankovitch cycles), as well as their implications. In the latter part of the course, additional context on related questions of current research will be covered in special topics presented by members of the Göttingen Research Campus. **Core skills:** After successful completion of the modul the students should ... • know how to approach the study of climate in planetary systems from a rigorous physical perspective; • know which factors influence the climate, and how to analyse climate patterns and stability; • be able to develop a familiarity with the principles of climate science, and apply these to a broad range of situations, from the large-scale convection patterns in atmospheres and oceans, to the impact of clouds and precipitation, and box models for the energy and entropy budget.	**Workload:** Attendance time: 56 h Self-study time: 124 h

Course: Lecture with exercises	

Examination: Written examination (120 Min.) or oral examination (approx. 30 Min.) **Examination requirements:** Profound geophysical basis for the work on issues of climate physics.	

Admission requirements: none	**Recommended previous knowledge:** Basics of Hydrodynamics
Language: German, English	**Person responsible for module:** apl. Prof. Dr. Jürgen Vollmer
Course frequency: two year as required, winter term or summer term	**Duration:** 1 semester[s]
Number of repeat examinations permitted: 3 times	**Recommended semester:** Bachelor: 5 - 6; Master: 1 - 4
Maximum number of students: 50	

Georg-August-Universität Göttingen **Module B.Phy.5647: Physics of Coffee, Tea and other drinks**	4 C 2 WLH

Learning outcome, core skills: After completing this module a student should be able to: • Research a topic in the scientific literature and analyse it critically. • Show fundamental skills in model building and, for example, in the discussion of nonlinear differential equations or other complex physical models. • Understand the phase behaviour of two (or more) component mixtures, the kinetics of phase separation, the physics of multi-phase fluids and soft materials such as foams and gels.	**Workload:** Attendance time: 28 h Self-study time: 92 h

Course: Physics of Coffee, Tea and other drinks (Seminar)	

Examination: Presentation with discussion (approx. 45 minutes) and written elaboration (max. 4 pages) **Examination prerequisites:** Active Participation **Examination requirements:** Presentation of a complex physical summary of the key physics underlying a mixed drink, or other beverage (e.g. drainage of foam in espresso, slow waves and convective stripes in latte macchiato, bubble formation and growth in champagne). Where appropriate, the student must take into account a critical discussion of the relevant literature.	

Admission requirements: none	**Recommended previous knowledge:** Basic analytical mechanics and fluid dynamics
Language: German, English	**Person responsible for module:** Prof. Dr. Stephan Herminghaus Contact Person: Dr. M. Mazza
Course frequency: unregular, two year as required	**Duration:** 1 semester[s]
Number of repeat examinations permitted: 3 times	**Recommended semester:** Bachelor: 5 - 6; Master: 1 - 4
Maximum number of students: 25	

Georg-August-Universität Göttingen **Module B.Phy.5648: Theoretical and Computational Biophysics**	3 C 2 WLH

Learning outcome, core skills: This combined lecture and hands-on computer tutorial focuses on the basics of computational biophysics and deals with questions like "How can the particle dynamics of thousands of atoms be described precisely?" or "How does a sequence alignment algorithm function?" The aim of the lecture is to develop a physical understanding of those "nano maschines" by using modern concepts of non-equilibrium thermodynamics and computer simulations of the dynamics on an atomistic scale. Moreover, the lecture shows (by means of examples) how computers can be used in modern biophysics, e.g. to simulate the dynamics of biomolecular systems or to calculate or refine a protein structure. No cell could live without the highly specialized macromolecules. Proteins enable virtually all tasks in our bodies, e.g. photosynthesis, motion, signal transmission and information processing, transport, sensor system, and detection. The perfection of proteins had already been highly developed two billion years ago.	**Workload:** Attendance time: 28 h Self-study time: 62 h

Course: Theoretical and Computational Biophysics (Lecture, Exercise)	

Examination: Oral examination (approx. 30 minutes) **Examination prerequisites:** none **Examination requirements:** Protein structure and function, physics of protein dynamics, relevant intermolecular interactions, principles of molecular dynamics simulations, numeric integration, influence of approximations, efficient algorithms, parallel programing, methods of electrostatics, protonation balances, influence of solvents, protein structure determination (NMR, X-ray), principal component analysis, normal mode analysis, functional mechanisms in proteins, bioinformatics: sequence comparison, protein structure prediction, homology modeling, and hands-on computer simulation.	

Admission requirements: none	**Recommended previous knowledge:** • Introduction to Biophysics • Introduction to Physics of Complex Systems
Language: English, German	**Person responsible for module:** Hon.-Prof. Dr. Karl Helmut Grubmüller
Course frequency: each winter semester	**Duration:** 1 semester[s]
Number of repeat examinations permitted: 3 times	**Recommended semester:** Bachelor: 5 - 6; Master: 1 - 4
Maximum number of students: 30	

Georg-August-Universität Göttingen **Module B.Phy.5651: Advanced Computational Neuroscience I**	3 C 2 WLH

Learning outcome, core skills: Participants in the course can explain and relate biological foundations and mathematical modelling of selected (neuronal) algorithms for learning and pattern formation. Based on the the algorithms' properties, they can discuss and derive possible technical applications (robots).	**Workload:** Attendance time: 28 h Self-study time: 62 h

Course: Vorlesung (Lecture)	

Examination: Written examination (90 Min.) or oral examination (approx. 20 Min.) **Examination requirements:** Algorithms for learning: - Unsupervised Learning (Hebb, Differential Hebb), - Reinforcement Learning, - Supervised Learning Algorithms for pattern formation. Biological motivation and technical Application (robots).	3 C

Admission requirements: none	**Recommended previous knowledge:** Basics Computational Neuroscience
Language: English	**Person responsible for module:** Prof. Dr. Florentin Andreas Wörgötter
Course frequency: each winter semester1	**Duration:** 1 semester[s]
Number of repeat examinations permitted: 3 times	**Recommended semester:** Bachelor: 5 - 6; Master: 1 - 4
Maximum number of students: 50	

Additional notes and regulations: Hinweis: Die B.Phy.5652 kann als vorlesungsbegleitendes Praktikum besucht werden.

Georg-August-Universität Göttingen **Module B.Phy.5652: Advanced Computational Neuroscience II**	3 C 2 WLH

Learning outcome, core skills: Participants in the course can implement, test, and evaluate the properties of selected (neuronal) algorithms for learning and pattern formation.	**Workload:** Attendance time: 28 h Self-study time: 62 h

Course: Praktikum	

Examination: 4 Protocols (max. 3 Pages) and Presentations (ca. 10 Min.), not graded, not graded **Examination requirements:** Algorithms for learning: - Unsupervised Learning (Hebb, Differential Hebb), - Reinforcement Learning, - Supervised Learning Algorithms for pattern formation. Biological motivation and technical Application (robots). *For each of the 4 programming assignments 1 protocol (ca. 3 pages) and 1 oral presentations (demonstration and discussion of the program, ca. 10 min).*	3 C

Admission requirements: B.Phy.5651 (can be taken in parallel to B.Phy.5652)	**Recommended previous knowledge:** Programming in C++, basic numerical algorithms, Grundlagen Computational Neuroscience B.Phy.5504: Computational Physics (Scientific Computing)
Language: English	**Person responsible for module:** Prof. Dr. Florentin Andreas Wörgötter
Course frequency: unregelmäßig	**Duration:** 1 semester[s]
Number of repeat examinations permitted: 3 times	**Recommended semester:** Bachelor: 5 - 6; Master: 1 - 4
Maximum number of students: 24	

Georg-August-Universität Göttingen **Module B.Phy.5656: Experimental work at large scale facilities for X-ray photons**	3 C 3 WLH

Learning outcome, core skills:	**Workload:**
The goal of this course is to acquire the competence to perform experiments at modern synchrotron sources and free-electron-laser sources (large scale facilities) in a team; this includes the theoretical and experimental preparation of such beam times, as well as the experiment itself and the data analysis; Competences: after successfully finishing this course, students should have the theoretical basis as well as the experimental abilities for performing modern X-ray experiments and should have applied their knowledge to specific examples from biophysics, soft matter physics and materials physics.	Attendance time: 42 h Self-study time: 48 h

Course: Lab Course *Contents*: Lab course during an x-ray beam time performed by the Institute for X-Ray Physics at a national or international source (in particular DESY, BESSY, XFEL, ESRF, SLS, NSLSII, SACLA, Diamond, Soleil, Elettra); students will already be involved in the preparation and will thus be well prepared for the experimental approach. At the x-ray source, they experience the technical/experimental as well as the theoretical part of the work; after the campaign, they learn modern methods of data analysis by direct interaction with the project leaders.	

Examination: Written report (max. 10 p.) or oral examination (approx. 30 min.) about the finished scientific project **Examination prerequisites:** Active participation at an X-ray beam time, including preparation and post-processing **Examination requirements:** Description of the scientific project, including the theoretical background and the experimental challenges and approaches; description of the data analysis and the results; discussion within the scientific context.	3 C

Admission requirements: none	**Recommended previous knowledge:** Good basic knowledge of physics (semesters 1-4) and good or very good knowledge of biophysics and x-ray optics
Language: German, English	**Person responsible for module:** Prof. Dr. Sarah Köster Prof. Dr. Tim Salditt
Course frequency: each semester; every semester, depending of availability of X-ray beam times	**Duration:** 1 semester[s]
Number of repeat examinations permitted: twice	**Recommended semester:** Bachelor: 5 - 6; Master: 1 - 4

Additional notes and regulations:
Maximum number of students: 2/beam time; if there are more applicants than slots, participants will be selected according to their experience and knowledge

Georg-August-Universität Göttingen **Module B.Phy.5657: Biophysics of gene regulation**	3 C 2 WLH

Learning outcome, core skills: **Objectives:** The students will learn basic concepts of the biophysics of gene regulation, including physical mechanisms and their physiological functions, as well as the methods for the theoretical analysis of such systems and their dynamics. **Competences:** After successful participation in the module, students should be able to analyze problems in gene regulation using the theoretical tools discussed in the lecture.	**Workload:** Attendance time: 28 h Self-study time: 62 h

Course: Biophysics of gene regulation (Lecture) *Course frequency:* jedes Wintersemester	WLH

Examination: written examination (60 Min.) or oral examination (approx. 30 Min.) **Examination requirements:** Physical principles of gene regulation, mechanisms of regulation, thermodynamic modelling, deterministic and stochastic dynamics	3 C

Admission requirements: none	**Recommended previous knowledge:** Basic knowledge in statistical physics and biophysics
Language: English, German	**Person responsible for module:** Prof. Dr. Stefan Klumpp
Course frequency: every 4th semester	**Duration:** 1 semester[s]
Number of repeat examinations permitted: 3 times	**Recommended semester:** Bachelor: 5 - 6; Master: 1 - 4
Maximum number of students: not limited	

Georg-August-Universität Göttingen **Module B.Phy.5658: Statistical Biophysics**	6 C 4 WLH

Learning outcome, core skills: **Objectives:** The students will learn basic concepts of statistical biophysics at the molecular, cellular and population level, as well as methods for the theoretical analysis of biophysical systems. **Competences:** After successful participation in the module, students should have working knowledge of basic concepts of statistical biophysics and be able to apply them to selected problems.	**Workload:** Attendance time: 56 h Self-study time: 124 h

Course: Statistical Biophysics (Lecture with integrated problem sessions) *Course frequency:* jedes Wintersemester	WLH

Examination: written examination (120 Min.) or oral examination (approx. 30 Min.) **Examination requirements:** Physical principles of biological systems on the molecular, cellular and population level, application of methods from statistical physics to biological and biophysical problems.	6 C

Admission requirements: none	**Recommended previous knowledge:** Basic knowledge in biophysics and statistical physics
Language: English, German	**Person responsible for module:** Prof. Dr. Stefan Klumpp
Course frequency: every 4th semester	**Duration:** 1 semester[s]
Number of repeat examinations permitted: 3 times	**Recommended semester:** Bachelor: 5 - 6; Master: 1 - 4
Maximum number of students: not limited	

Georg-August-Universität Göttingen **Module B.Phy.5659: Seminar on current topics in theoretical biophysics**	4 C 2 WLH

Learning outcome, core skills: **Objectives:** The students will develop a basic understanding of current topics and methods of theoretical biophysics at the molecular, cellular and population level, based on selected examples. **Competences:** After completing this module, the students should be able to research a topic in theoretical biophysics in the scientific literature, analyse it critically and present it in a seminar talk.	**Workload:** Attendance time: 28 h Self-study time: 92 h

Course: Seminar on current topics in theoretical biophysics	

Examination: Presentation with discussion (Bachelor approx. 30 min., Master approx. 60 min.) **Examination prerequisites:** Active participation **Examination requirements:** Presentation of a selected research topic and critical discussion of its methods and results	4 C

Admission requirements: none	**Recommended previous knowledge:** Basic knowledge in biophysics and statistical physics
Language: English, German	**Person responsible for module:** Prof. Dr. Stefan Klumpp
Course frequency: every 4th semester	**Duration:** 1 semester[s]
Number of repeat examinations permitted: 3 times	**Recommended semester:** Bachelor: 6; Master: 1 - 4

Additional notes and regulations:

Georg-August-Universität Göttingen **Module B.Phy.5660: Theoretical Biofluid Mechanics**	3 C 2 WLH

Learning outcome, core skills: **Learning objectives:** The course will discuss the theoretical foundations of fluid mechanics used in the study of biological systems. Important concepts in the mathematical study of fluids will be introduced and employed to investigate blood flow and circulation, the propulsion of organisms and transport facilitated by fluid flow. **Competencies:** Students will learn to set up theoretical models for a range of biological systems involving fluids employing the Navier-Stokes equation and appropriate boundary conditions. The course will prepare the students to simplify, assess and analyze models to investigate the intricate role of fluids in biological settings.	**Workload:** Attendance time: 28 h Self-study time: 62 h

Course: Theoretical Biofluid Mechanics (Lecture)	

Examination: Written (60 minutes) or oral exam (30 minutes) **Examination prerequisites:** None **Examination requirements:** Solving Navier-Stokes equation in simple geometry, derive simplified equations from models of fluid flow and transport, explore theoretical models in limiting parameter range and assess prediction in relation to modeled biological system. The exam will be oral, if max. 20 students take part at the first date of the course. Oherwise it will be a written exam.	

Admission requirements: none	**Recommended previous knowledge:** Basic knowledge of calculus and algebra
Language: English, German	**Person responsible for module:** Prof. Dr. Stefan Klumpp Contact: Karin Alim
Course frequency: every 4th semester; Every second Summerterm in Rotation to Microfluidic	**Duration:** 1 semester[s]
Number of repeat examinations permitted: 3 times	**Recommended semester:** Bachelor: 3 - 6; Master: 1 - 4
Maximum number of students: not limited	

Georg-August-Universität Göttingen **Module B.Phy.5661: Biomedical Techniques in Complex Systems**	4 C 2 WLH

Learning outcome, core skills: **Learning objectives:** The seminar provides an overview of current biomedical techniques applied in research and therapy. A strong orientation towards the combination of theoretical basics and practical use will be given by introducing up-to-date research results (original articles and text book material). **Competencies**: Besides getting a deeper understanding of current biomedical techniques, the students will learn how to prepare and present up-to-date scientific results. This includes literature research, understanding of underlying methodological basics and didactic preperation (talk in front of the seminar participants).	**Workload:** Attendance time: 28 h Self-study time: 92 h

Course: Biomedical Techniques in Complex Systems (Seminar)	

Examination: Oral examination, (Bachelor: ca 30 min.; Master: ca. 45 min.) **Examination prerequisites:** none **Examination requirements:** The students will elaborate and give a presentation about current biomedical techniques. The talk should include an introductory part to the underlying basics.	

Admission requirements: none	**Recommended previous knowledge:** none
Language: English, German	**Person responsible for module:** Prof. Dr. Stefan Luther
Course frequency: each winter semester1	**Duration:** 1 semester[s]
Number of repeat examinations permitted: 3 times	**Recommended semester:** Bachelor: 5 - 6; Master: 1 - 4
Maximum number of students: not limited	

Additional notes and regulations: Contact: Dr. C. Richter

Georg-August-Universität Göttingen **Module B.Phy.5662: Active Soft Matter**	4 C 2 WLH

Learning outcome, core skills: Students acquire in depth expertise in the discipline of Active Soft Matter, focussed on artificial and biological microswimmers in experiment and theory. Topics include self-propulsion at low Reynolds numbers, chemo-, electro-, magneto- , gravi- and phototaxis, active droplets, colloids and Janus particles, dynamics of flagellae and ciliae in bacteria and algae, interaction with interfaces and complex geometries, collective and swarming dynamics and active emulsions. Core skills include the independent study of literature on current research, and the condensation, presentation and discussion of a specific topic, which are vital skills pertaining to presenting your own research and its position in a wider research field. Students will practice the critical appreciation of current research in scientific discussion and receive feedback on their presentation skills.	**Workload:** Attendance time: 28 h Self-study time: 92 h

Course: Active Soft Matter (Seminar)	

Examination: Oral seminar presentation (ca. 45 min.) and handout (4 pages max.) **Examination prerequisites:** none **Examination requirements:** Preparation, presentation and discussion of a current topic in active soft matter based on published literature. Active engagement in discussions on other student's presentations. Handouts must be submitted before the presentation.	

Admission requirements: none	**Recommended previous knowledge:** introductory hydrodynamics and thermodynamics
Language: English, German	**Person responsible for module:** Prof. Dr. Stephan Herminghaus
Course frequency: every 3rd semester	**Duration:** 1 semester[s]
Number of repeat examinations permitted: 3 times	**Recommended semester:** Bachelor: 5 - 6; Master: 1 - 4
Maximum number of students: 26	

Additional notes and regulations: Contact: Dr. Oliver Bäumchen, Dr. Corinna Maaß,

Georg-August-Universität Göttingen **Module B.Phy.5709: Seminar on Nanoscience**	4 C 2 WLH

Learning outcome, core skills: **Lernziele**: Electronic properties of electrons confined in low-dimensional structures (2D, 1D and 0D). Experimental methods for the preparation and characterization of nanostrucures. Functional nanostructures. Devices in nanoelectronics. Semiconductor materials will be on focus. **Kompetenzen**: After successful completion of the modul the students should be able to gain a deep knowledge of a current topic in nanoscience and nanodevices from the recommended scientific literature. The student will present and discuss the topic in a Seminar.	**Workload:** Attendance time: 28 h Self-study time: 92 h

Course: Seminar (Blockveranstaltung)	

Examination: Vortrag (ca. 30 Min.) - student choice if in German or in English **Examination prerequisites:** Aktive Teilnahme	

Examination requirements: The students should achieve a deep knowledge of a current topic in nanoscience and nanodevices from the recommended scientific literature; the student should be able to transfer this knowledge to an audience in a seminar.	

Admission requirements: none	**Recommended previous knowledge:** • Einführung in die Festkörperphysik • Einführung in die Materialphysik • Quantenmechanik I • Nanoscience
Language: English	**Person responsible for module:** StudiendekanIn der Fakultät für Physik
Course frequency: unregelmäßig	**Duration:** 1 semester[s]
Number of repeat examinations permitted: 3 times	**Recommended semester:** Bachelor: 5 - 6; Master: 1 - 2
Maximum number of students: 20	

Georg-August-Universität Göttingen **Module B.Phy.5714: Introduction to Solid State Theory**	6 C 6 WLH

Learning outcome, core skills: **Lernziele:** Fundamental concepts of of solid state theory, Born-Oppenheimer approximation, homogeneous electron gas, electrons in lattices, lattice vibrations, elementary transport theory **Kompetenzen:** After successful completion of the modul students should be able to describe and calculate fundamental properties of solids; understand and use the language of solid-state theory.	**Workload:** Attendance time: 84 h Self-study time: 96 h

Courses:	
1. lecture	4 WLH
2. exercises	2 WLH

Examination: Written examination (90 minutes) **Examination requirements:** Application of fundamental concepts in solid state theory, interpretation of basic experimental observations, theoretical description of fundamental phenomena in solid state physics.	6 C

Admission requirements: keine	**Recommended previous knowledge:** Quantum mechanics I
Language: German, English	**Person responsible for module:** Prof. Dr. Thomas Pruschke Prof. Kehrein
Course frequency: each winter semester	**Duration:** 1 semester[s]
Number of repeat examinations permitted: 3 times	**Recommended semester:** Bachelor: 5 - 6; Master: 1 - 4
Maximum number of students: not limited	

Georg-August-Universität Göttingen **Module B.Phy.5716: Nano-Optics meets Strong-Field Physics**	6 C 4 WLH

Learning outcome, core skills: At the end of the course, students should understand and be able to apply the basic concepts of nano-optics and strong-field physics, as well as their connection in modern research. In the accompanying exercises, numerical simulations will be developed which build on the topics discussed in the lectures. An introduction will be given to scripting in Matlab and to finite element simulations with Comsol Multiphysics.	**Workload:** Attendance time: 56 h Self-study time: 124 h

Courses:	
1. Vorlesung	2 WLH
2. Übung	2 WLH

Examination: Oral examination (approx. 30 minutes) **Examination prerequisites:** Implementation of a task in an executable programme.	6 C

Admission requirements: none	**Recommended previous knowledge:** Experimentalphysik I-IV, Quantenmechanik
Language: German, English	**Person responsible for module:** Prof. Dr. Claus Ropers StudiendekanIn der Fakultät für Physik
Course frequency: unregelmäßig	**Duration:** 1 semester[s]
Number of repeat examinations permitted: 3 times	**Recommended semester:** Bachelor: 5 - 6; Master: 1 - 4
Maximum number of students: 20	

Georg-August-Universität Göttingen **Module B.Phy.5717: Mechanisms and Materials for Renewable Energy**	6 C 4 WLH

Learning outcome, core skills: By participation in both lectures on photovoltaics and solar thermal energy, thermoelectrics and solar fuels students gain knowledge about the full spectrum of physical and chemical basics of renewable energy conversion. In addition, overlapping aspects of fundamental concepts and technological approaches have been reviewed. Students shall independently apply gained knowledge to acquire and present current research in the field.	**Workload:** Attendance time: 56 h Self-study time: 124 h

Course: Mechanismen und Materialien für erneuerbare Energien (Lecture)	

Examination: Poster presentation with oral examination (approx. 30 Min.) **Examination requirements:** Beherrschung der grundlegenden Begriffe, Fakten und Methoden. Selbständige Erarbeitung wissenschaftlicher Publikationen und deren Präsentation.	6 C

Admission requirements: none	**Recommended previous knowledge:** Introduction to solid state physics, Introduction to materials physics
Language: German, English	**Person responsible for module:** apl. Prof. Dr. Michael Seibt Prof. Dr. Christian Jooß
Course frequency: two-year as required, summer semester	**Duration:** 1 semester[s]
Number of repeat examinations permitted: 3 times	**Recommended semester:** Bachelor: 6; Master: 1 - 2
Maximum number of students: 30	

Georg-August-Universität Göttingen **Module B.Phy.5718: Mechanisms and Materials for Renewable Energy: Photovoltaics**	4 C 2 WLH

Learning outcome, core skills: After successful completion of this module students are familiar with physical basics or photo-electric energy conversion, are able to apply fundamental concepts and gained knowledge about important materials systems of photovoltaics. In addition, important experimental methods as well as current and future technological concepts have been reviewed. Students shall independently apply gained knowledge to acquire and present current research in the field.	**Workload:** Attendance time: 28 h Self-study time: 92 h

Course: Mechanismen und Materialien für erneuerbare Energien: Photovoltaik (Lecture)	

Examination: Poster presentation with oral examination (approx. 30 Min.) **Examination requirements:** Beherrschung der grundlegenden Begriffe, Fakten und Methoden. Selbständige Erarbeitung wissenschaftlicher Publikationen und deren Präsentation.	4 C

Admission requirements: none	**Recommended previous knowledge:** Introduction to solid state physics, Introduction to Materials physics
Language: German, English	**Person responsible for module:** apl. Prof. Dr. Michael Seibt
Course frequency: zweijährig im SoSe	**Duration:** 1 semester[s]
Number of repeat examinations permitted: 3 times	**Recommended semester:** Bachelor: 6; Master: 1 - 2
Maximum number of students: 30	

Georg-August-Universität Göttingen **Module B.Phy.5719: Mechanisms and Materials for Renewable Energy: Solar heat, Thermoelectric, solar fuel**	4 C 2 WLH

Learning outcome, core skills: Physical and chemical basics of light and heat conversion to electrical and chemical energy. In particular:Mechanisms of solarthermic, thermoelectric, elctro- and photochemical energy conversion. Important model systems and materials. Outlook in current research activities. Students shall independently apply gained knowledge to acquire and present current research on relevant systems.	**Workload:** Attendance time: 28 h Self-study time: 92 h

Course: Mechanismen und Materialien für erneuerbare Energien: Solarthermie, Thermoelektrik, solarer Treibstoff (Lecture)	

Examination: Posterpresentation with oral examination (approx. 30 Min.) **Examination requirements:** Beherrschung der grundlegenden Begriffe, Fakten und Methoden. Selbständige Erarbeitung wissenschaftlicher Publikationen und deren Präsentation.	4 C

Admission requirements: none	**Recommended previous knowledge:** Introduction to solid state physics, Introduction to Materials Physics
Language: German, English	**Person responsible for module:** Prof. Dr. Christian Jooß
Course frequency: two-year as required, summer semester	**Duration:** 1 semester[s]
Number of repeat examinations permitted: 3 times	**Recommended semester:** Bachelor: 6; Master: 1 - 2
Maximum number of students: 30	

Georg-August-Universität Göttingen **Module B.Phy.5804: Quantum mechanics II**	6 C 6 WLH

Learning outcome, core skills: **Acquisition of knowledge:** Scattering theory; Symmetries in QM, especially angular momentum and spin; Many particle systems and Fock formalism; Quantization of the electromagnetic field; Relativistic QM: Klein-Gordon equation and Dirac equation in external fields. **Competencies:** The students shall be familiar with advanced concepts of Quantum Mechanics. They can apply them to explicit examples.	**Workload:** Attendance time: 84 h Self-study time: 96 h

Courses:	
1. Quantum mechanics II (Lecture)	4 WLH
2. Quantum mechanics II (Exercise)	2 WLH

Examination: Written examination (120 minutes) **Examination requirements:** Solution of concrete problems treated in the lecture course. Explanation of notions and methods of advanced QM.	6 C

Admission requirements: none	**Recommended previous knowledge:** Quantum mechanics I, Classical field theory
Language: English	**Person responsible for module:** apl. Prof. Dr. Karl-Henning Rehren
Course frequency: once a year	**Duration:** 1 semester[s]
Number of repeat examinations permitted: 3 times	**Recommended semester:** Bachelor: 5 - 6; Master: 1 - 3
Maximum number of students: 80	

Georg-August-Universität Göttingen **Module B.Phy.5805: Quantum field theory I**	6 C 6 WLH

Learning outcome, core skills:	**Workload:**
Acquisition of knowledge: Quantization of free relativistic wave equations (Klein-Gordon and Dirac); General properties of quantum fields; Interaction with external sources; Perturbation theory and basics of renormalization theory; Quantum Electro Dynamics and abelian gauge symmetry. **Competencies:** The students shall be familiar with the basic concepts and methods of Quantum Field Theory. They can apply them to explicit examples.	Attendance time: 84 h Self-study time: 96 h

Courses:	
1. Quantum field theory I (Lecture)	4 WLH
2. Quantum field theory I (Exercise)	2 WLH

Examination: Written examination (120 minutes) **Examination requirements:** Solution of concrete problems treated in the lecture course. Explanation of notions and methods of Quantum Field Theory.	6 C

Admission requirements: none	**Recommended previous knowledge:** Quantum mechanics I, II, Classical Field theory
Language: English	**Person responsible for module:** apl. Prof. Dr. Karl-Henning Rehren
Course frequency: each summer semester	**Duration:** 1 semester[s]
Number of repeat examinations permitted: 3 times	**Recommended semester:** Bachelor: 6; Master: 1 - 2
Maximum number of students: 50	

Georg-August-Universität Göttingen **Module B.Phy.5807: Physics of particle accelerators**	3 C 3 WLH

Learning outcome, core skills: After successful completion of this module, students should be familiar with the concepts, the physics (mainly electromagnetism) and explicit examples of historic and modern particle accelerators. Ideally, they should be able to simulate beam optics via numerical simulations (MatLab/SciLab).	**Workload:** Attendance time: 42 h Self-study time: 48 h

Course: Physics of particle accelerator (Lecture)	

Examination: Oral examination (approx. 30 minutes) **Examination requirements:** Introduction to physics of particle accelerators; synchrotron radiation; linear beam optics; injection and ejection; high-frequency system for particle acceleration; radiation effects; luminosity, wigglers and undulators; modern particle accelerators based on the examples HERA, LEP, Tevatron, LHC, ILC and free electron laser FLASH/XFEL.	

Admission requirements: none	**Recommended previous knowledge:** Introduction to Nuclear/Particle Physics
Language: German, English	**Person responsible for module:** Prof. Dr. Arnulf Quadt
Course frequency: every 4th semester; unregular	**Duration:** 1 semester[s]
Number of repeat examinations permitted: 3 times	**Recommended semester:** Bachelor: 5 - 6; Master: 1 - 4
Maximum number of students: not limited	

Georg-August-Universität Göttingen **Module B.Phy.5808: Interactions between radiation and matter - detector physics**	3 C 3 WLH

Learning outcome, core skills: After successful completion of this module, students should be familiar with a conceptional understanding of different particle detectors and the underlying interactions. They should be familiar with physics processes of particle or radiation detection in high energy physics and related fields and applications.	**Workload:** Attendance time: 42 h Self-study time: 48 h

Course: Interactions between radiation and matter - detector physics (Lecture)	

Examination: Oral examination (approx. 30 minutes) **Examination requirements:** Mechanism of particle detection; interactions of charged particles and photons with matter; proportional and drift chambers; semiconductor detectors; microstrip and pixel detectors; Cherenkov detectors; transition radiation detectors; scintillation (organic crystals and plastic scintillators); electromagnetic calorimeter; hadron calorimeter.	

Admission requirements: none	**Recommended previous knowledge:** Introduction to Nuclear/Particle Physics
Language: German	**Person responsible for module:** Prof. Dr. Arnulf Quadt
Course frequency: each summer semester	**Duration:** 1 semester[s]
Number of repeat examinations permitted: 3 times	**Recommended semester:** Bachelor: 5 - 6; Master: 1 - 4
Maximum number of students: not limited	

Georg-August-Universität Göttingen **Module B.Phy.5809: Hadron-Collider-Physics**	3 C 3 WLH

Learning outcome, core skills:	**Workload:**
Learning Objectives and Competencies: After successful completion of this module, students should be well-versed in the challenges and concepts of experimental physics at modern hadron colliders.	Attendance time: 42 h Self-study time: 48 h

Course: Hadron-Collider-Physics (Lecture)	

Examination: Oral examination (approx. 30 minutes) **Examination requirements:** Introduction to particle physics; Kinematics at hadron colliders; historical overview and experimental features of hadron colliders such as PS, SPS, Tevatron, HERA, and LHC; Typical detectors and their functionalities for hadron collider physics; Structure of the proton and measurements thereof; Factorization theorem; Total and differential hadron cross sections; Diffraction; Soft underlying event, multiple interactions, and pile-up; QCD and Jet Physics; Angular correlations; Physics of vector bosons; Z-Asymmetry and W mass measurements; W charge asymmetry; W/Z cross sections; Physics of the top quark; Search for supersymmetric particles as candidates of dark matter; Searches for new physics in exotic models; Experimental methods for data analysis.	

Admission requirements: none	**Recommended previous knowledge:** Introduction to Nuclear and Particle Physics
Language: German, English	**Person responsible for module:** Prof. Dr. Arnulf Quadt
Course frequency: every 4th semester; irregular	**Duration:** 1 semester[s]
Number of repeat examinations permitted: 3 times	**Recommended semester:** Bachelor: 5 - 6; Master: 1 - 4
Maximum number of students: 30	

Georg-August-Universität Göttingen **Module B.Phy.5810: Physics of the Higgs boson**	3 C 3 WLH

Learning outcome, core skills: After successful completion of this module, students should possess a deep understanding of the Higgs mechanism, the properties of the Higgs boson, and experimental methods (concepts and concrete examples) used in investigations of the Higgs sector.	**Workload:** Attendance time: 42 h Self-study time: 48 h

Course: Physics of the Higgs boson (Lecture)	

Examination: Oral examination (approx. 30 minutes) **Examination requirements:** Review of the Standard Model of particle physics; The Higgs mechanism and the Higgs potential; properties of the Standard Model Higgs boson; Experimental methods in the search for the Higgs boson at LEP, Tevatron and LHC; Discovery of the Higgs boson; Measurement of the Higgs boson couplings and other properties; Two Higgs Doublet Modells and extended Higgs sectors (in particular, the MSSM); Searches for Higgs bosons beyond the Standard Model.	

Admission requirements: none	**Recommended previous knowledge:** Introduction to Nuclear/Particle Physics
Language: German, English	**Person responsible for module:** Prof. Dr. Arnulf Quadt
Course frequency: every 4th semester; irregular	**Duration:** 1 semester[s]
Number of repeat examinations permitted: 3 times	**Recommended semester:** Bachelor: 5 - 6; Master: 1 - 4
Maximum number of students: 30	

Georg-August-Universität Göttingen **Module B.Phy.5811: Statistical methods in data analysis**	3 C 3 WLH

Learning outcome, core skills: After successful completion of this module, students should be well-versed in the theoretical foundations of statistical methodology used in data analysis. This is complemented with concrete examples where statistical analysis is performed using the ROOT software package (a free C++ type software package for data analysis, which runs on Linux, Windows, and Mac operating systems).	**Workload:** Attendance time: 42 h Self-study time: 48 h

Course: Statistische Methoden der Datenanalyse (Lecture)	

Examination: Oral examination (approx. 30 minutes) **Examination requirements:** Concepts, methods, can concrete examples of statistical methods in data analysis: Introduction and description of data; theoretical probability density functions, including Gaussian, Poisson, and multi-dimensional distributions; parameter estimation; maximum likelihood method (and examples); chi^2 method and chi^2-distribution; optimization; hypothesis tests; classification methods; Monte Carlo methods; unfolding.	

Admission requirements: none	**Recommended previous knowledge:** Introduction to Nuclear/Particle Physics
Language: German, English	**Person responsible for module:** Prof. Dr. Arnulf Quadt
Course frequency: irregular	**Duration:** 1 semester[s]
Number of repeat examinations permitted: 3 times	**Recommended semester:** Bachelor: 5 - 6; Master: 1 - 4
Maximum number of students: 30	

Georg-August-Universität Göttingen **Module B.Phy.5812: Physics of the top-quark**	3 C 3 WLH

Learning outcome, core skills:	**Workload:**
Learning Objectives and Competencies: After successful completion of this module, students should be familiar with the properties and interactions of the top-quark as well as the experimental methods for its studies.	Attendance time: 42 h Self-study time: 48 h

Course: Physics of the top-quark (Lecture)	

Examination: Oral examination (approx. 30 minutes) **Examination requirements:** Concepts and specific experimental methods for the discovery and studies of the top-quark. Introduction to particle physics of quarks, discovery of the top-quark, top-antitop production (theory and experiment); electroweak production of single-top quarks; top-quark mass; electric charge and spin of top-quarks; W-helicity in top-quark decay; top-quark decay in the standard modell and beyond; sensitivity to new physics; top-quark physics at the ILC, recent results of top-quark physics.	

Admission requirements: keine	**Recommended previous knowledge:** Introduction to Nuclear/Particle Physics
Language: German, English	**Person responsible for module:** Prof. Dr. Arnulf Quadt
Course frequency: every 4th semester; irregular	**Duration:** 1 semester[s]
Number of repeat examinations permitted: 3 times	**Recommended semester:** Bachelor: 5 - 6; Master: 1 - 4
Maximum number of students: 30	

Georg-August-Universität Göttingen **Module B.Phy.5901: Advanced Algorithms for Computational Physics**	6 C 4 WLH

Learning outcome, core skills: The goal of the module is to introduce advanced algorithms and program structures / design, enabling the students to write codes for more advanced tasks in computational physics from scratch (preferably in C++).	**Workload:** Attendance time: 56 h Self-study time: 124 h

Course: Vorlesung und Übung	

Examination: Oral exam (approx.30 min.) or oral presentation with discussion (approx.30 min.), 2 weeks time for preparation) or project work at home with a final report (max. 15 pages) **Examination prerequisites:** none **Examination requirements:** • Implementation and usage of advanced algorithms to solve problems in computational physics • Understanding of the algorithms • Ability to choose suitable methods for solving a given problem Topics: 1. „Design Patterns“: typical programming/design structures and strategies 2. Algorithms for quantum problems, e.g., exact diagonalization approaches, numerical renormalization group and related methods, Quantum Monte Carlo 3. Algorithms used in engineering, e.g., finite element methods 4. Algorithms for and basics of computational finance	6 C

Admission requirements: none	**Recommended previous knowledge:** Programming course, course lecture „CWR“
Language: English	**Person responsible for module:** StudiendekanIn der Fakultät für Physik
Course frequency: irregular	**Duration:** 1 semester[s]
Number of repeat examinations permitted: 3 times	**Recommended semester:** Bachelor: 6; Master: 1 - 4
Maximum number of students: 40	

Additional notes and regulations:

Georg-August-Universität Göttingen **Module B.Phy.606: Electronic Lab Course for Natural Scientists**	6 C 6 WLH

Learning outcome, core skills: Learning Objectives and Competencies: After successful completion of this module, students should be familiar with • fundamental concepts and terminology of electronics • be able to handle modern electronic devices (simple devices, basic circuits) • be able to work out and conduct a scientific project within a given time window	**Workload:** Attendance time: 84 h Self-study time: 96 h

Course: B.Phy.606. Electronic lab course for natural scientists (Internship, Lecture, Exercise) 1. Vorlesung mit Übung 2. Praktikum (5 Versuche) 3. Praktikum (1 Projekt)	
Examination: Presentation with discussion (approx. 30 minutes) and written elaboration (max. 10 pages) **Examination prerequisites:** At least 50% of problem sets (homework) have to be solved (passed) **Examination requirements:** 1. fundamental concepts and terminology of electronics, 2. handling of simple electronics devices, basic circuits and functional units; 3. conceptual design and realisation of projects in electronics.	

Admission requirements: none	**Recommended previous knowledge:** none
Language: German, English	**Person responsible for module:** Prof. Dr. Arnulf Quadt
Course frequency: each summer semester	**Duration:** 1 semester[s]
Number of repeat examinations permitted: 3 times	**Recommended semester:** Bachelor: 4 - 6; Master: 1 - 4
Maximum number of students: 20	

Additional notes and regulations: Block course

Georg-August-Universität Göttingen **Module B.Phy.7601(Bio): Computational Neuroscience: Basics**	4 C 2 WLH

Learning outcome, core skills:	**Workload:**
Goals: Introduction to the different fields of Computational Neuroscience: • Models of single neurons, • Small networks, • Implementation of all simple as well as more complex numerical computations with few neurons. • Aspects of sensory signal processing (neurons as ‚filters'), • Development of topographic maps of sensory modalities (e.g. visual, auditory) in the brain, • First models of brain development, • Basics of adaptivity and learning, • Basic models of cognitive processing. **Kompetenzen/Competences:** On completion the students will have gained… • …overview over the different sub-fields of Computational Neuroscience; • …first insights and comprehension of the complexity of brain function ranging across all sub-fields; • …knowledge of the interrelations between mathematical/modelling methods and the to-be-modelled substrate (synapse, neuron, network, etc.); • …access to the different possible model level in Computational Neuroscience.	Attendance time: 28 h Self-study time: 92 h

Course: Vorlesung	

Examination: Written examination (45 minutes) **Examination requirements:** Actual examination requirements: Having gained overview across the different sub-fields of Computational Neuroscience; Having acquired first insights into the complexity of across the whole bandwidth of brain function; Having learned the interrelations between mathematical/modelling methods and the to-be-modelled substrate (synapse, neuron, network, etc.) Being able to realize different level of modelling in Computational Neuroscience.	4 C

Admission requirements: none	**Recommended previous knowledge:** none
Language: English	**Person responsible for module:** Prof. Dr. Florentin Andreas Wörgötter
Course frequency: each summer semester	**Duration:** 1 semester[s]
Number of repeat examinations permitted: twice	**Recommended semester:** Bachelor: 2 - 6; Master: 1 - 4

Georg-August-Universität Göttingen **Module B.SK-Phy.9001: Papers, Proposals, Presentations: Skills of Scientific Communication**	4 C 2 WLH

Learning outcome, core skills: Goals: Handling of different presentation media (written and oral); presenting complex facts to experts and laymen; skills of communication and scientific discussion	**Workload:** Attendance time: 28 h Self-study time: 92 h

Course: Papers, Proposals, Presentations: Skills of Scientific Communication (Seminar)	2 WLH
Examination: Lecture (approx. 30 minutes) **Examination prerequisites:** Active participation **Examination requirements:** Independent preparation and scientific publications and their presentation Time for preparation 4 weeks	4 C

Admission requirements: none	**Recommended previous knowledge:** none
Language: German, English	**Person responsible for module:** Prof. Dr. Ansgar Reiners
Course frequency: each summer semester	**Duration:** 1 semester[s]
Number of repeat examinations permitted: 3 times	**Recommended semester:** Bachelor: 4 - 6; Master: 1 - 4
Maximum number of students: 18	

Additional notes and regulations: Einbringbar in den Wahlbereich nicht-physikalisch.

Georg-August-Universität Göttingen **Module M.Phy-AM.001: Active Galactic Nuclei**	6 C 2 WLH

Learning outcome, core skills: **Learning outcome:** Observational properties of active galaxies, taxonomy of AGN, continuum and emission line physics, structure and cinematics of the central region, supermassive black holes, unified models, environment, evolution of AGN. **Core skills:** After successful completion of the modul students should be able to describe and explain spectroscopy and physical properties of active galaxies.	**Workload:** Attendance time: 28 h Self-study time: 152 h

Course: Lecture with exercises	
Examination: Oral Exam (ca. 30 Min.)	6 C

Examination requirements: Classification, spectral properties and physics of the central region in active galaxies surrounding the central supermassive black hole, properties of the hostgalaxies, large scale environment, evolution of AGN.	

Admission requirements: Previous AstroMundus courses (1.+2. Sem.)	**Recommended previous knowledge:** none
Language: English	**Person responsible for module:** Prof. Dr. Wolfram Kollatschny
Course frequency: each winter semester	**Duration:** 1 semester[s]
Number of repeat examinations permitted: twice	**Recommended semester:** 3
Maximum number of students: 15	

Georg-August-Universität Göttingen **Module M.Phy-AM.002: Stellar structure and evolution**	6 C 2 WLH

Learning outcome, core skills: **Learning outcome:** The physics of stellar interiors and the evolution of stars belong to the fundamentals of astrophysics. The following topics will be studied in detail: Equations of stellar structure - Energy transport by diffusion of radiation, convection, and conduction - Equation of state, opacity and nuclear energy generation - Methods for the solution of the equations of stellar structure - Simple stellar models (polytropes) and their application - Stellar evolution: Pre - main sequence evolution, main sequence phase, post - main sequence evolution, final stages of stellar evolution.. **Core skills:** After successful completion of the modul students should be able to describe and explain the fundamentals of stellar structure and evolution, application of the concepts and results of the subject to other areas of astrophysics	**Workload:** Attendance time: 28 h Self-study time: 152 h

Course: Lecture	
Examination: Oral Exam (ca. 30 Min.) **Examination prerequisites:** Solution of exercises	6 C

Examination requirements: Knowledge of the physics of stellar structure and evolution, the mechanics and thermodynamics of stellar structure, the methods for the solution of the equations of stellar structure, the various stages of stellar evolution and their interpretation.	

Admission requirements: Previous AstroMundus courses (1.+2. Sem.)	**Recommended previous knowledge:** none
Language: English	**Person responsible for module:** Prof. Dr. Wolfram Kollatschny
Course frequency: each winter semester	**Duration:** 1 semester[s]
Number of repeat examinations permitted: twice	**Recommended semester:** 3
Maximum number of students: 15	

Georg-August-Universität Göttingen **Module M.Phy-AM.011: Computer simulation methods in statistical physics**	3 C 2 WLH

Learning outcome, core skills: **Learning outcome:** The use of computers to solve problems in statistical physics is well established, and extremely useful in cases where exact solutions are not available. In this course, the Monte Carlosimulation method will be presented, whose applications are widespread, and include the field of biology. Starting with the basic Metropolis algorithm for the Ising model, this course will gradually move on to consider more complex systems, and show how the Monte Carlo method can be used to extract thermodynamic limit properties with relative ease. **Core skills:** Implement state-of-the-art MC simulations	**Workload:** Attendance time: 28 h Self-study time: 62 h

Course: Lecture	2 WLH
Examination: Oral Exam (ca. 30 Min.)	3 C

Examination requirements: The aim of the course is to present the Monte Carlo simulation method,with the focus of application on many-body problems as encountered in statistical physics.	

Admission requirements: Previous AstroMundus courses (1.+2. Sem.)	**Recommended previous knowledge:** none
Language: English	**Person responsible for module:** Prof. Dr. Wolfram Kollatschny
Course frequency: each winter semester	**Duration:** 1 semester[s]
Number of repeat examinations permitted: twice	**Recommended semester:**
Maximum number of students: 40	

Georg-August-Universität Göttingen **Module M.Phy-AM.012: Astrophysical Properties: From planets to cosmology**	12 C 8 WLH

Learning outcome, core skills: After successful completion of the modul the students should have competence in different fields of observational as well as theoretical astrophysics. The topics of these lectures range from the nearby universe covering the Sun, Space Weather, helioseismology and planets up to more distant stars. Another subject is the physics and evolution of galaxies including their central supermassive Black Holes. Finally, aspects of the evolution of the universe (cosmology) will be addressed.	**Workload:** Attendance time: 112 h Self-study time: 248 h

Course: students choose 4 courses of the following contents *Contents*: - Cosmology, Early Universe, String theory - Galaxies, Supermassive Black Holes, Interstellar Medium - Stars, Planets - Solar Physics, (Helio)seismology, Space Weather - Observational Astrophysics - Numerical Experiments in Astrophysics	

Examination: Oral examination (approx. 60 minutes) **Examination requirements:** The basic physical principals that have been taught in the individual lectures have to be understood in the context of the astrophysical relevance. This includes competence in numerical methods for the lecture on numerical experiments in astrophysics.	12 C

Admission requirements: 1st year AstroMundus courses	**Recommended previous knowledge:** none
Language: English	**Person responsible for module:** Prof. Dr. Wolfram Kollatschny
Course frequency: once a year	**Duration:** 1 semester[s]
Number of repeat examinations permitted: twice	**Recommended semester:** 3
Maximum number of students: 15	

Georg-August-Universität Göttingen **Module M.Phy.1401: Advanced Lab Course I**	6 C 6 WLH

Learning outcome, core skills:	**Workload:**
After successful completion of the module, students should - familiarise oneself independently into complex issues - perform experimental tasks under guidance in teamwork - write scientific protocols in terms of good scientific practice	Attendance time: 84 h Self-study time: 96 h

Course: Praktikum	

Examination: 4 reports (max. 25 pages) **Examination prerequisites:** 4 successful performed experiments. **Examination requirements:** Advanced experimental methods for solving physical problems.	6 C

Admission requirements: none	**Recommended previous knowledge:** none
Language: English, German	**Person responsible for module:** StudiendekanIn der Fakultät für Physik
Course frequency: each winter semester	**Duration:** 1 semester[s]
Number of repeat examinations permitted: 3 times	**Recommended semester:** 1
Maximum number of students: not limited	

Georg-August-Universität Göttingen **Module M.Phy.1402: Advanced Lab Course II**	6 C 6 WLH

Learning outcome, core skills:	**Workload:**
After successful completion of the module, students should - familiarise oneself independently into complex issues - perform experimental tasks under guidance in teamwork - write scientific protocols in terms of good scientific practice	Attendance time: 84 h Self-study time: 96 h

Course: Advanced Lab Course II	

Examination: 4 reports (max. 25 pages) **Examination prerequisites:** 4 successfull performed experiments **Examination requirements:** Advanced experimental methods for solving physical problems.	6 C

Admission requirements: none	**Recommended previous knowledge:** none
Language: German	**Person responsible for module:** StudiendekanIn der Fakultät für Physik
Course frequency: each summer semester	**Duration:** 1 semester[s]
Number of repeat examinations permitted: 3 times	**Recommended semester:** 2
Maximum number of students: not limited	

Georg-August-Universität Göttingen **Module M.Phy.1403: Internship**	6 C 6 WLH

Learning outcome, core skills: After successful completion of the module, students should familiarise oneself independently in complex issues and perform tasks under guidance in team work. The students should be able to present the obtained results in a talk or as a poster.	**Workload:** Attendance time: 84 h Self-study time: 96 h

Course: Internship	

Examination: Talk (approx. 30 min.) or Poster **Examination prerequisites:** Internship **Examination requirements:** Advanced methods for solving physical problems in the area of the chosen focus.	6 C

Admission requirements: This module can be selected only on the recommendation of a lecturer.	**Recommended previous knowledge:** none
Language: English, German	**Person responsible for module:** StudiendekanIn der Fakultät für Physik
Course frequency: each semester	**Duration:** 1 semester[s]
Number of repeat examinations permitted: 3 times	**Recommended semester:** 2

Georg-August-Universität Göttingen **Module M.Phy.405: Research Lab Course in Astro- and Geophysics**	18 C

Learning outcome, core skills: **Competencies:** Students should be able to familiarise oneself independently in a current scientific research project, perform it successfully and present the results to a professional audience.	**Workload:** Attendance time: 0 h Self-study time: 540 h

Course: Research Lab Course in Astro- and Geophysics	

Examination: Lecture, (2 weeks preparation time) (approx. 30 minutes) **Examination requirements:** Methods for in-depth familiarisation in a scientific field of work, critical review of literature, scientific presentation, good scientific practice.	

Admission requirements: none	**Recommended previous knowledge:** none
Language: English, German	**Person responsible for module:** Alle Dean of Studies of the Faculty of Physics
Course frequency: each winter semester	**Duration:** 1 semester[s]
Number of repeat examinations permitted: twice	**Recommended semester:** 3 - 4
Maximum number of students: 40	

Georg-August-Universität Göttingen **Module M.Phy.406: Research Lab Course in Biophysics and Physics of Complex Systems**	18 C

Learning outcome, core skills: **Competencies:** Students should be able to familiarise oneself independently in a current scientific research project, perform it successfully and present the results to a professional audience.	**Workload:** Attendance time: 0 h Self-study time: 540 h

Course: Research Lab Course in Biophysics and Physics of Complex Systems	

Examination: Lecture, (2 weeks preparation time) (approx. 30 minutes) **Examination requirements:** Methods for in-depth familiarisation in a scientific field of work, critical review of literature, scientific presentation, good scientific practice.	18 C

Admission requirements: none	**Recommended previous knowledge:** none
Language: English, German	**Person responsible for module:** Alle Dean of Studies of the Faculty of Physics
Course frequency: each winter semester	**Duration:** 1 semester[s]
Number of repeat examinations permitted: twice	**Recommended semester:** 3 - 4
Maximum number of students: 40	

Georg-August-Universität Göttingen **Module M.Phy.407: Research Lab Course in Solid State/Materials Physics**	18 C

Learning outcome, core skills: **Competencies:** Students should be able to familiarise oneself independently in a current scientific research project, perform it successfully and present the results to a professional audience.	**Workload:** Attendance time: 0 h Self-study time: 540 h

Course: Research Lab Course in Solid State/Materials Physics	

Examination: Lecture, (2 weeks preparation time) (approx. 30 minutes) **Examination requirements:** Methods for in-depth familiarisation in a scientific field of work, critical review of literature, scientific presentation, good scientific practice.	

Admission requirements: none	**Recommended previous knowledge:** none
Language: English, German	**Person responsible for module:** Dean of Studies of the Faculty of Physics
Course frequency: each winter semester	**Duration:** 1 semester[s]
Number of repeat examinations permitted: twice	**Recommended semester:** 3 - 4
Maximum number of students: 40	

Georg-August-Universität Göttingen **Module M.Phy.408: Research Lab Course in Particle Physics**	18 C

Learning outcome, core skills: Students should be able to familiarise oneself independently in a current scientific research project, perform it successfully and present the results to a professional audience.	**Workload:** Attendance time: 0 h Self-study time: 540 h

Course: Research Lab Course in Particle Physics	

Examination: Lecture, (2 weeks preparation time) (approx. 30 minutes) **Examination requirements:** Methods for in-depth familiarisation in a scientific field of work, critical review of literature, scientific presentation, good scientific practice.	

Admission requirements: none	**Recommended previous knowledge:** none
Language: English, German	**Person responsible for module:** Dean of Studies of the Faculty of Physics
Course frequency: each winter semester	**Duration:** 1 semester[s]
Number of repeat examinations permitted: twice	**Recommended semester:** 3 - 4
Maximum number of students: 40	

Georg-August-Universität Göttingen **Module M.Phy.409: Research Seminar Astro-/Geophysics**	4 C 2 WLH

Learning outcome, core skills: After successful completion of the module, students should present complex lines of reasoning and evaluate own and others' presentations in critical discussion.	**Workload:** Attendance time: 28 h Self-study time: 92 h

Course: Research Seminar Astro-/Geophysics	

Examination: Lecture, (4 weeks preparation time) (approx. 60 minutes) **Examination requirements:** Preparation of complex topics for presentation and scientific discussions.	

Admission requirements: none	**Recommended previous knowledge:** none
Language: English, German	**Person responsible for module:** Dean of Studies of the Faculty of Physics
Course frequency: each semester	**Duration:** 1 semester[s]
Number of repeat examinations permitted: twice	**Recommended semester:** 1 - 2
Maximum number of students: 40	

Georg-August-Universität Göttingen **Module M.Phy.410: Research Seminar Biophysics/Physics of Complex Systems**	4 C 2 WLH

Learning outcome, core skills: After successful completion of the module, students should present complex lines of reasoning and evaluate own and others' presentations in critical discussion.	**Workload:** Attendance time: 28 h Self-study time: 92 h

Course: Research Seminar Biophysics/Physics of Complex Systems	

Examination: Lecture, (4 weeks preparation time) (approx. 60 minutes) **Examination prerequisites:** active partizipation **Examination requirements:** Preparation of complex topics for presentation and scientific discussions.	

Admission requirements: none	**Recommended previous knowledge:** none
Language: English, German	**Person responsible for module:** Dean of Studies of the Faculty of Physics
Course frequency: each semester	**Duration:** 1 semester[s]
Number of repeat examinations permitted: twice	**Recommended semester:** 1 - 2
Maximum number of students: 40	

Georg-August-Universität Göttingen **Module M.Phy.411: Research Seminar Solid State/Materials Physics**	4 C 2 WLH

Learning outcome, core skills: After successful completion of the module, students should present complex lines of reasoning and evaluate own and others' presentations in critical discussion.	**Workload:** Attendance time: 28 h Self-study time: 92 h

Course: Research Seminar Solid State/Materials Physics	

Examination: Lecture, (4 weeks preparation time) (approx. 60 minutes) **Examination prerequisites:** active participation **Examination requirements:** Preparation of complex topics for presentation and scientific discussions.	

Admission requirements: none	**Recommended previous knowledge:** none
Language: English, German	**Person responsible for module:** Dean of Studies of the Faculty of Physics
Course frequency: each semester	**Duration:** 1 semester[s]
Number of repeat examinations permitted: twice	**Recommended semester:** 1 - 2
Maximum number of students: 40	

Georg-August-Universität Göttingen **Module M.Phy.412: Research Seminar Particle Physics**	4 C 2 WLH

Learning outcome, core skills: After successful completion of the module, students should present complex lines of reasoning and evaluate own and others' presentations in critical discussion.	**Workload:** Attendance time: 28 h Self-study time: 92 h

Course: Research Seminar Particle Physics	

Examination: Lecture, (4 weeks preparation time) (approx. 60 minutes) **Examination prerequisites:** active participation **Examination requirements:** Preparation of complex topics for presentation and scientific discussions.	

Admission requirements: none	**Recommended previous knowledge:** none
Language: English, German	**Person responsible for module:** Dean of Studies of the Faculty of Physics
Course frequency: each semester	**Duration:** 1 semester[s]
Number of repeat examinations permitted: twice	**Recommended semester:** 1 - 2
Maximum number of students: 40	

Georg-August-Universität Göttingen **Module M.Phy.413: General Seminar**	4 C 2 WLH

Learning outcome, core skills: After successful completion of the module, students should be able to develop the content of scientific publications (usually in English) independently and present it to a wide audience. They should be also able to evaluate it criticaly.	**Workload:** Attendance time: 28 h Self-study time: 92 h

Course: General Seminar	

Examination: Lecture, (4 weeks preparation time) (approx. 60 minutes) **Examination prerequisites:** active participation **Examination requirements:** Use of presentation media, presentation of complex issues in front of expert and non-expert audiences, communication and discussion skills, critical awareness and expressiveness.	

Admission requirements: none	**Recommended previous knowledge:** none
Language: English, German	**Person responsible for module:** Dean of Studies of the Faculty of Physics
Course frequency: each semester	**Duration:** 1 semester[s]
Number of repeat examinations permitted: twice	**Recommended semester:** 1 - 2
Maximum number of students: 150	

Additional notes and regulations: We recomend to chose the seminar not of the own research focus.

Georg-August-Universität Göttingen **Module M.Phy.5002: Contemporary Physics**	4 C 2 WLH

Learning outcome, core skills: **Lernziele**: To understand cutting-edge research in 6 topics in physics by attending the physics colloquia. Introductory lectures will be provided to bridge the gap between students lectures and the scientific level of the colloquium. **Kompetenzen**: After successful completion of modul students should be able to... • independent learning; • independent analysis; • work in teams; • write scientific reports; • read scientifc literature; • extract the important research questions and results from the physics colloquia.	**Workload:** Attendance time: 28 h Self-study time: 92 h

Course: Contemporary Physics	2 WLH

Examination: written report (max. 5 pages) **Examination requirements:** Ability to combine the information given in the introductory lecture, the physics colloquium and current literature in 6 written reports on each of the colloquium topics.	4 C

Admission requirements: none	**Recommended previous knowledge:** none
Language: English	**Person responsible for module:** StudiendekanIn der Fakultät für Physik
Course frequency: each semester	**Duration:** 1 semester[s]
Number of repeat examinations permitted: 3 times	**Recommended semester:** 1 - 4
Maximum number of students: 20	

Georg-August-Universität Göttingen **Module M.Phy.5502: Numerical experiments in stellar astrophysics**	3 C 2 WLH

Learning outcome, core skills: After successful completion of the modul students should have hands-on experience computing stellar models and solving oscillation eigenvalue problems.	**Workload:** Attendance time: 28 h Self-study time: 62 h

Course: Vorlesung (Lecture)	

Examination: Oral examination (approx. 30 minutes) **Examination prerequisites:** keine **Examination requirements:** • Use of numerical codes to model the internal structure and oscillations of stars. • Hands-on experience with the codes. • Computation of stellar models and their oscillation frequencies. • Experimenting with parameters and physical inputs.	3 C

Admission requirements: keine	**Recommended previous knowledge:** keine
Language: English	**Person responsible for module:** Prof. Dr. Laurent Gizon
Course frequency: each summer semester	**Duration:** 1 semester[s]
Number of repeat examinations permitted: 3 times	**Recommended semester:** Master: 2 - 4
Maximum number of students: 40	

Georg-August-Universität Göttingen **Module M.Phy.551: Advanced Topics in Astro-/Geophysics I**	6 C 6 WLH

Learning outcome, core skills: After successful completion of the modul students should be familiar with advanced concepts of astrophysics and Geophysics.	**Workload:** Attendance time: 84 h Self-study time: 96 h

Course: Course (6 C) in the field of Astro- or Geophysics	

Examination: Written exam (120 min) or oral exam (ca. 30 min) or talk (ca. 30 min), 2 weeks preparation time **Examination requirements:** Advanced experimental techniques or theoretical models in astro- or geophysics	

Admission requirements: none	**Recommended previous knowledge:** none
Language: English, German	**Person responsible for module:** Dean of Studies of the Faculty of Physics
Course frequency: each semester	**Duration:** 1 semester[s]
Number of repeat examinations permitted: 3 times	**Recommended semester:** 1 - 4
Maximum number of students: 40	

Georg-August-Universität Göttingen **Module M.Phy.552: Advanced Topics in Astro-/Geophysics II**	6 C 4 WLH

Learning outcome, core skills: After successful completion of the modul students should be familiar with advanced concepts of astrophysics and Geophysics.	**Workload:** Attendance time: 56 h Self-study time: 124 h

Course: Advanced Topics in Astro-/Geophysics IIa	2 WLH
Examination: Written examination (120 Min.) or oral examination (approx. 30 Min.) or talk (approx. 30 Min.), 2 weeks preparation time **Examination requirements:** Advanced experimental techniques or theoretical models in astro- or geophysics	3 C

Course: Advanced Topics in Astro-/Geophysics IIb	2 WLH
Examination: Written examination (120 Min.) or oral examination (approx. 30 Min.) or talk (approx. 30 Min.), 2 weeks preparation time **Examination requirements:** Advanced experimental techniques or theoretical models in astro- or geophysics	3 C

Admission requirements: none	**Recommended previous knowledge:** none
Language: German, English	**Person responsible for module:** StudiendekanIn der Fakultät für Physik
Course frequency: each semester	**Duration:** 2 semester[s]
Number of repeat examinations permitted: 3 times	**Recommended semester:** 1 - 4
Maximum number of students: 40	

Georg-August-Universität Göttingen **Module M.Phy.556: Seminar Advanced Topics in Astro-/Geophysics**	4 C 2 WLH

Learning outcome, core skills: After successful completion of the modul students should be familiar with the presentation of complext problems, scientific discussion as well as evaluation of contents of the presentations.	**Workload:** Attendance time: 28 h Self-study time: 92 h

Course: Seminar Advanced Topics in Astro-/Geophysics I	

Examination: Lecture, 4 weeks preparation time (approx. 60 minutes) **Examination prerequisites:** active Participation **Examination requirements:** Advanced experimental techniques or theoretical models in astro- or geophysics	4 C

Admission requirements: none	**Recommended previous knowledge:** none
Language: German, English	**Person responsible for module:** Prof. Dr. Stefan Dreizler
Course frequency: each semester	**Duration:** 1 semester[s]
Number of repeat examinations permitted: twice	**Recommended semester:** 1 - 2
Maximum number of students: 40	

Georg-August-Universität Göttingen **Module M.Phy.5601: Seminar Computational Neuroscience/Neuro-informatics**	4 C 2 WLH

Learning outcome, core skills: After successful completion of the module, students should ... • have deepened their knowledge of computational neuroscience / neuroinformatics by an independent elaboration of a topic; • have learned methods of presentation of topics from computer science; • be able to deal with (English-language) literature; • be able to present an informatic topic; • be able to lead a scientific discussion.	**Workload:** Attendance time: 28 h Self-study time: 92 h

Course: Seminar (Seminar)	

Examination: Seminartalk (approx. 45 Min.) with written report (max. 7 S.) **Examination prerequisites:** Active Participation **Examination requirements:** Independent preparation and presentation of research-related topics from the area of computational neuroscience / neuroinformatics as well as biophysics of neuronal systems.	4 C

Admission requirements: none	**Recommended previous knowledge:** B.Phy.5614
Language: English	**Person responsible for module:** StudiendekanIn der Fakultät für Physik
Course frequency: each semester	**Duration:** 1 semester[s]
Number of repeat examinations permitted: twice	**Recommended semester:** Master: 1 - 3
Maximum number of students: 14	

Georg-August-Universität Göttingen **Module M.Phy.5604: Biomedicine imaging physics and medical physics**	6 C 4 WLH

Learning outcome, core skills: After taking this course, students will have quantitative insight into the physical, mathematical and algorithmic foundations of imaging techniques for biomedical applications, in particular CT, MRI, tomographic reconstruction, image processing, nuclear techniques, ultrasound and laser-tissue interaction up to emerging techniques such as phase contrast radiography. Further, the course leads a basic understanding of medical physics in a broader sense, including radiotherapy, radiobiology.	**Workload:** Attendance time: 56 h Self-study time: 124 h

Course: Vorlesung (Lecture)	

Examination: Written examination (120 Min.) or oral examination (approx. 30 Min.) or Presentation (approx. 30 Min., 2 weeks preparation time) **Examination requirements:** Knowledge of physical principles in medical diagnostics and therapy, in particular modern imaging techniques: Radiography (Absorptions- and Phase contrast), tomography, magnetic resonance imaging () positron-emissions-tomography, single photon emission tomography (SPECT), nuclear methods and probes, ultrasound imaging, optical microscopy. Along with the experimental principles, the algorithmic and mathematical concepts of image reconstruction and processing have to be mastered.	6 C

Admission requirements: none	**Recommended previous knowledge:** none
Language: German, English	**Person responsible for module:** Prof. Dr. Tim Salditt
Course frequency: every 4th semester; alle 2 jahre	**Duration:** 1 semester[s]
Number of repeat examinations permitted: 3 times	**Recommended semester:** Master: 2 - 4
Maximum number of students: 50	

Georg-August-Universität Göttingen **Module M.Phy.5608: Liquid State Physics**	4 C 2 WLH

Learning outcome, core skills: Lernziele/Kompetenzen: Students should learn the core concepts of the theories and experimental phenomenology of the liquid state, from simple to macromolecular/polymeric to granular liquids. Through readings of the important papers, both seminal or at the fore-front of research, they should learn how to understand the modern open questions regarding the liquid state. Students should also explore a specific topic that is currently subject of active research, and prepare an oral presentation and a written handout at the end of the semester.	**Workload:** Attendance time: 28 h Self-study time: 92 h

Course: Liquid State Physics *Contents*: This course will cover the foundations of the theoretical and experimental description of simple liquids, macromolecular/polymeric liquids and granular liquids and gases. We will learn about the statistico-mechanical approach to the liquid state, including distribution function theories, Boltzmann equation and Navier-Stokes equation. We will then move on to the dynamics of macromolecular liquids such as polymers. Based on concepts like viscosity and visco-elasticity, we will also explore thin film flows and non-Newtonian phenomena. The final part of the course will consider liquids composed of “macroscopic molecules” like sand grains. While their flow behavior is often reminiscent of molecular liquids, the dissipative nature of their interaction makes them an intrinsic out of equilibrium phenomenon.	

Examination: Presentation (ca. 40 min.) and handout on special topic of choice **Examination prerequisites:** Participation in course discussion and assignments **Examination requirements:** Students will perform an in-depth investigation on a particular course topic, and present this in a symposium at the end of the course.	4 C

Admission requirements: none	**Recommended previous knowledge:** none
Language: English	**Person responsible for module:** StudiendekanIn der Fakultät für Physik; Ansprechpartner Dr. Marco Mazza
Course frequency: unregelmäßig	**Duration:** 1 semester[s]
Number of repeat examinations permitted:	**Recommended semester:**

3 times	Master: 1 - 4
Maximum number of students: 50	

Additional notes and regulations:

SP: Biophysik/nichtlineare Dynamik; Festkörperphysik; Materialphysik; Astrophysik; Geophysik

Georg-August-Universität Göttingen **Module M.Phy.561: Advanced Topics in Biophysics/Physics of complex systems I**	6 C 6 WLH

Learning outcome, core skills: After successful completion of the modul students should be familiar with advanced concepts of Biophysics and Physics of Complex Systems	**Workload:** Attendance time: 84 h Self-study time: 96 h

Course: Course (6 C) in the field of Biophysics and Physics of Complex Systems	

Examination: Written exam (120 min) or oral exam (ca. 30 min) or talk (ca. 30 min), 2 weeks preparation time **Examination prerequisites:** M.Phy.561.Mp **Examination requirements:** Advanced experimental techniques or theoretical models in Biophysics and Physics of Complex Systems.	

Admission requirements: none	**Recommended previous knowledge:** none
Language: English, German	**Person responsible for module:** Dean of Studies
Course frequency: each semester	**Duration:** 1 semester[s]
Number of repeat examinations permitted: 3 times	**Recommended semester:** 1 - 4
Maximum number of students: 40	

Georg-August-Universität Göttingen **Module M.Phy.562: Advanced Topics in Biophysics/Physics of complex systems II**	6 C 4 WLH

Learning outcome, core skills: After successful completion of the modul students should be familiar with advanced concepts of Biophysics and Physics of Complex Systems.	**Workload:** Attendance time: 56 h Self-study time: 124 h

Course: Course (3 C) in the Field of Biophysics/Physics of complex systems	2 WLH
Examination: Written exam (120 min) or oral exam (ca. 30 min) or talk (ca. 30 min), 2 weeks preparation time **Examination requirements:** Advanced experimental techniques or theoretical models in Biophysics and Physics of Complex Systems	3 C

Course: Course (3 C) in the Field of Biophysics/Physics of complex systems	2 WLH
Examination: Written exam (120 min) or oral exam (ca. 30 min) or talk (ca. 30 min), 2 weeks preparation time **Examination requirements:** Advanced experimental techniques or theoretical models in Biophysics and Physics of Complex Systems	3 C

Admission requirements: none	**Recommended previous knowledge:** none
Language: English, German	**Person responsible for module:** Dean of Studies
Course frequency: each semester	**Duration:** 1 semester[s]
Number of repeat examinations permitted: 3 times	**Recommended semester:** 1 - 4
Maximum number of students: 40	

Georg-August-Universität Göttingen **Module M.Phy.566: Seminar Advanced Topics in Biophysics/Complex Systems**	4 C 2 WLH

Learning outcome, core skills: After successful completion of the modul students should be familiar with the presentation of complext problems, scientific discussion as well as evaluation of contents of the presentations.	**Workload:** Attendance time: 28 h Self-study time: 92 h

Course: Seminar Advanced Topics in Biophysics/Complex Systems	
Examination: Lecture, 4 weeks preparation time (approx. 60 minutes) **Examination prerequisites:** active Participation **Examination requirements:** Advanced experimental techniques or theoretical models in astro- or geophysics	4 C

Admission requirements: none	**Recommended previous knowledge:** none
Language: English, German	**Person responsible for module:** Dean of Studies
Course frequency: each semester	**Duration:** 1 semester[s]
Number of repeat examinations permitted: twice	**Recommended semester:** 1 - 2
Maximum number of students: 40	

Georg-August-Universität Göttingen **Module M.Phy.5701: Advanced Solid State Theory**	6 C 6 WLH

Learning outcome, core skills: After successful completion of the modul students should be able to perform calculations using many-body techniques, describe and model simple experimental observations, understand and use the language of modern solid-state theory.	**Workload:** Attendance time: 84 h Self-study time: 96 h

Courses:	
1. Lecture	4 WLH
2. Exercises	2 WLH

Examination: Written examination (90 minutes) **Examination requirements:** Quantum-field theoretical description of solids, elements of ab initio methods, symmetries and binding, optical properties of solids, correlated electron systems, elements of transport theory. Formulation of theories based on experimental observation, description and interpretation of experiments in solids, knowledge of manybody techniques	6 C

Admission requirements: none	**Recommended previous knowledge:** Introduction to Solid State Physics Quantum mechanics I
Language: English	**Person responsible for module:** Dean of Studies, Faculty of Physics
Course frequency: each summer semester	**Duration:** 1 semester[s]
Number of repeat examinations permitted: 3 times	**Recommended semester:** Master: 2 - 3
Maximum number of students: 40	

Georg-August-Universität Göttingen **Module M.Phy.5705: Materials Physics I: Microstructure-Property-Relations**	4 C 3 WLH

Learning outcome, core skills: After successful completion of this Module, the student will have obtained an overview about the realistic structure of materials (realistic = including defects and irregularities). In addition, a deepened understanding of the relation between micro-structure and fundamental material properties will have been gained via the discussion of theoretical models and experimental results.	**Workload:** Attendance time: 42 h Self-study time: 78 h

Course: Lecture and exercises *Contents*: Basic concepts of structure-property relations and defects, topology, thermodynamics and properties of defects, microstructure and mechanical properties.	

Examination: Presentation (approximately 30 minutes) or written examination (120 minutes) or oral examination (approximately 30 minutes) **Examination prerequisites:** Participation in exercise classes or completion of homework problem sheets or participation in discussions during lectures can be set at the start of the lectures as prerequisites for participation in the examination. **Examination requirements:** Global and local symmetries in materials, elastic continuum theory, structure of pointdefects, dislocations and grain boundaries, thermodynamics of defects, mechanical /chemical / electronic / transport properties of defects, as well as methods for the investigation of micro-structure and related properties.	4 C

Admission requirements: none	**Recommended previous knowledge:** Introductory courses in materials science and solid state physics.
Language: English	**Person responsible for module:** Prof.in Cynthia Volkert
Course frequency: each winter semester	**Duration:** 1 semester[s]
Number of repeat examinations permitted: 3 times	**Recommended semester:** 1 - 3
Maximum number of students: not limited	

Georg-August-Universität Göttingen **Module M.Phy.5706: Materials Physics II: Kinetics and Phase Transformations**	4 C 3 WLH

Learning outcome, core skills: After successful completion of this Module, the student will have obtained an overview of theoretical concepts and mechanisms of phase transformations in materials. In addition, a deeper understanding of the description of kinetic processes in the framework of irreversible thermodynamics will have been gained.	**Workload:** Attendance time: 42 h Self-study time: 78 h

Course: Vorlesung und Übung *Contents*: Fundamentals and specific examples of the behavior of condensed matter systems in non-equilibrium situations.	

Examination: Presentation (approximately 30 minutes) or written exam (120 minutes) or oral examination (approximately 30 minutes) **Examination prerequisites:** Participation in exercise classes or completion of homework problem sheets or participation in discussions during lectures can be set at the start of the lectures as prerequisites for participation in the examination. **Examination requirements:** Non-equilibrium thermodynamics, generalized driving forces, diffusion, nucleation, motion and instabilities of interfaces, solidification, precipitation, domain growth, spinodal decomposition, order-disorder phase transitions, kinetically controlled transformations.	4 C

Admission requirements: none	**Recommended previous knowledge:** Introductory courses in materials science and solid state physics, as well as the course Materials Physics I.
Language: English	**Person responsible for module:** Prof.in Cynthia Volkert
Course frequency: each summer semester	**Duration:** 1 semester[s]
Number of repeat examinations permitted: 3 times	**Recommended semester:** 2 - 4
Maximum number of students: not limited	

Georg-August-Universität Göttingen **Module M.Phy.5707: Materials research with electrons**	3 C 2 WLH

Learning outcome, core skills:	**Workload:**
Fundamentals of the application of electron microscopy to the characterization and analysis of materials, with emphasis on: * Interactions between electrons and solids * Preparation of samples, limits of electron microscopy * Fundamentals and advanced concepts of electron microscopy * Diffraction and imaging * Analytical applications (EDX, EELS, GPA, …) * Overview of current research topics After successful completion of this Module, the student will be able to understand further developments of electron microscopy and gain access to current research themes.	Attendance time: 28 h Self-study time: 62 h

Course: Materials research with electrons (Lecture)	

Examination: Oral examination, (approximately 30 minutes) **Examination requirements:** Understanding of fundamental concepts, facts, and methods. Basic understanding of diffraction, imaging, and analysis.	3 C

Admission requirements: none	**Recommended previous knowledge:** Introductory courses in materials science and solid state physics.
Language: English	**Person responsible for module:** apl. Prof. Dr. Michael Seibt
Course frequency: Every 2 years, summer semester	**Duration:** 1 semester[s]
Number of repeat examinations permitted: 3 times	**Recommended semester:** Master: 1 - 4
Maximum number of students: 30	

Georg-August-Universität Göttingen **Module M.Phy.571: Advanced Topics in Solid State/Materials Physics I**	6 C 6 WLH

Learning outcome, core skills: After successful completion of the modul students should be familiar with advanced concepts of Solid State/Materials Physics	**Workload:** Attendance time: 84 h Self-study time: 96 h

Course: A course (6 C) in the field of Solid State/Materials Physics	

Examination: Written exam (120 min) or oral exam (ca. 30 min) or talk (ca. 30 min), 2 weeks preparation time **Examination requirements:** Advanced experimental techniques or theoretical models in Solid State/Materials Physics	

Admission requirements: none	**Recommended previous knowledge:** none
Language: English, German	**Person responsible for module:** Dean of Studies
Course frequency: each semester	**Duration:** 1 semester[s]
Number of repeat examinations permitted: 3 times	**Recommended semester:** Master: 1 - 4
Maximum number of students: 40	

Georg-August-Universität Göttingen **Module M.Phy.572: Advanced Topics in Solid State/Materials Physics II**	6 C 4 WLH

Learning outcome, core skills: After successful completion of the modul students should be familiar with advanced concepts of Solid State/Materials Physics.	**Workload:** Attendance time: 56 h Self-study time: 124 h

Course: Course (3 C) in the field of Solid State/Materials Physics	2 WLH
Examination: Written exam (120 min) or oral exam (ca. 30 min) or talk (ca. 30 min), 2 weeks preparation time **Examination requirements:** Advanced experimental techniques or theoretical models in Solid State/Materials Physics	3 C

Course: Course (3 C) in the field of Solid State/Materials Physics	2 WLH
Examination: Written exam (120 min) or oral exam (ca. 30 min) or talk (ca. 30 min), 2 weeks preparation time **Examination requirements:** Advanced experimental techniques or theoretical models in Solid State/Materials Physics	3 C

Admission requirements: none	**Recommended previous knowledge:** none
Language: English, German	**Person responsible for module:** Dean of Studies
Course frequency: each semester	**Duration:** 2 semester[s]
Number of repeat examinations permitted: 3 times	**Recommended semester:** 1 - 4
Maximum number of students: 40	

Georg-August-Universität Göttingen **Module M.Phy.576: Seminar Advanced Topics in Solid State/Materials Physics**	4 C 2 WLH

Learning outcome, core skills: After successful completion of the modul students should be familiar with the presentation of complext problems, scientific discussion as well as evaluation of contents of the presentations.	**Workload:** Attendance time: 28 h Self-study time: 92 h

Course: Seminar Advanced Topics in Solid State/Materials Physics	

Examination: Lecture, 4 weeks preparation time (approx. 60 minutes) **Examination prerequisites:** active participation **Examination requirements:** Advanced experimental techniques or theoretical models in Solid State/Materials Physics	4 C

Admission requirements: none	**Recommended previous knowledge:** none
Language: English, German	**Person responsible for module:** Dean of Studies
Course frequency: each semester	**Duration:** 1 semester[s]
Number of repeat examinations permitted: twice	**Recommended semester:** 1 - 2
Maximum number of students: 40	

Georg-August-Universität Göttingen **Module M.Phy.5801: Detectors for particle physics and imaging**	3 C 3 WLH

Learning outcome, core skills: After successful completion of this module, students should be familiar with modern methods and questions about detector physics in high energy physics, imaging and related fields.	**Workload:** Attendance time: 42 h Self-study time: 48 h

Course: Vorlesung mit Übung	

Examination: Oral examination (approx. 30 minutes) **Examination requirements:** Based on the introductory lecture "interactions between radiation and matter" this lecture covers special topics of detector physics such as the layout of certain detector types (i.e. semiconductor detectors, ionisation detectors etc.), readout systems and noise contribution, radiation damage of detector material and readout as well as the application of such detectors.	3 C

Admission requirements: none	**Recommended previous knowledge:** none
Language: English	**Person responsible for module:** Prof. Dr. Arnulf Quadt
Course frequency: every 4th semester; irregular	**Duration:** 1 semester[s]
Number of repeat examinations permitted: 3 times	**Recommended semester:** Master: 1 - 3
Maximum number of students: 20	

Georg-August-Universität Göttingen **Module M.Phy.5804: Simulation methods for theoretical particle physics**	3 C 3 WLH

Learning outcome, core skills: **Learning Outcome:** The aim of the lecture is to convey the theoretical foundations of simulations of particle-physics scattering experiments. While the relevant theoretical concepts get introduced and discussed in the lectures, the tutorials provide hands-on experience with corresponding computer codes. **Competencies:** The successful participation in the module the students will have experience with the tools and methods used in high-energy particle physics research. They will be in a position to carry out corresponding calculations and understand contemporary research subjects	**Workload:** Attendance time: 42 h Self-study time: 48 h

Courses:	
1. Tutorial Simulation methods for theoretical particle physics	1 WLH
2. Lecture Simulation methods for theoretical particle physics (Lecture)	2 WLH

Examination: written (30 Min.) or oral exam (ca. 30 Min.) **Examination requirements:** Solid understanding of the foundations of the theoretical description of high-energy scattering experiments. Ability to carry out corresponding calculations and simulations.	3 C

Admission requirements: keine	**Recommended previous knowledge:** Quantum mechanics II, Quantum Field Theory
Language: English	**Person responsible for module:** Jun.-Prof. Dr. rer. nat. Steffen Schumann
Course frequency: every 4th semester	**Duration:** 1 semester[s]
Number of repeat examinations permitted: 3 times	**Recommended semester:** Master: 1 - 4
Maximum number of students: 30	

Georg-August-Universität Göttingen **Module M.Phy.5807: Particle Physics III - of and with leptons**	6 C 6 WLH

Learning outcome, core skills: After successful completion of this module, students should be familiar with the properties and interactions of leptons as well as with experimental methods and experiments which lead to their discovery and are used for precise studies.	**Workload:** Attendance time: 84 h Self-study time: 96 h

Course: Lecture and exercises - Particle Physics III	

Examination: Oral examination (approx. 30 minutes) **Examination requirements:** Discovery of leptons, properties of leptons, weak interactions and V-A structure, neutral currents, standard model of particle physics, e+e- physics at LEP, fermion pair production at varying center of mass energy, lineshape of cross-section at Z-pole, number of light neutrino generations, forward-backward-asymmetry, tau-polarisation, e+e- physics at the LHC, (g-2)_myon, neutrinos and neutrino oscillations, solar neutrinos, atmospheric neutrinos, long-baseline experiments, neutrino factories, neutrino mass, neutrinoless double-beta decay	6 C

Admission requirements: none	**Recommended previous knowledge:** Introduction to Nuclear/Particle Physics
Language: German, English	**Person responsible for module:** Prof. Dr. Arnulf Quadt
Course frequency: each winter semester	**Duration:** 1 semester[s]
Number of repeat examinations permitted: 3 times	**Recommended semester:** Master: 1 - 3
Maximum number of students: not limited	

Georg-August-Universität Göttingen **Module M.Phy.5809: Axiomatic Quantum Field Theory**	3 C 3 WLH

Learning outcome, core skills: **Acquisition of knowledge:** Axiomatic settings and general structure theorems of relativistic quantum field theory; Symmetries and representations; Exact models (two spacetime dimensions, especially with conformal symmetry). **Competences:** The students shall be familiar with the model-independent concepts and structures of relativistic Quantum Field Theory. They understand the transfer between complementary approaches.	**Workload:** Attendance time: 42 h Self-study time: 48 h

Courses:	
1. Axiomatic Quantum Field Theory (Lecture)	2 WLH
2. Axiomatic Quantum Field Theory (Exercise) *Contents*: in-class problems	1 WLH

Examination: Written examination (120 minutes) **Examination requirements:** Mastery of the conceptual framework and elementary methods of proof. Application in concrete situations.	3 C

Admission requirements: none	**Recommended previous knowledge:** Classical Field Theory I, QM I, II
Language: English	**Person responsible for module:** apl. Prof. Dr. Karl-Henning Rehren
Course frequency: irregular	**Duration:** 1 semester[s]
Number of repeat examinations permitted: 3 times	**Recommended semester:** 1 - 4
Maximum number of students: 20	

Georg-August-Universität Göttingen **Module M.Phy.581: Advanced Topics in Particle Physics I**	6 C 6 WLH

Learning outcome, core skills: After successful completion of the modul students should be familiar with advanced concepts of Particle Physics	**Workload:** Attendance time: 84 h Self-study time: 96 h

Course: A Course (6 C) in the field of Particle Physics	
Examination: Written examination (120 Min.) or oral examination approx. 30 Min.) or talk (approx. 30 Min.),2 weeks preparation time **Examination requirements:** Advanced experimental techniques or theoretical models in Particle Physics	

Admission requirements: none	**Recommended previous knowledge:** none
Language: English, German	**Person responsible for module:** Dean of Studies
Course frequency: each semester	**Duration:** 1 semester[s]
Number of repeat examinations permitted: 3 times	**Recommended semester:** 1 - 4
Maximum number of students: 40	

Georg-August-Universität Göttingen **Module M.Phy.582: Advanced Topics in Particle Physics II**	6 C 4 WLH

Learning outcome, core skills: After successful completion of the modul students should be familiar with advanced concepts of Particle Physics	**Workload:** Attendance time: 56 h Self-study time: 124 h

Course: A Course (3 C) in the field of Particle Physics	2 WLH
Examination: Written exam (120 min) or oral exam (ca. 30 min) or talk (ca. 30 min), 2 weeks preparation time **Examination requirements:** Advanced experimental techniques or theoretical models in Particle Physics	3 C

Course: A Course (3 C) in the field of Particle Physics	2 WLH
Examination: Written exam (120 min) or oral exam (ca. 30 min) or talk (ca. 30 min), 2 weeks preparation time **Examination requirements:** Advanced experimental techniques or theoretical models in Particle Physics	3 C

Admission requirements: none	**Recommended previous knowledge:** none
Language: English, German	**Person responsible for module:** Dean of Studies
Course frequency: each semester	**Duration:** 2 semester[s]
Number of repeat examinations permitted: 3 times	**Recommended semester:** 1 - 4
Maximum number of students: 40	

Georg-August-Universität Göttingen **Module M.Phy.586: Seminar Advanced Topics in Particle Physics**	4 C 2 WLH

Learning outcome, core skills: After successful completion of this module, students should be able to reproduce and present complex chains of arguments, assess their own and other students' presentation critically.	**Workload:** Attendance time: 28 h Self-study time: 92 h

Course: Seminar Advanced Topics in Particle Physics	

Examination: Lecture, 4 weeks preparation time (approx. 60 minutes) **Examination prerequisites:** Active participation **Examination requirements:** Preparation of complex topics for presentation and scientific discussion.	4 C

Admission requirements: none	**Recommended previous knowledge:** none
Language: English, German	**Person responsible for module:** Dean of Studies
Course frequency: each semester	**Duration:** 1 semester[s]
Number of repeat examinations permitted: twice	**Recommended semester:** 1 - 2
Maximum number of students: 40	

Georg-August-Universität Göttingen **Module M.Phy.601: Development and Realization of Scientific Projects**	9 C

Learning outcome, core skills: After successful completion of the module, students should be able to carry out the planning and the "controlling" of scientific research projects independently. They should ... • tbe able o use Literature Databases systematically; • have a good command of modern word processors; • have skills in good scientific practice.	**Workload:** Attendance time: 0 h Self-study time: 270 h

Course: Development and Realization of Scientific Projects	

Examination: written report (max. 30 S.)	

Examination requirements: Use of Literature Databases, good command of modern word processors	

Admission requirements: none	**Recommended previous knowledge:** none
Language: English, German	**Person responsible for module:** Dean of Studies of the Faculty of Physics
Course frequency: each semester	**Duration:** 1 semester[s]
Number of repeat examinations permitted: 3 times	**Recommended semester:** 3 - 4
Maximum number of students: 150	

Georg-August-Universität Göttingen **Module M.Phy.602: Networking**	3 C

Learning outcome, core skills: **Objectives:** Formulation of proposals, registration, funding and participation in congresses **Competences:** After successful completion of the module the student should have gained networking skills.	**Workload:** Attendance time: 0 h Self-study time: 90 h

Course: Networking	

Examination: written report (max. 10 S.), not graded	

Examination requirements: Networking and application in scientific and professional environment on student's own initiative.	

Admission requirements: none	**Recommended previous knowledge:** none
Language: English, German	**Person responsible for module:** Studiendekan/in der Fakultät für Physik
Course frequency: each semester	**Duration:** 1 semester[s]
Number of repeat examinations permitted: 3 times	**Recommended semester:** 3 - 4
Maximum number of students: 150	

Georg-August-Universität Göttingen **Module M.Phy.603: Writing scientific articles**	6 C 2 WLH

Learning outcome, core skills: **Objective:** Basics of writing a scientific paper, form and and content of a Scientific paper, correspondence with scientific journals, understanding and imparting of content of current research, scientific discussion with co - authors **Competences:** After successfully completing the module students should know how to... • write a scientific article • submit a publication in the respective field • impart their independently developed effort	**Workload:** Attendance time: 28 h Self-study time: 152 h

Courses:	
1. Workshop	1 WLH
2. Accompanying Seminar	1 WLH

Examination: written report (max. 20 S.), not graded **Examination prerequisites:** active participation	6 C

Examination requirements: a) Writing scientific articles b) Submit sciientific publications	

Admission requirements: The Bachelor Thesis has to... • meet high academic standards • be a scientific progress in the science • be an independent performance The determination of the access authorization is performed by the module responsible. She/He may request the opinion of an authorized examinator in the related field.	**Recommended previous knowledge:** none
Language: English, German	**Person responsible for module:** Dean of Studies of the Faculty of Physics
Course frequency: each semester; nach Bedarf	**Duration:** 2 semester[s]
Number of repeat examinations permitted: 3 times	**Recommended semester:** 1 - 4
Maximum number of students: not limited	