Georg-August-Universität
Göttingen

Modulverzeichnis

zu der Prüfungs- und Studienordnung für den konsekutiven Master-Studiengang "Physics" (Amtliche Mitteilungen I Nr. 52/2016 S. 1384, zuletzt geändert durch Amtliche Mitteilungen I Nr. 17/2022 S. 230)

Module

Übersicht nach Modulgruppen

I. Master-Studiengang "Physics"

Es müssen nach Maßgabe der folgenden Bestimmungen wenigstens 120 C erworben werden.

1. Praktika

Es müssen folgende Praktika im Umfang von insgesamt 12 C nach Maßgabe der folgenden Bestimmungen erfolgreich absolviert werden.

a. Praktikum Teil I

Es muss eines der beiden folgenden Module im Umfang von 6 C erfolgreich absolviert werden:

b. Praktikum Teil II

Es muss eines der folgenden Wahlpflichtmodule im Umfang von 6 C erfolgreich absolviert werden; das Modul B.Phy.606 darf nur gewählt werden, sofern es nicht bereits im Bachelorstudium eingebracht wurde:

2. Forschungsschwerpunkt

Der Master-Studiengang "Physics" muss mit einem der fünf Studienschwerpunkte "Astro- und Geophysik", "Biophysik und Physik komplexer Systeme", "Festkörper- und Materialphysik", "Kern- und Teilchenphysik" oder "Theoretische Physik" im Umfang von jeweils wenigstens 56 C nach Maßgabe der folgenden Bestimmungen studiert werden.

a. Forschungsschwerpunkt "Astro- und Geophysik"

Es müssen Module im Umfang von insgesamt wenigstens 56 C nach Maßgabe der nachfolgenden Bestimmungen erfolgreich absolviert werden.

aa. Erster Studienschnitt (1. und 2. Semester)

Es müssen Module im Umfang von insgesamt wenigstens 26 C nach Maßgabe der folgenden Bestimmungen erfolgreich absolviert werden.

i. Forschungsseminar

Es muss folgendes Modul im Umfang von 4 C erfolgreich absolviert werden:

ii. Wahlpflichtbereich A

Es muss folgendes Modul im Umfang von 8 C erfolgreich absolviert und ins Zeugnis eingebracht werden. Bereits im Bachelor eingebrachte Module können nicht berücksichtigt werden. Sind alle hier genannten Module bereits im Bachelor im Rahmen der 180 C eingebracht worden, sind alle 26 C aus iii zu wählen.

iii. Wahlpflichtbereich B

Ergänzend muss die Differenz zu den 26 C durch erfolgreiche Absolvierung wenigstens zwei der folgenden Module erbracht werden; bereits im Bachelorstudium absolvierte Module können nicht berücksichtigt werden:

bb. Zweiter Studienabschnitt (3. Semester)

Es müssen folgende drei Module im Umfang von insgesamt 30 C erfolgreich absolviert werden:

b. Forschungsschwerpunkt "Biophysik und Physik komplexer Systeme"

Es müssen Module im Umfang von insgesamt wenigstens 56 C nach Maßgabe der nachfolgenden Bestimmungen erfolgreich absolviert werden.

aa. Erster Studienabschnitt (1. und 2. Semester)

Es müssen Module im Umfang von insgesamt wenigstens 26 C nach Maßgabe der folgenden Bestimmungen erfolgreich absolviert werden.

i. Forschungsseminar

Es muss folgendes Modul im Umfang von 4 C erfolgreich absolviert werden:

ii. Wahlpflichtbereich A

Es muss mindestens eines der folgenden Module im Umfang von 6 C erfolgreich absolviert und ins Zeugnis eingebracht werden. Bereits im Bachelor eingebrachte Module können nicht berücksichtigt werden. Sind alle hier genannten Module bereits im Bachelor im Rahmen der 180 C eingebracht worden, sind alle 26 C aus iii zu wählen.

iii. Wahlpflichtbereich B

Ergänzend muss die Differenz zu den 26 C durch erfolgreiche Absolvierung wenigstens zwei der folgenden Module erbracht werden; bereits im Bachelorstudium absolvierte Module können nicht berücksichtigt werden:

bb. Zweiter Studienabschnitt (3. Semester)

Es müssen folgende drei Module im Umfang von insgesamt 30 C erfolgreich absolviert werden:

c. Forschungsschwerpunkt "Festkörper- und Materialphysik"

Es müssen Module im Umfang von insgesamt wenigstens 56 C nach Maßgabe der nachfolgenden Bestimmungen erfolgreich absolviert werden.

aa. Erster Studienabschnitt (1. und 2. Semester)

Es müssen Module im Umfang von insgesamt wenigstens 26 C nach Maßgabe der folgenden Bestimmungen erfolgreich absolviert werden.

i. Forschungsseminar

Es muss folgendes Modul im Umfang von 4 C erfolgreich absolviert werden:

ii. Wahlpflichtbereich A

Es muss mindestens eines der folgenden Module im Umfang von wenigstens 4 C erfolgreich absolviert und ins Zeugnis eingebracht werden. Bereits im Bachelor eingebrachte Module können nicht berücksichtigt werden. Sind alle hier genannten Module bereits im Bachelor im Rahmen der 180 C eingebracht worden, sind alle 26 C aus iii zu wählen.

iii. Wahlpflichtbereich B

Ergänzend muss die Differenz zu den 26 C durch erfolgreiche Absolvierung wenigstens eines der folgenden Module erbracht werden; bereits im Bachelorstudium absolvierte Module können nicht berücksichtigt werden:

bb. Zweiter Studienabschnitt (3. Semester)

Es müssen folgende drei Module im Umfang von insgesamt 30 C erfolgreich absolviert werden:

d. Forschungsschwerpunkt "Kern- und Teilchenphysik"

Es müssen Module im Umfang von insgesamt wenigstens 56 C nach Maßgabe der nachfolgenden Bestimmungen erfolgreich absolviert werden.

aa. Erster Studienabschnitt (1. und 2. Semester)

Es müssen Module im Umfang von insgesamt wenigstens 26 C nach Maßgabe der folgenden Bestimmungen erfolgreich absolviert werden.

i. Forschungsseminar

Es muss folgendes Modul im Umfang von 4 C erfolgreich absolviert werden:

ii. Wahlpflichtbereich A

Es muss das folgende Modul im Umfang von 8 C erfolgreich absolviert und ins Zeugnis eingebracht werden. Bereits im Bachelor eingebrachte Module können nicht berücksichtigt werden. Wurde das folgende Modul bereits im Bachelor im Rahmen der 180 C eingebracht worden, sind weitere 8 C aus iii und iv zu wählen.

iii. Wahlpflichtbereich B

Es muss mindestens eines der folgenden Module im Umfang von 6 C erfolgreich absolviert und ins Zeugnis eingebracht werden. Bereits im Bachelor eingebrachte Module können nicht berücksichtigt werden. Wurden alle zwei folgenden Module bereits im Bachelor im Rahmen der 180 C eingebracht worden, sind weitere 6 C aus iv zu wählen. Die Bestimmungen zu ii bleiben hiervon unberührt.

iv. Wahlpflichtbereich C

Ergänzend muss die Differenz zu den 26 C durch erfolgreiche Absolvierung wenigstens eines der folgenden Module erbracht werden; bereits im Bachelorstudium absolvierte Module können nicht berücksichtigt werden:

bb. Zweiter Studienabschnitt (3. Semester)

Es müssen folgende drei Module im Umfang von insgesamt 30 C erfolgreich absolviert werden:

e. Forschungsschwerpunkt "Theoretische Physik"

Es müssen Module im Umfang von insgesamt wenigstens 56 C nach Maßgabe der folgenden Bestimmungen erfolgreich absolviert werden.

aa. Erster Studienabschnitt (1. und 2. Semester)

Es müssen Module im Umfang von insgesamt wenigstens 26 C nach Maßgabe der folgenden Bestimmungen erfolgreich absolviert werden.

i. Forschungsseminar

Es muss folgendes Modul im Umfang von 4 C erfolgreich absolviert werden:

ii. Wahlpflichtbereich A

Es müssen folgende beiden Module im Umfang von 12 C erfolgreich absolviert und ins Zeugnis eingebracht werden. Bereits im Bachelor eingebrachte Module können nicht berücksichtigt werden. Wurden diese Module bereits im Bachelor im Rahmen der 180 C eingebracht, sind weitere Module im Umfang der bereits im Bachelor eingebrachten Credits nach den Bestimmungen des nachfolgenden Punktes iii zu wählen.

iii. Wahlpflichtbereich B

Die Differenz zu mindestens 20 C bis maximal 26 C muss durch erfolgreiche Absolvierung einer Auswahl aus den folgenden Modulen erbracht werden:

iv. Wahlpflichtbereich C

Werden weniger als 26 C aus Buchstabe i-iii erbracht kann die Differeznz durch erfolgreiche Absolvierung wenigstens eines der folgenden Module oder der unter Buchstabe a/aa/iii aufgeführten Module mit Modulnummern der Formate M.Phy.54X, M.Phy.54XX bzw. B.Phy.54XX, der unter Buchstabe b/aa/iii aufgeführten Module mit Modulnummern der Formate M.Phy.56X, M.Phy.56XX bzw. B.Phy.56XX, der unter Buchstabe c/aa/ii+iii aufgeführten Module mit Modulnummern der Formate M.Phy.57X, M.Phy.57XX bzw. B.Phy.57XX oder der unter Buchstabe d/aa/iii+iv aufgeführten Module mit Modulnummern der Formate M.Phy.58X, M.Phy.58XX bzw. B.Phy.58XX im Umfang von insgesamt wenigstens 6 C erbracht werden; bereits im Bachelorstudium absolvierte Module können nicht berücksichtigt werden:

bb. Zweiter Studienabschnitt (3. Semester)

Es müssen folgende drei Module im Umfang von insgesamt 30 C erfolgreich absolviert werden:

3. Profilierungsbereich

Es müssen Module im Umfang von insgesamt wenigstens 22 C nach Maßgabe der nachfolgenden Bestimmungen erfolgreich absolviert werden.

a. Profilierungsseminar

Es muss folgendes Pflichtmodul im Umfang von 4 C erfolgreich absolviert werden:

b. Profilierungsbereich Mathematik-Naturwissenschaften

Es müssen aus dem Lehrangebot der mathematisch-naturwissenschaftlichen Fakultäten (inkl. Fakultät für Physik) Module im Umfang von insgesamt wenigstens 6 C erfolgreich absolviert werden. Wählbar sind insbesondere nach Nr. 2 nicht eingebrachte Module sowie die nachfolgenden Module; darüber hinaus wird ein Verzeichnis wählbarer Module durch die Fakultät für Physik in geeigneter Weise bekannt gemacht. Bachelormodule können nur eingebracht werden, sofern sie nicht bereits im Rahmen des Bachelorstudiums erfolgreich absolviert wurden.

c. Schlüsselkompetenzen

Es müssen Module im Umfang von insgesamt wenigstens 12 C aus dem Lehrangebot der Universität außerhalb der Fakultät für Physik erfolgreich absolviert werden. Wählbar sind Angebote aufgrund der Prüfungsordnung für Studienangebote der Zentralen Einrichtung für Sprachen und Schlüsselqualifikationen (ZESS); darüber hinaus wird ein Verzeichnis wählbarer Module durch die Fakultät für Physik in geeigneter Weise bekannt gemacht.

d. Alternativmodule

Anstelle der Module nach Buchstaben a und b können auf Antrag, der an die Studiendekanin oder den Studiendekan der Fakultät für Physik zu richten ist, andere Module (Alternativmodule) nach Maßgabe der nachfolgenden Bestimmungen absolviert werden. Dem Antrag ist die Zustimmung der Studiendekanin oder des Studiendekans der Fakultät oder Lehreinheit, die das Alternativmodul anbietet, beizufügen. Die Entscheidung trifft die Studiendekanin oder der Studiendekan der Fakultät für Physik. Der Antrag kann ohne Angabe von Gründen abgelehnt werden; ein Rechtsanspruch der Antragstellerin oder des Antragstellers auf Zulassung eines Alternativmoduls besteht nicht.

4. Masterarbeit

Durch die erfolgreiche Anfertigung der Masterarbeit werden 30 C erworben.

II. Ergänzende Hinweise zu Modulprüfungen

Soweit in diesem Modulverzeichnis Modulbeschreibungen in englischer Sprache veröffentlicht werden, gilt für die verwendeten Prüfungsformen nachfolgende Zuordnung:

written exam - Klausur

written/supplementary report/elaboraton - schriftliche/-r Bericht/Ausarbeitung

presentation - Präsentation

term paper - Hausarbeit

oral exam - mündliche Prüfung

handout -Handout

lecture/talk - Vortrag

report - Protokoll

Georg-August-Universität Göttingen **Modul B.Che.2301: Chemische Reaktionskinetik** *English title: Kinetics of Chemical Reactions*	6 C 4 SWS

Lernziele/Kompetenzen: Die Studierenden können chemische Elementarreaktionen, Transportvorgänge und Reaktionsmechanismen in verschiedenen Aggregatzuständen analysieren bzw. auf molekularer Basis verstehen. Sie sind mit Anwendungen der Reaktionskinetik in Gebieten wie der Photochemie, Atmosphärenchemie und Umweltchemie vertraut.	**Arbeitsaufwand:** Präsenzzeit: 56 Stunden Selbststudium: 124 Stunden

Lehrveranstaltung: Vorlesung: Chemische Reaktionskinetik (Vorlesung)	2 SWS
Lehrveranstaltung: Übung zu: Chemische Reaktionskinetik (Übung)	2 SWS
Prüfung: Klausur (180 Minuten)	6 C

Prüfungsanforderungen: Formale Reaktionskinetik, experimentelle Methoden der Reaktionskinetik, theoretische Beschreibung von Elementarreaktionen und Transportvorgängen, Anwendungen der Reaktionskinetik	

Zugangsvoraussetzungen: keine	**Empfohlene Vorkenntnisse:** keine
Sprache: Deutsch	**Modulverantwortliche[r]:** Prof. Dr. Alec Wodtke
Angebotshäufigkeit: jedes Wintersemester	**Dauer:** 1 Semester
Wiederholbarkeit: dreimalig	**Empfohlenes Fachsemester:**
Maximale Studierendenzahl: 100	

Georg-August-Universität Göttingen **Modul B.Che.4104: Allgemeine und Anorganische Chemie (Lehramt und Nebenfach)** *English title: Introduction to General and Inorganic Chemistry*	6 C 6 SWS

Lernziele/Kompetenzen: Die Studierenden verstehen die allgemeinen Prinzipien und Gesetzmäßigkeiten der Chemie und sind mit grundlegenden Begriffen der allgemeinen und anorganischen Chemie vertraut. Sie erwerben erste Kenntnisse der anorganischen Stoffchemie.	**Arbeitsaufwand:** Präsenzzeit: 84 Stunden Selbststudium: 96 Stunden

Lehrveranstaltung: "Experimentalchemie I (Allgemeine und Anorganische Chemie)" (Vorlesung)	4 SWS
Lehrveranstaltung: "Experimentalchemie I (Allgemeine und Anorganische Chemie)" (Übung)	2 SWS
Prüfung: Klausur (120 Minuten) **Prüfungsvorleistungen:** Erfolgreiche Teilnahme an den Übungen; Näheres regelt die Übungs-Ordnung	6 C

Prüfungsanforderungen: Allgemeine Chemie: Atombau und Periodensystem, Elemente und Verbindungen, Chemische Gleichungen und Stöchiometrie, Lösungen und Lösungsvorgänge, chemische Gleichgewichte, einfache Thermodynamik und Kinetik, Säure-Base-Reaktionen, Fällungs- und Komplexbildungsreaktionen, Redoxreaktionen; Grundlagen der Anorganischen Chemie: Vorkommen, Darstellung, Eigenschaften einiger Elemente und ihrer wichtigsten Verbindungen.	

Zugangsvoraussetzungen: Keine	**Empfohlene Vorkenntnisse:** keine
Sprache: Deutsch	**Modulverantwortliche[r]:** Prof. Dr. Dietmar Stalke
Angebotshäufigkeit: jedes Wintersemester	**Dauer:** 1 Semester
Wiederholbarkeit: dreimalig	**Empfohlenes Fachsemester:**

Georg-August-Universität Göttingen **Modul B.Che.9107: Chemisches Praktikum für Studierende der Physik und Geowissenschaften** *English title: Laboratory course in General and Inorganic Chemistry for Physisists and Geologists*	6 C 8 SWS

Lernziele/Kompetenzen: Verstehen der allgemeinen Prinzipien und Gesetzmäßigkeiten der allgemeinen und anorganischen Chemie, sicherer Umgang mit deren Begriffen. Anwendung der im Modul B.Che.4104 erworbenen Kenntnisse der anorganischen Stoffchemie, Kennenlernen experimenteller Arbeitstechniken anhand von Schlüsselreaktionen. Integrative Vermittlung von Schlüsselkompetenzen: Teamarbeit; gute wissenschaftliche Praxis; Protokollführung; sicheres Arbeiten im Labor.	**Arbeitsaufwand:** Präsenzzeit: 112 Stunden Selbststudium: 68 Stunden

Lehrveranstaltung: Chemisches Praktikum für Studierende der Physik und Geowissenschaften *Angebotshäufigkeit:* jedes Semester	6 SWS
Lehrveranstaltung: Seminar zum Chemischen Praktikum für Studierende der Physik und Geowissenschaften (Seminar) *Angebotshäufigkeit:* jedes Semester	2 SWS
Prüfung: Klausur (120 Minuten) **Prüfungsvorleistungen:** Erfolgreiche Teilnahme am Praktikum, Details siehe Praktikumsordnung **Prüfungsanforderungen:** Atombau und Periodensystem, Grundbegriffe, Elemente und Verbindungen, Aufbau der Materie, einfache Bindungskonzepte, Chemische Gleichungen und Stöchiometrie, Chemische Gleichgewichte, einfache Thermodynamik und Kinetik, Säure-Base-Reaktionen inklusive Puffer, Redoxreaktionen, Löslichkeit, einfache Elektrochemie, Vorkommen, Darstellung und Eigenschaften der Elemente und ihrer wichtigsten Verbindungen, Einführung in spektroskopische Methoden.	6 C

Zugangsvoraussetzungen: B.Che.4104	**Empfohlene Vorkenntnisse:** keine
Sprache: Deutsch	**Modulverantwortliche[r]:** Prof. Dr. Franc Meyer
Angebotshäufigkeit: jedes Wintersemester (Blockpraktikum in vorlesungsfreier Zeit) und jedes Sommersemester (in der Vorlesungszeit)	**Dauer:** 1 Semester
Wiederholbarkeit: dreimalig	**Empfohlenes Fachsemester:**

Bemerkungen: Das Seminar wird von den Dozierenden und Assistent/innen der Anorganischen Chemie durchgeführt.

Ansprechpersonen für das Praktikum sind Frau Dr. Stückl sowie die entsprechenden Assistent/innen.

Georg-August-Universität Göttingen **Modul B.Inf.1101: Grundlagen der Informatik und Programmierung** *English title: Introduction to Computer Science and Programming*	10 C 6 SWS
Lernziele/Kompetenzen: Studierende • kennen grundlegende Begriffe, Prinzipien und Herangehensweisen der Informatik, kennen einige Programmierparadigmen und Grundzüge der Objektorientierung. • erlangen elementare Grundkenntnisse der Aussagenlogik, verstehen die Bedeutung für Programmsteuerung und Informationsdarstellung und können sie in einfachen Situationen anwenden. • verstehen wesentliche Funktionsprinzipien von Computern und der Informationsdarstellung und deren Konsequenzen für die Programmierung. • erlernen die Grundlagen einer Programmiersprache und können einfache Algorithmen in dieser Sprache codieren. • kennen einfache Datenstrukturen und ihre Eignung in typischen Anwendungssituationen, können diese programmtechnisch implementieren. • analysieren die Korrektheit einfacher Algorithmen und bewerten einfache Algorithmen und Probleme nach ihrem Ressourcenbedarf.	**Arbeitsaufwand:** Präsenzzeit: 84 Stunden Selbststudium: 216 Stunden
Lehrveranstaltung: Informatik I (Vorlesung, Übung)	6 SWS
Prüfung: Klausur (90 Minuten) **Prüfungsvorleistungen:** Nachweis von 50% der in den Übungsaufgaben erreichbaren Punkte. Kontinuierliche Teilnahme an den Übungen. **Prüfungsanforderungen:** In der Prüfung wird das Verständnis der vermittelten Grundbegriffe sowie die aktive Beherrschung der vermittelten Inhalte und Techniken nachgewiesen, z.B. • Kenntnis von Grundbegriffen nachweisen durch Umschreibung in eigenen Worten. • Standards der Informationsdarstellung in konkreter Situation umsetzen. • Ausdrücke auswerten oder Bedingungen als logische Ausdrücke formulieren usw. • Programmablauf auf gegebenen Daten geeignet darstellen. • Programmcode auch in nicht offensichtlichen Situationen verstehen. • Fehler im Programmcode erkennen/korrigieren/klassifizieren. • Datenstrukturen für einfache Anwendungssituationen auswählen bzw. geeignet in einem Kontext verwenden. • Algorithmen für einfache Probleme auswählen und beschreiben (ggf. nach Hinweisen) und/oder einen vorgegebenen Algorithmus (ggf. fragmentarisch) programmieren bzw. ergänzen. • einfache Algorithmen/Programme nach Ressourcenbedarf analysieren. • einfachsten Programmcode auf Korrektheit analysieren. • einfache Anwendungssituation geeignet durch Modul- oder Klassenschnittstellen modellieren. Die Klausur wird als **E-Prüfung** durchgeführt.	10 C

Zugangsvoraussetzungen: keine	**Empfohlene Vorkenntnisse:** keine
Sprache: Deutsch	**Modulverantwortliche[r]:** Prof. Dr. Carsten Damm
Angebotshäufigkeit: jedes Wintersemester	**Dauer:** 1 Semester
Wiederholbarkeit: zweimalig	**Empfohlenes Fachsemester:** ab bis
Maximale Studierendenzahl: 300	

Georg-August-Universität Göttingen **Modul B.Inf.1102: Grundlagen der Praktischen Informatik** *English title: Introduction to Computer Systems*	10 C 6 SWS

Lernziele/Kompetenzen:	**Arbeitsaufwand:**
Die Studierenden • beherrschen die Grundlagen einer deklarativen Programmiersprache und können Programme erstellen, testen und analysieren. • beherschen die Grundlagen einer Programmiersprache, die als Skriptsprache nutzbar ist, und können Skripte erstellen, testen und analysieren. • kennen Aufgaben und Struktur eines Betriebssystems, die Verfahren zur Verwaltung, Scheduling und Synchronisation von Prozessen und zur Speicherverwaltung, sie können diese Verfahren jeweils anwenden, analysieren und vergleichen. • kennen Grundlagen und verschiedene Beschreibungen von formalen Sprachen, z.B. Automaten und Grammatiken, und können diese konstruieren, analysieren und vergleichen. • kennen Grundlagen des Compilerbaus und können einfache Versionen der zugehörigen Softwarewerkzeuge, z.B. Lexer, Parser, Interpeter und Compiler, konstruieren und analysieren. • kennen verschiedene Teilgebieten der formalen Logik, z.B. Aussagen- und Prädikatenlogik, und darauf beruhende Verfahren, z.B. Auswertung, Konstruktion und Resolution, und können diese anwenden. • kennen die Schichtenarchitektur von Computernetzwerken, sowie sowohl Dienste als auch Protokolle und können diese analysieren und vergleichen. • kennen unterschiedliche Verschlüsselungsverfahren, z.B. symmetrische und asymmetrische, sowie Methoden sowohl zum Schlüsselaustausch als auch zur Schlüsselvereinbarung und können diese anwenden, analysieren und vergleichen. • kennen die Grundlagen einzelnen Teilgebiete der Softwaretechnik, z.B. Softwaretest, und können diese anwenden und analysieren.	Präsenzzeit: 84 Stunden Selbststudium: 216 Stunden

Lehrveranstaltung: Grundlagen der Praktischen Informatik (Vorlesung, Übung)	6 SWS
Prüfung: Klausur (90 Minuten) **Prüfungsvorleistungen:** Nachweis von 50% der in den Übungsaufgaben erreichbaren Punkte. Kontinuierliche Teilnahme an den Übungen. **Prüfungsanforderungen:** Deklarative Programmierung, Programmierung von Skripten, Betriebssysteme, formale Sprachen, Compilerbau, formale Logik, Telematik, Kryptographie, Softwaretechnik Die Klausur wird als **E-Prüfung** durchgeführt.	10 C

Zugangsvoraussetzungen: keine	**Empfohlene Vorkenntnisse:** B.Inf.1101
Sprache:	**Modulverantwortliche[r]:**

Deutsch	Dr. Henrik Brosenne
Angebotshäufigkeit: jedes Sommersemester	**Dauer:** 1 Semester
Wiederholbarkeit: zweimalig	**Empfohlenes Fachsemester:**
Maximale Studierendenzahl: 300	

Georg-August-Universität Göttingen **Modul B.Phy.1511: Einführung in die Kern- und Teilchenphysik** *English title: Introduction to Particle Physics*	8 C 6 SWS
Lernziele/Kompetenzen: Nach erfolgreichem Absolvieren des Moduls kennen die Studierenden physikalische Fakten und Modellvorstellungen über den Aufbau der Atomkerne und die Eigenschaften von Elementarteilchen. Außerdem sollten sie mit den grundlegenden Begriffen und Modellen der Kern- und Teilchenphysik umgehen können.	**Arbeitsaufwand:** Präsenzzeit: 84 Stunden Selbststudium: 156 Stunden
Lehrveranstaltung: Einführung in die Kern- und Teilchenphysik	
Prüfung: Klausur (120 Min.) oder mdl. Prüfung (ca. 30 Min.) **Prüfungsvorleistungen:** Mindestens 50% der Hausaufgaben in den Übungen müssen bestanden worden sein.	8 C
Prüfungsanforderungen: Eigenschaften und Spektroskopie von stabilen und instabilen Atomkernen; Eigenschaften von Elementarteilchen und Experimente der Hochenergiephysik; Grundlagen der Teilchenbeschleunigerphysik.	

Zugangsvoraussetzungen: keine	**Empfohlene Vorkenntnisse:** keine
Sprache: Deutsch	**Modulverantwortliche[r]:** StudiendekanIn der Fakultät für Physik
Angebotshäufigkeit: jedes Wintersemester	**Dauer:** 1 Semester
Wiederholbarkeit: dreimalig	**Empfohlenes Fachsemester:** 5 - 6
Maximale Studierendenzahl: 180	

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

Course: Particle physics II - of and with quarks (Lecture)	4 WLH
Course: 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: three times	**Recommended semester:** Bachelor: 6; Master: 1 - 2
Maximum number of students: 30	

Georg-August-Universität Göttingen **Modul B.Phy.1521: Einführung in die Festkörperphysik** *English title: Introduction to Solid State Physics*	8 C 6 SWS
Lernziele/Kompetenzen: Nach erfolgreichem Absolvieren des Moduls haben die Studierenden die Grundlagen und die physikalische Erscheinungen der Zusammenhalt der Ionen und Elektronen in einem Festkörper mit idealen periodischen Anordnung der konstituierenden Atomen verinnerlicht. Basierend auf der Eigenschaften freier Atomen und deren Wechselwirkung im Kristallgitter wird ein grundlegendes Verständnis verschiedener kollektiven Phänomene gewonnen. Dazu gehören beispielsweise die elektronische Bandstruktur im periodischen Gitterpotential (Dynamik der Elektronen) sowie die Gitterschwingungen (Dynamik der Ionen), die Elektrizitätsleitung - auch in niederdimensionalen Strukturen - sowie thermische Eigenschaften (spezifische Wärme).	**Arbeitsaufwand:** Präsenzzeit: 84 Stunden Selbststudium: 156 Stunden
Lehrveranstaltung: Vorlesung und Übung Einführung in die Festkörperphysik	
Prüfung: Klausur (120 min.) oder mdl. Prüfung (ca. 30 min.) **Prüfungsvorleistungen:** Mindestens 50% der Hausaufgaben in den Übungen müssen bestanden worden sein. **Prüfungsanforderungen:** Grundlagen, Phänomene und Modelle für Elektronen- und Gitterdynamik in Festkörpern. Insbesondere, Chemische Bindung in Festkörpern, Atomare Kristallstruktur, Streuung an periodischen Strukturen, das Elektronengas ohne Wechselwirkung (Freie Elektronen), das Elektronengas mit Wechselwirkung (Abschirmung, Plasmonen), das periodische Potential (Bandstrukturd der Kristall-Elektronen), Gitterschwingungen (Phononen) und spezifische Wärme	8 C

Zugangsvoraussetzungen: keine	**Empfohlene Vorkenntnisse:** keine
Sprache: Deutsch	**Modulverantwortliche[r]:** Prof. Dr. Angela Rizzi
Angebotshäufigkeit: jedes Wintersemester	**Dauer:** 1 Semester
Wiederholbarkeit: dreimalig	**Empfohlenes Fachsemester:** 5 - 6
Maximale Studierendenzahl: 120	

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 understand: • The role of the band-structure for electron and lattice dynamics • The motion of crystal electrons/holes in electric and magnetic fields • Quasiparticle scattering processes • The deviation of macroscopic dielectric properties from microscopic theory • The dielectric properties of metals and plasma oscillations • Independent electron magnetism and the emergence of collective magnetic phenomena • Magnetic ordering phenomena • The BCS theory of superconductivity	**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, plasmons. 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:** Prof. Dr. Stefan Mathias
Course frequency: each summer semester	**Duration:** 1 semester[s]
Number of repeat examinations permitted: three times	**Recommended semester:** Bachelor: 6; Master: 1 - 2
Maximum number of students: 120	

Georg-August-Universität Göttingen Module B.Phy.1531: Introduction to Materials Physics	4 C 4 WLH
Learning outcome, core skills: This 2 week long intensive course is offered between the winter and summer semesters. It applies the knowledge obtained in the Einführung in die Festkörperphysik and Thermodynamik und statistische Physik to understanding the structure, properties and dynamic behavior of the materials we use in our everyday lives. **Learning outcomes:** crystal defects, disordered systems, impurities, crystalline mixtures and alloys, phase diagrams, phase transformations, diffusion, kinetics, materials selection, structure-property relations. **Core skills:** The students will gain an understanding of the different materials classes that we use in everyday life, including: how properties of materials are determined by their atomic scale structure, which driving forces determine the structure of equilibrium phases, and how kinetic processes control phase transformations and the dynamics of non-equilibrium processes.	**Workload:** Attendance time: 56 h Self-study time: 64 h
Course: Introduction to Materials Physics (Lecture)	2 WLH
Examination: Written or oral examWritten exam (120 minutes) or oral examination (approximately 30 minutes) **Examination prerequisites:** 50% of the homework problems must be solved successfully. **Examination requirements:** Crystal defects, disordered systems, impurities, crystalline mixtures and alloys, phase diagrams, phase transformations, diffusion, kinetics, materials selection.	4 C
Course: Introduction to Materials Physics (Exercise)	2 WLH

Admission requirements: none	**Recommended previous knowledge:** • Experimentelle Methoden der Materialphysik, • Einführung in die Festkörperphysik, • Thermodynamik und statistische Physik
Language: English	**Person responsible for module:** Prof.in Cynthia Volkert
Course frequency: each winter semester	**Duration:** 1 semester[s]
Number of repeat examinations permitted: three times	**Recommended semester:** Bachelor: 5 - 6; Master: 1
Maximum number of students: 30	

Georg-August-Universität Göttingen **Modul B.Phy.1541: Einführung in die Geophysik** *English title: Introduction to Geophysics*	4 C 3 SWS
Lernziele/Kompetenzen: Nach erfolgreichem Absolvieren des Moduls können die Studierenden mit den grundlegenden Begriffen und Modellen der Geophysik umgehen: • Treibhauseffekt • Gravimetrie • Seismologie • Elektromagnetische Tiefenforschung • Altersbestimmung • Gezeiten • Konvektion • Erdmagnetfeld • Fraktale und chaotische Prozesse • Plattentektonik	**Arbeitsaufwand:** Präsenzzeit: 42 Stunden Selbststudium: 78 Stunden
Lehrveranstaltung: Vorlesung und Übung zu Einführung in die Geophysik	
Prüfung: Klausur (120 min.) oder mdl. Prüfung (ca. 30 min.) **Prüfungsvorleistungen:** Mindestens 50% der Hausaufgaben in den Übungen müssen bestanden worden sein. **Prüfungsanforderungen:** Grundlagen der Geophysik, insbes. Plattentektonik, Erdbeben	4 C

Zugangsvoraussetzungen: keine	**Empfohlene Vorkenntnisse:** keine
Sprache: Deutsch	**Modulverantwortliche[r]:** Prof. Dr. Andreas Tilgner
Angebotshäufigkeit: jedes Sommersemester	**Dauer:** 1 Semester
Wiederholbarkeit: dreimalig	**Empfohlenes Fachsemester:** Bachelor: 6; Master: 1 - 2
Maximale Studierendenzahl: 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 module students are familiar with the basic concepts of astrophysics in observation and theory. In particular, they • have gained an overview of observational techniques in astronomy • understand the basic physics of the formation, structure and evolution of stars and planets have learned about the classification and structure of normal and active galaxies • understand the basic physics of homogeneous cosmology and cosmological structure formation	**Workload:** Attendance time: 84 h Self-study time: 156 h
Course: Lecture and exercises for introduction to astrophysics	
Examination: oral (approx. 30 minutes) or written (120 min.) exam **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. Jens Niemeyer
Course frequency: each winter semester	**Duration:** 1 semester[s]
Number of repeat examinations permitted: three times	**Recommended semester:** Bachelor: 5 - 6; Master: 1
Maximum number of students: 120	

Georg-August-Universität Göttingen Module B.Phy.1561: Introduction to Physics of Complex Systems	6 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: 96 h
Course: Introduction to Physics of Complex Systems (Lecture)	4 WLH
Examination: written examination (120 Min.) or oral examination (approx. 30 Min.) **Examination prerequisites:** At least 50% of the homework of the excercises have to be solved successfully. **Examination requirements:** • Knowledge of fundamental principles and methods of Nonlinear Physics • Modern experimental techniques and theoretical models of Complex Systems theory.	6 C
Course: Introduction to Physics of Complex Systems (Exercise)	2 WLH

Admission requirements: none	**Recommended previous knowledge:** Basic programming skills (for the exercises)
Language: English, German	**Person responsible for module:** Prof. Dr. Stefan Klumpp Prof. Dr. Ulrich Parlitz
Course frequency: each winter semester	**Duration:** 1 semester[s]
Number of repeat examinations permitted: three 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**	6 C 6 WLH

Learning outcome, core skills: After attending this course, students will have basic knowledge about • the build-up of cells and the function of the components • transport phenomena on small length scales, derivation and solution of the diffusion equation • laminar hydrodynamics and its application in biological systems (flow, swimming, motility) • reaction kinetics and cooperativity, including enzymes • non-covalent interaction forces • self-assembly • biological (lipid) membrane build-up and dynamics • biopolymer physics and cytoskeletal filaments, including filament and cell mechanics • neurobiophysics • experimental methods, including state-of-the-art microscopy	**Workload:** Attendance time: 84 h Self-study time: 96 h

Course: 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
Examination: Written exam (120 min.) or oral exam (ca. 30 min.) **Examination prerequisites:** At least 50% of the homework problems have to be solved successfully. **Examination requirements:** Knowledge of the fundamental principles, theoretical descriptions and experimental methods of biophysics.	6 C

Course: Introduction to Biophysics (Exercise)	2 WLH

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

Georg-August-Universität Göttingen **Modul B.Phy.1603: Vermittlung wissenschaftlicher Zusammenhänge durch neue Medien** *English title: Procurement of scientific phenomena via new media*	4 C 2 SWS
Lernziele/Kompetenzen: In dieser Veranstaltung werden Grundkonzepte und Regeln des Videofilmens physikalischer/naturwissenschaftlicher Phänomene vermittelt, treatments erstellt, und das Drehen von Filmen handwerklich geübt. Physikalische Phänomene z.B. aus der Physik-Show "Zauberhafte Physik" werden gefilmt und in Kombination mit Archivmaterial zu kurzen Video-Clips zusammengeschnitten. Dabei wird unter anderem ein Schwerpunkt auf die allgemeinverständliche physikalische Erklärung (Pädagogik) gelegt. Es wurden aber auch formale Aspekte im Umgang mit Medien wie Copyrights, GEMA-Gebühren, Rechte am eigenen Bild etc. vermittelt. Die Video-Clips werden nach Abnahme durch die Seminarleitung und die Presseabteilung in den offiziellen Youtube-Kanal der Georg-August-Universität Göttingen gestellt. Beispiele aus vergangenen Semester sind unter „Zauberhafte Physik“ auf http://www.youtube.de zu finden.	**Arbeitsaufwand:** Präsenzzeit: 28 Stunden Selbststudium: 92 Stunden
Lehrveranstaltung: Seminar (Seminar)	
Prüfung: Vortrag (ca. 30 Minuten) **Prüfungsvorleistungen:** Aktive Teilnahme **Prüfungsanforderungen:** Physikalische/wissenschaftliche Zusammenhänge allgemeinverständlich und unterstützt durch den Einsatz von selbstgedrehten Videofilmen erklären zu können.	4 C

Zugangsvoraussetzungen: keine	**Empfohlene Vorkenntnisse:** keine
Sprache: Deutsch, Englisch	**Modulverantwortliche[r]:** Prof. Dr. Arnulf Quadt
Angebotshäufigkeit: jedes Wintersemester1	**Dauer:** 1 Semester
Wiederholbarkeit: dreimalig	**Empfohlenes Fachsemester:** Bachelor: 5 - 6; Master: 1 - 4
Maximale Studierendenzahl: 16	

Georg-August-Universität Göttingen **Modul B.Phy.1609: Grundlagen zur Einheit von Mensch und Natur** *English title: Foundations of the Unity of Human and Nature*	4 C 2 SWS

Lernziele/Kompetenzen:	**Arbeitsaufwand:**
Nach erfolgreichem Absolvieren des Moduls sollten Studierende Einblicke in die naturwissenschaftlichen, ökonomischen und weltanschaulichen Grundlagen der Wechselbeziehung Mensch – Natur gewonnen haben. Sie sollten... • über Grundlagen in der Systemdynamik komplexer Systeme verfügen; • mit Präsentationsmedien umgehen können; • komplexe Sachverhalte vor Experten und fachfremden Zuhörern präsentieren können; • den Erkenntnisforschritt im Seminar kritisch reflektieren können. Als Schlüsselkompetenzen sollten sie Diskussionsfähigkeit, Kritikfähigkeit und Ausdrucksfähigkeit erworben haben.	Präsenzzeit: 28 Stunden Selbststudium: 92 Stunden

Lehrveranstaltung: Grundlagen zur Einheit von Mensch und Natur	
Prüfung: Vortrag (ca. 30 Minuten) **Prüfungsvorleistungen:** Aktive Mitwirkung an der Diskussion der Präsentationen und Erarbeitung eines laufenden Erkenntnisfortschritt des Seminars als Hausaufgabe **Prüfungsanforderungen:** Verständnis der wissenschaftlichen Grundlagen der Wechselbeziehung Mensch-Natur anhand wissenschaftlicher Fachliteratur. Die Entwicklung des Stoffwechsels des Menschen mit der Natur, insbesondere in der Produktion und Reproduktion von Gütern behandelt und ihre philosophische Reflektion wird behandelt. Der Schwerpunkt liegt auf der modernen Entwicklung der internationalen kapitalistischen Produktion zu einem dominanten Einflussfaktor auf die Biosphäre, die daraus resultierenden Möglichkeiten und die Faktoren der möglichen Untergrabung der Einheit von Mensch und Natur in einer globalen Umweltkatastrophe.	4 C

Zugangsvoraussetzungen: keine	**Empfohlene Vorkenntnisse:** keine
Sprache: Deutsch, Englisch	**Modulverantwortliche[r]:** StudiendekanIn der Fakultät für Physik
Angebotshäufigkeit: jedes Sommersemester	**Dauer:** 1 Semester
Wiederholbarkeit: dreimalig	**Empfohlenes Fachsemester:** Bachelor: 4 - 6; Master: 1 - 4
Maximale Studierendenzahl: nicht begrenzt	

Georg-August-Universität Göttingen **Modul B.Phy.5001: Die Vermittlung und Untersuchung von strömungsphysikalischen Vorgängen im Experiment Teil I** *English title: Teaching and analysis of flow dynamic processes in physical experiments Part I*	6 C 4 SWS
Lernziele/Kompetenzen: Nach erfolgreichem Absolvieren des Moduls sollten die Studierenden... • die strömungsphysikalischen Grundlagen beherrschen und Messverfahren zur Strömungsvisualisierung an Beispielen anwenden können; • die Strömungsphysikalischen Phänomene anhand von Experimenten vorstellen und erklären können.	**Arbeitsaufwand:** Präsenzzeit: 56 Stunden Selbststudium: 124 Stunden
Lehrveranstaltung: Vorlesung (Vorlesung)	2 SWS
Prüfung: 80 % mündliche Prüfung (ca. 30 Min.) + 20 % Praktische Prüfung (Experiment) (ca. 30 Min.)	6 C
Lehrveranstaltung: Übung	2 SWS
Prüfungsanforderungen: Auftrieb; Bernoulli-Gleichung; Energiebetrachtung von Strömungsvorgängen; Wirbelablösung; Kontinuitätsgleichung; Wirbelbildung/Entstehung in Abhängigkeit von der Reynoldszahl; Messverfahren zur Visualisierung.	

Zugangsvoraussetzungen: keine	**Empfohlene Vorkenntnisse:** keine
Sprache: Deutsch	**Modulverantwortliche[r]:** Dr. rer. nat. Oliver Boguhn
Angebotshäufigkeit: jedes Sommersemester	**Dauer:** 1 Semester
Wiederholbarkeit: dreimalig	**Empfohlenes Fachsemester:** Bachelor: 3 - 6; Master: 1
Maximale Studierendenzahl: 20	

Georg-August-Universität Göttingen **Modul B.Phy.5002: Die Vermittlung und Untersuchung von strömungsphysikalischen Vorgängen im Experiment Teil II** *English title: Teaching and analysis of flow dynamic processes in physical experiments Part II*	6 C 4 SWS
Lernziele/Kompetenzen: Nach erfolgreichem Absolvieren des Moduls sollten die Studierenden... • die theoretischen Grundlagen praxisbezogen anwenden und strömungsphysikalische Gesetzmäßigkeiten in Experimenten verifizieren können; • die strömungsphysikalischen Phänomene anhand von Experimenten vorstellen und erklären können.	**Arbeitsaufwand:** Präsenzzeit: 56 Stunden Selbststudium: 124 Stunden
Lehrveranstaltung: Vorlesung (Vorlesung)	2 SWS
Prüfung: mündliche Prüfung (ca. 30 Min.) + Praktische Prüfung (Experiment) (ca. 30 Min.)	6 C
Lehrveranstaltung: Übung	2 SWS
Prüfungsanforderungen: Wirbelbildung/Entstehung in Abhängigkeit von der Reynoldszahl, Schwingungs- und Flatteranalyse, Schallentstehung, Ausbreitung, Quellenund Entfernungsabhängigkeiten, Strömungsvorgänge unter Schwerelosigkeit, Strahlungsinduzierte Strömungsvorgänge, Einfluss der Corioliskraft auf großräumige Strömungen	

Zugangsvoraussetzungen: keine	**Empfohlene Vorkenntnisse:** keine
Sprache: Deutsch	**Modulverantwortliche[r]:** Dr. rer. nat. Oliver Boguhn
Angebotshäufigkeit: jedes Wintersemester	**Dauer:** 1 Semester
Wiederholbarkeit: dreimalig	**Empfohlenes Fachsemester:** Bachelor: 3 - 6; Master: 1
Maximale Studierendenzahl: 20	

Georg-August-Universität Göttingen **Modul B.Phy.5003: Sammlung und Physikalisches Museum** *English title: Collection and museum of physics*	4 C 2 SWS
Lernziele/Kompetenzen: Nach erfolgreichem Absolvieren des Moduls sollten die Studierenden eigenständig Inhalte erarbeiten und als Ziel diese Inhalte publikumswirksam im Museum im Rahmen der laufenden Ausstellung präsentieren. Dazu gehört die Darstellung der Funktion, Entwicklungsgeschichte und pädagog. Präsentation eines Gerätes der historischen Sammlung.	**Arbeitsaufwand:** Präsenzzeit: 28 Stunden Selbststudium: 92 Stunden
Lehrveranstaltung: Seminar (Seminar)	
Prüfung: Hausarbeit (max. 15 S.) und Posterpräsentation **Prüfungsvorleistungen:** Aktive Teilnahme	4 C
Prüfungsanforderungen: Aufarbeitung und Darstellung eines Gerätes der historischen Sammlung.	

Zugangsvoraussetzungen: keine	**Empfohlene Vorkenntnisse:** keine
Sprache: Deutsch	**Modulverantwortliche[r]:** StudiendekanIn der Fakultät für Physik
Angebotshäufigkeit: jedes Semester	**Dauer:** 1 Semester
Wiederholbarkeit: dreimalig	**Empfohlenes Fachsemester:** Bachelor: 6; Master: 1 - 2
Maximale Studierendenzahl: 8	

Georg-August-Universität Göttingen **Module B.Phy.5402: Advanced Quantum Mechanics**	6 C 6 WLH

Learning outcome, core skills: **Acquisition of knowledge:** After successful completion of the module students will be familiar with the core concepts and mathematical methods of advanced quantum mechanics and quantum many-body theory. **Competencies:** Students will be able to model and analyse single-particle and many-body quantum mechanical systems, drawing also on concepts of quantum information theory.	**Workload:** Attendance time: 84 h Self-study time: 96 h

Course: Advanced Quantum Mechanics (Lecture)	4 WLH
Examination: written exam (120 min.) or oral exam (approx. 30 min.) **Examination prerequisites:** At least 50% of the homework of the excercises have to be solved successfully. **Examination requirements:** Time-dependent perturbation theory, scattering, mixed states, path integrals in quantum mechanics, quantum information, entanglement as resource, many-body systems, second quantisation, basis elements of quantum field theory.	6 C

Course: Advanced Quantum Mechanics (Exercise)	2 WLH

Admission requirements: none	**Recommended previous knowledge:** Basic knowledge of 1-particle quantum mechanics
Language: English	**Person responsible for module:** Prof. Dr. Stefan Kehrein
Course frequency: each winter semester	**Duration:** 1 semester[s]
Number of repeat examinations permitted: three times	**Recommended semester:** Bachelor: 5 - 6; Master: 1 - 3
Maximum number of students: 80	

Georg-August-Universität Göttingen **Module B.Phy.5403: Fluctuation theorems, stochastic thermodynamics and molecular machines**	3 C 3 WLH

Learning outcome, core skills: After successful completion of the module students will be familiar with the core concepts and mathematical methods of stochastic thermodynamics, the key fluctuation theorems and applications to simple systems. Students will be able to model and analyse strongly fluctuating non-equilibrium processes within the framework of stochastic thermodynamics, in particular in the context of open reaction networks and simple discrete state models of molecular machines.	**Workload:** Attendance time: 42 h Self-study time: 48 h

Course: Fluctuation theorems, stochastic thermodynamics and molecular machines (lecture with exercise if necessary)	
Examination: oral (approx. 30 min.) or written exam (120 min.) **Examination requirements:** Stochastic dynamics (Markov chains), time reversal symmetry, integral and detailed fluctuation theorems, Langevin dynamics, applications to non-equilibrium dynamics of discrete state space models.	3 C

Admission requirements: none	**Recommended previous knowledge:** Module „Statistical mechanics and thermodynamics“ or equivalent knowledge of equilibrium statistical mechanics.
Language: English	**Person responsible for module:** Prof. Dr. Peter Sollich
Course frequency: every 4th semester	**Duration:** 1 semester[s]
Number of repeat examinations permitted: three times	**Recommended semester:** Bachelor: 6; Master: 1 - 4
Maximum number of students: 80	

Georg-August-Universität Göttingen **Module B.Phy.5404: Introduction to Statistical Machine Learning**	3 C 3 WLH
Learning outcome, core skills: After successful completion of the module students will be familiar with the core concepts and mathematical methods of statistical machine learning. Students will be able to devise, implement and analyse a range of machine learning approaches based primarily on a Bayesian statistics framework, including methods for regression, classification and approximate inference methods based on connections to statistical physics.	**Workload:** Attendance time: 42 h Self-study time: 48 h
Course: Introduction to Statistical Machine Learning (lecture with exercise if necessary)	
Examination: oral (approx. 30 min.) or written exam (120 min.) **Examination requirements:** Bayesian regression and classification, non-parametric models including Gaussian process, graphical models, variational inference	3 C

Admission requirements: none	**Recommended previous knowledge:** Basic probability theory and linear algebra; familiarity with equilibrium statistical mechanics is helpful
Language: English	**Person responsible for module:** Prof. Dr. Peter Sollich
Course frequency: every 4th semester	**Duration:** 1 semester[s]
Number of repeat examinations permitted: three times	**Recommended semester:** Bachelor: 6; Master: 1 - 4
Maximum number of students: 80	

Georg-August-Universität Göttingen Module B.Phy.5405: Active Matter	3 C 2 WLH
Learning outcome, core skills: **Learning objectives**: The students will learn about the basic principles of the physics of active matter as characterized via nonequilibrium statistical physics. Topics will include: physics of micro-swimming, hydrodynamic coordination, continuum description of scalar active matter and motility-induced phase separation, polar active matter and flocking, active liquid crystals (e.g. nematics) and defects, phoretic active matter, activity in enzyme suspensions, and active membranes. **Competences**: This course will give the students a good theoretical understanding of active matter and enable them to follow the state-of-the-art research in the area of active matter.	**Workload:** Attendance time: 28 h Self-study time: 62 h
Course: Active Matter (Lecture)	
Examination: written examination (60 Min.) or oral examination (approx. 30 Min.)	3 C

Admission requirements: none	**Recommended previous knowledge:** Basic knowledge in statistical physics and hydrodynamics
Language: English	**Person responsible for module:** Prof. Dr. Ramin Golestanian
Course frequency: each summer semester	**Duration:** 1 semester[s]
Number of repeat examinations permitted: three times	**Recommended semester:** Bachelor: 5 - 6; Master: 1 - 4
Maximum number of students: not limited	

Georg-August-Universität Göttingen **Module B.Phy.5406: Physics with fluctuating paths: stochastic and trajectory thermodynamics**	3 C 3 WLH

Learning outcome, core skills: After successful completion of the module students will be familiar with the core concepts and mathematical methods of stochastic and trajectory thermodynamics including the key fluctuation theorems, statistics of path-based observables and dynamical phase transitions Students will be able to model and analyse strongly fluctuating non-equilibrium processes within the framework of stochastic and trajectory thermodynamics, with applications e.g. in driven systems, non-equilibrium dynamics and reaction networks.	**Workload:** Attendance time: 42 h Self-study time: 48 h

Course: Physics with fluctuating paths: stochastic and trajectory thermodynamics	2 WLH
Course: Physics with fluctuating paths: stochastic and trajectory thermodynamics	1 WLH
Examination: Mdl. Prüfung (ca. 30 Minuten) oder Klausur (120 Minuten) **Examination requirements:** Stochastic dynamics (Markov chains) and Langevin dynamics, entropy production and work, time reversal symmetry and fluctuation theorems, trajectory thermodynamics and large deviations, dynamical phase transitions	3 C

Admission requirements: none	**Recommended previous knowledge:** Module "Statistical mechanics and thermodynamics" or equivalent knowledge of equilibrium statistical mechanics.
Language: German, English	**Person responsible for module:** Prof. Dr. Peter Sollich
Course frequency: every 4th semester	**Duration:** 1 semester[s]
Number of repeat examinations permitted: three times	**Recommended semester:** Bachelor: 6; Master: 1 - 4
Maximum number of students: 80	

Georg-August-Universität Göttingen **Modul B.Phy.5501: Aerodynamik** *English title: Aerodynamics*	6 C 4 SWS

Lernziele/Kompetenzen: Nach erfolgreichem Absolvieren des Moduls sind die Studierenden mit den physikalischen Grundlagen der Aerodynamik vertraut und sollten diese auf elementare aerodynamische Zusammenhänge anwenden können.	**Arbeitsaufwand:** Präsenzzeit: 56 Stunden Selbststudium: 124 Stunden

Lehrveranstaltung: Vorlesung Aerodynamik I (Vorlesung)	2 SWS
Lehrveranstaltung: Vorlesung Aerodynamik II (Vorlesung)	2 SWS

Von den folgenden Prüfungen ist genau eine erfolgreich zu absolvieren:	
Prüfung: Klausur (120 Minuten)	6 C
Prüfung: Mündlich (ca. 30 Minuten)	6 C

Prüfungsanforderungen: Kontinuumsphysikalische Grundlagen, Grundgleichungen der reibungsfreien und reibungsbehafteteten Strömung, Theorie des Auftriebs, induzierter Widerstand, Kompressibilitäts- und Reibungseffekte und ihre Einordnung über entsprechende Kennzahlen (Machzahl, Reynoldszahl), Grundzüge der Flugmechanik	

Zugangsvoraussetzungen: keine	**Empfohlene Vorkenntnisse:** keine
Sprache: Deutsch	**Modulverantwortliche[r]:** Prof. Dr. rer. nat. Dr. habil. Andreas Dillmann StudiendekanIn der Fakultät für Physik
Angebotshäufigkeit: jedes Wintersemester	**Dauer:** 2 Semester
Wiederholbarkeit: dreimalig	**Empfohlenes Fachsemester:** Bachelor: 5 - 6; Master: 1 - 2
Maximale Studierendenzahl: 30	

Bemerkungen: Schwerpunkt: AG, BK

Georg-August-Universität Göttingen **Modul B.Phy.5502: Aktive Galaxien** *English title: Active galaxies*	3 C 2 SWS

Lernziele/Kompetenzen: Nach dem erfolgreichem Absolvieren des Moduls verfügen die Studierenden Kenntnisse in: • Klassifizierung von Aktiven Galaxien, • spektrale Eigenschaften, • Multifrequenzbeobachtungen, • Struktur und Komponenten der Kernregion, • supermassereiche Schwarze Loecher, • thermische und nichtthermische Strahlungsprozesse, • Energieerzeugung	**Arbeitsaufwand:** Präsenzzeit: 28 Stunden Selbststudium: 62 Stunden

Lehrveranstaltung: Aktive Galaxien (Vorlesung)	
Prüfung: Mündlich (ca. 30 Minuten) **Prüfungsanforderungen:** Beherrschen des Stoffs der Vorlesung und der zugehörigen Literatur.	3 C

Zugangsvoraussetzungen: keine	**Empfohlene Vorkenntnisse:** Grundvorlesung zur Astronomie
Sprache: Deutsch	**Modulverantwortliche[r]:** Prof. Dr. Wolfram Kollatschny
Angebotshäufigkeit: jedes Sommersemester	**Dauer:** 1 Semester
Wiederholbarkeit: dreimalig	**Empfohlenes Fachsemester:** Bachelor: 4 - 6; Master: 1
Maximale Studierendenzahl: 40	

Georg-August-Universität Göttingen **Modul B.Phy.5504: Computational Physics** *English title: Computational Physics*	6 C 4 SWS

Lernziele/Kompetenzen: Nach erfolgreichem Absolvieren des Moduls sollten die Studenten fortgeschrittene Methoden aus der Computerphysik kennen- und anwenden können, insbesondere Lösen nichtlinearer algebraischer Gleichungssysteme, Diagonalisierung von Matrizen (Eigenwert-Problem), Fast Fourier Transforms sowie Methoden zur Lösung von gewöhnlichen und partiellen Differentialgleichungen.	**Arbeitsaufwand:** Präsenzzeit: 56 Stunden Selbststudium: 124 Stunden

Lehrveranstaltung: Vorlesung + Übung	

Von den folgenden Prüfungen ist genau eine erfolgreich zu absolvieren:	
Prüfung: Hausarbeit (max. 15 Seiten)	6 C
Prüfung: Klausur (120 Minuten)	6 C
Prüfung: Mündlich Mündliche Prüfung (ca. 30 Minuten)	6 C

Prüfungsanforderungen: Anwendung fortgeschrittener numerischer Verfahren aus der Computerphysik zur Lösung physikalischer Probleme; Beschreiben der Methoden und Auswahl geeigneter Methoden für ein gegebenes Problem.	

Zugangsvoraussetzungen: keine	**Empfohlene Vorkenntnisse:** Programmierkenntnisse, einfache numerische Algorithmen (Programmierkurs, CWR)
Sprache: Deutsch	**Modulverantwortliche[r]:** PD Dr. Wolfram Schmidt Prof. Dominik Schleicher
Angebotshäufigkeit: jedes Sommersemester	**Dauer:** 1 Semester
Wiederholbarkeit: dreimalig	**Empfohlenes Fachsemester:** Bachelor: 3 - 6; Master: 1
Maximale Studierendenzahl: 40	

Bemerkungen: Schwerpunkt alle

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: three times	**Recommended semester:** Bachelor: 6; Master: 1
Maximum number of students: 40	

Georg-August-Universität Göttingen **Modul B.Phy.5506: Einführung in die Strömungsmechanik** *English title: Introduction to fluid dynamics*	6 C 4 SWS

Lernziele/Kompetenzen: Nach erfolgreichem Absolvieren des Moduls sollten die Studierenden die grundlegenden Begriffe der Strömungsmechanik auf entsprechende Fragestellungen aus den Bereichen der Geo- und Astrophysik bzw. der Biophysik und der Physik komplexer Systeme anwenden können.	**Arbeitsaufwand:** Präsenzzeit: 56 Stunden Selbststudium: 124 Stunden

Lehrveranstaltung: Vorlesung (Vorlesung)	

Von den folgenden Prüfungen ist genau eine erfolgreich zu absolvieren:	
Prüfung: Klausur (120 Minuten)	6 C
Prüfung: Mündlich (ca. 30 Minuten)	6 C

Prüfungsanforderungen: Theoretische und experimentelle Grundlagen der Strömungsmechanik tropfbarer Flüssigkeiten und Gase: Kontinuumshypothese; Statik, Kinematik und Dynamik von Fluiden; Kontinuitätsgleichung; Bewegungsgleichungen; Dimensionsanalyse; reibungsbehaftete Strömungen, schleichende Strömungen, Grenzschichten, Turbulenz; Potentialströmungen; Wirbelsätze; Impuls- /Impulsmomentengleichungen; Energiegleichung; Stromfadentheorie	

Zugangsvoraussetzungen: keine	**Empfohlene Vorkenntnisse:** keine
Sprache: Deutsch	**Modulverantwortliche[r]:** StudiendekanIn der Fakultät für Physik
Angebotshäufigkeit: jedes Sommersemester	**Dauer:** 1 Semester
Wiederholbarkeit: dreimalig	**Empfohlenes Fachsemester:** Bachelor: 4 - 6; Master: 1 - 3
Maximale Studierendenzahl: 30	

Georg-August-Universität Göttingen **Modul B.Phy.5508: Geophysikalische Strömungsmechanik** *English title: Geophysical fluid mechanics*	3 C 2 SWS
Lernziele/Kompetenzen: Nach erfolgreichem Absolvieren des Moduls sollten die Studierenden die Bewegungsformen der flüssigen Bestandteile der Erde (Atmosphäre, Ozeane, Kern) oder anderer Planeten kennen und die Thermodynamik, insbesondere der Atmosphäre, verstehen.	**Arbeitsaufwand:** Präsenzzeit: 28 Stunden Selbststudium: 62 Stunden
Lehrveranstaltung: Vorlesung (Vorlesung)	
Prüfung: mündliche Prüfung (ca. 30 Min.) oder Klausur (30 Min.)	
Prüfungsanforderungen: Aufbau der Erdatmosphäre, adiabatischer Gradient und Temperaturschichtung, Corioliskraft und Besonderheiten rotierender Strömungen (geostrophisches Gleichgewicht, Inertial- und Rossbywellen, Ekmanschichten), Strahlungshaushalt, globale Zirkulation der Atmosphäre und Ozeane, Wettersysteme der mittleren Breiten, Schwerewellen, Konvektion, Instabilität und Turbulenz.	

Zugangsvoraussetzungen: keine	**Empfohlene Vorkenntnisse:** keine
Sprache: Deutsch	**Modulverantwortliche[r]:** Prof. Dr. Andreas Tilgner
Angebotshäufigkeit: unregelmäßig	**Dauer:** 1 Semester
Wiederholbarkeit: dreimalig	**Empfohlenes Fachsemester:** Bachelor: 4 - 6; Master: 1 - 3
Maximale Studierendenzahl: nicht begrenzt	

Bemerkungen: Schwerpunkt Astro-/Geophysik

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)	
Von den folgenden Prüfungen ist genau eine erfolgreich zu absolvieren:	
Examination: Written examination (120 minutes)	3 C
Examination: Oral examination (approx. 30 minutes)	3 C

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: three times	**Recommended semester:** Bachelor: 5 - 6; Master: 1 - 4
Maximum number of students: 20	

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	
Von den folgenden Prüfungen ist genau eine erfolgreich zu absolvieren:	
Examination: Term Paper (max. 15 pages)	6 C
Examination: Oral examination (approx. 30 minutes)	6 C

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: three 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: three times	**Recommended semester:** Bachelor: 5 - 6; Master: 1 - 3
Maximum number of students: 40	

<table>
<tr><td>Georg-August-Universität Göttingen
Modul B.Phy.5516: Physik der Galaxien
English title: Physics of Galaxies</td><td>3 C
2 SWS</td></tr>
<tr><td>Lernziele/Kompetenzen:
Nach erfolgreichem Absolvieren des Moduls verfügen die Studierenden über Kenntnisse zu folgenden Schwerpunkten:
• Klassifizierung von Galaxien,
• Helligkeitsprofile,
• spektroskopische Eigenschaften,
• stellare Population und interstellares Medium,
• Kinematik,
• Massen(bestimmungsmethoden),
• Galaxienentwicklung</td><td>Arbeitsaufwand:
Präsenzzeit:
28 Stunden
Selbststudium:
62 Stunden</td></tr>
<tr><td>Lehrveranstaltung: Vorlesung (Vorlesung)</td><td></td></tr>
<tr><td>Prüfung: Mündlich (ca. 30 Minuten)
Prüfungsanforderungen:
• morphologische Galaxienklassifikation,
• Oberflaechenhelligkeit,
• Aufbau und Struktur von Galaxien,
• Rotation und Dynamik,
• stellare Zusammensetzung und Gaskomponenten des Interstellaren Mediums,
• Galaxienmassen,
• Skalierungsrelationen,
• Galaxienentwicklung</td><td>3 C</td></tr>
</table>

Zugangsvoraussetzungen: keine	**Empfohlene Vorkenntnisse:** keine
Sprache: Deutsch	**Modulverantwortliche[r]:** Prof. Dr. Wolfram Kollatschny
Angebotshäufigkeit: jedes Wintersemester	**Dauer:** 1 Semester
Wiederholbarkeit: dreimalig	**Empfohlenes Fachsemester:** Bachelor: 4 - 6; Master: 1
Maximale Studierendenzahl: 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: After successful completion of the module the participants understand: • the elementary parameters of the Sun-Earth-System, • the origin and different forms of solar activity, • the physical processes of the heliosphere, • the exploration of space and the Sun with space missions, • the effects of the Sun on Earth and space weather.	**Workload:** Attendance time: 28 h Self-study time: 62 h
Course: Physics of the Sun, Heliosphere and Space Weather: Key Knowledge (Lecture) *Contents*: • Basic knowledge of the Sun-Earth-System, • Basic physics of the Sun, its outer atmosphere and its effects on interplanetary spac, • Exploration of the Sun and space with dedicated spacecraft and instruments, • Effects of the Sun on Earth, including cosmic effects, Finally, the research field of space weather, different forecast methods and new projects will be presented.	
Von den folgenden Prüfungen ist genau eine erfolgreich zu absolvieren:	
Examination: Written examinationWritten examination (120 minutes)	3 C
Examination: Oral examinationoral examination (approx. 30 minutes)	3 C

Admission requirements: none	**Recommended previous knowledge:** none
Language: English, German	**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: three 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)	

Von den folgenden Prüfungen ist genau eine erfolgreich zu absolvieren:	
Examination: Written examination (120 minutes)	3 C
Examination: Oral examination (approx. 30 minutes)	3 C

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: three times	**Recommended semester:** Bachelor: 4 - 6; Master: 1
Maximum number of students: 30	

Georg-August-Universität Göttingen **Modul B.Phy.5521: Seminar zu einem Thema der Geophysik** *English title: Seminar on Geophysics*	4 C 2 SWS
Lernziele/Kompetenzen: Nach erfolgreichem Absolvieren des Moduls sollten Studierende sich selbstständig in eine Fragestellung aus der Geophysik und Ihrem fachlichen Umfeld einarbeiten und einen Vortrag mit schriftlicher Zusammenfassung erarbeiten können**.**	**Arbeitsaufwand:** Präsenzzeit: 28 Stunden Selbststudium: 92 Stunden
Lehrveranstaltung: Seminar (Seminar)	
Prüfung: Vortrag (ca. 60 Min.) mit schriftlicher Ausarbeitung (max. 20 S) **Prüfungsvorleistungen:** Aktive Teilnahme	4 C
Prüfungsanforderungen: Selbständige Einarbeitung in ein Thema der Geophysik, Vorbereitung eines für Bachelor-Studenten verständlichen Vortrages mit schriftlicher Zusammenfassung.	

Zugangsvoraussetzungen: keine	**Empfohlene Vorkenntnisse:** keine
Sprache: Deutsch	**Modulverantwortliche[r]:** Prof. Dr. Andreas Tilgner
Angebotshäufigkeit: unregelmäßig	**Dauer:** 1 Semester
Wiederholbarkeit: dreimalig	**Empfohlenes Fachsemester:** Bachelor: 4 - 6; Master: 1 - 3
Maximale Studierendenzahl: 20	

Bemerkungen: Schwerpunkt Astro-/Geophysik

Georg-August-Universität Göttingen **Module B.Phy.5523: General Relativity**	6 C 6 WLH
Learning outcome, core skills: The students master the foundations of General Relativity mathematically and physically. They are able to perform corresponding computations in simple models.	**Workload:** Attendance time: 84 h Self-study time: 96 h
Course: General Relativity (Lecture)	4 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
Course: Excercises	2 WLH

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: three times	**Recommended semester:** Bachelor: 5 - 6; Master: 1 - 4
Maximum number of students: 60	

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: three times	**Recommended semester:** from 4
Maximum number of students: not limited	

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

Course: Physics of stellar atmospheres (Vorlesung) *Course frequency:* each winter semester	2 WLH
Course: Stellar atmosphere modelling (Computerpraktikum) *Course frequency:* each winter semester	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 summer semester	**Duration:** 1 semester[s]
Number of repeat examinations permitted: three 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: three 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: three 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.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: three times	**Recommended semester:** Bachelor: 5 - 6; Master: 1 - 4
Maximum number of students: 25	

Georg-August-Universität Göttingen **Modul B.Phy.5601: Theoretical and Computational Neuroscience I** *English title: Theoretical and Computational Neuroscience I*	3 C 2 SWS

Lernziele/Kompetenzen: Nach erfolgreichem Absolvieren des Moduls sollten die Studierenden... • ein vertieftes Verständnis folgender Themen entwickelt haben: TCN I: biophysikalische Grundlagen neuronaler Anregbarkeit, mathematische Grundlagen neuronaler Anregbarkeit, Input-Output Beziehungen und Bifurkationen, Klassifizierung, Existenz, Stabilitaet und Koexistenz sychroner und asynchroner Zustaende in spikenden neuronalen Netzwerken; • Methoden und Methodenentwicklung für die Analyse hochdimensionaler Modelle ratenkodierter Einheiten in Feldmodellen verstehen; • die Handhabung von Bifurkationsszenarien und zugehörigen Instabilitäten verstanden haben.	**Arbeitsaufwand:** Präsenzzeit: 28 Stunden Selbststudium: 62 Stunden

Lehrveranstaltung: Collective Dynamics Biological Neural Networks I (Vorlesung)	

Von den folgenden Prüfungen ist genau eine erfolgreich zu absolvieren:	
Prüfung: Klausur (120 Minuten)	3 C
Prüfung: Mündlich Mündliche Prüfung (ca. 30 Minuten)	3 C
Prüfung: Vortrag (2 Wochen Vorbereitungszeit) (30 Minuten)	3 C

Prüfungsanforderungen: Grundlagen der Membranbiophysi;, Bifurkationen anregbarer Systeme; Verständnis der Grundlagen der Modellierungsansätze der Neurophysik; kollektive Zustände spikender neuronaler Netzwerke; insbesondere Synchonizität; Balanced State; Phase-Locking und diesen Zuständen unterliegenden lokalen und Netzwerkeigenschaften: Netzwerktopologie; Delays; inhibitorische und exzitatorische Kopplung; sparse random networks	

Zugangsvoraussetzungen: keine	**Empfohlene Vorkenntnisse:** keine
Sprache: Englisch	**Modulverantwortliche[r]:** Prof. Dr. Fred Wolf
Angebotshäufigkeit: jedes Wintersemester	**Dauer:** 1 Semester
Wiederholbarkeit: dreimalig	**Empfohlenes Fachsemester:** Bachelor: 4 - 6; Master: 1
Maximale Studierendenzahl: 90	

Georg-August-Universität Göttingen **Modul B.Phy.5602: Theoretical and Computational Neuroscience II** *English title: Theoretical and Computational Neuroscience II*	3 C 2 SWS

Lernziele/Kompetenzen: Nach erfolgreichem Absolvieren des Moduls sollten Studierende... • das vertiefte Verständnis folgender Themen entwickelt haben: TCN II: Grundlagen neuronaler Anregbarkeit, Input-Output Beziehungen bei Einzelneuronen, eindimensionale Feldmodelle (Feature Selectivity, Contrastinvariance), zweidimensionale Feldmodell (Zusammenwirken von kurz- und langreichweitigen Verbindungen sowie lokaler Nichtlinearitaeten), Amplitudengleichungen und ihre Loesungen; • Methoden und Methodenentwicklung für die Analyse spikender neuronaler Netzwerke mit und ohne Delays, Handhabung von Bifurkationsszenarien und zugehörigen Instabilitäten verstehen.	**Arbeitsaufwand:** Präsenzzeit: 28 Stunden Selbststudium: 62 Stunden

Lehrveranstaltung: Collective Dynamics Biological Neural Networks II (Vorlesung)	

Von den folgenden Prüfungen ist genau eine erfolgreich zu absolvieren:	
Prüfung: Klausur (120 Minuten)	3 C
Prüfung: Mündlich (ca. 30 Minuten)	3 C
Prüfung: Seminarvortrag (2 Wochen Vorbereitungszeit) (30 Minuten)	3 C

Prüfungsanforderungen: Ratenmodelle von Einzelneuronen; Feldansatz in der theoretischen Neurophysik; Grundlagen der Bifurkationen anregbarer System; Verständnis der Grundlagen der Modellierungsansätze der Neurophysik; Zusammenhang diskrete/kontinuierliche Modelle; kollektive Zustände ein- und zweidimensionaler Feldmodelle, insbesondere ring model of feature selectivity; orientation preference maps.	

Zugangsvoraussetzungen: keine	**Empfohlene Vorkenntnisse:** keine
Sprache: Englisch	**Modulverantwortliche[r]:** Prof. Dr. Fred Wolf
Angebotshäufigkeit: jedes Sommersemester	**Dauer:** 1 Semester
Wiederholbarkeit: dreimalig	**Empfohlenes Fachsemester:** Bachelor: 4 - 6; Master: 1
Maximale Studierendenzahl: 90	

Georg-August-Universität Göttingen **Modul B.Phy.5603: Einführung in die Laserphysik** *English title: Introduction to laserphysics*	3 C 2 SWS
Lernziele/Kompetenzen: Nach erfolgreichem Absolvieren des Moduls verfügen die Studierenden über folgende Grundkenntnisse: • Die dem Laser zugrundeliegenden Prinzipien. • Die Beschreibung des Laserprozesses durch Ratengleichungen sowie stationäre und zeitabhängige Lösungen derselben. • Stabilität von Laserresonatoren sowie Eigenschaften der aus Ihnen emittierten Strahlung. • Aufbau und Eigenschaften unterschiedlicher Lasertypen. • Ausgewählte Laserprobleme (Linienbreite, Hole Burning, Kurze Pulse, …)	**Arbeitsaufwand:** Präsenzzeit: 28 Stunden Selbststudium: 62 Stunden
Lehrveranstaltung: Vorlesung *Inhalte*: Das Prinzip des Lasers wird aufbauend auf einfachen Grundbegriffen entwickelt, dabei aber keineswegs auf quantitative Aussagen verzichtet. Im Mittelpunkt stehen die Analyse des stationären und zeitabhängigen Verhaltens von Lasern mit Hilfe des Ratengleichungsmodelles sowie die Diskussion optischer Resonatoren. Weiterhin werden die physikalischen Grundideen am Beispiel der wichtigsten Lasertypen herausgearbeitet. Eine einführende Behandlung einiger ausgewählter Probleme (Linienbreite, Hole Burning, Kurze Pulse, …) rundet die Vorlesung ab.	
Prüfung: Mündlich (ca. 30 Minuten) **Prüfungsanforderungen:** Laserprinzip; Ratengleichungen; Funktionsweise von Lasern (Festkörper, Farbstoff, Gas, Halbleiter und Freier-Elektronen); Wellengleichung; strahlen- und wellenoptische Behandlung von Resonatoren. Entwicklung des Laserprinzips aus einfachen Grundbegriffen: Licht und Materie, Laserprinzip, Ratengleichungen, Lasertypen, optische Resonatoren, ausgewählte Themen.	

Zugangsvoraussetzungen: keine	**Empfohlene Vorkenntnisse:** keine
Sprache: Deutsch	**Modulverantwortliche[r]:** apl. Prof. Dr. Alexander Egner
Angebotshäufigkeit: jedes Wintersemester	**Dauer:** 1 Semester
Wiederholbarkeit: dreimalig	**Empfohlenes Fachsemester:** Bachelor: 6; Master: 1 - 4
Maximale Studierendenzahl: 20	

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: three 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: Computational Neuroscience: Basics (Lecture)	
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.5607: Seminar: 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: Mechanics and dynamics of the cytoskeleton	
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: each summer semester	**Duration:** 1 semester[s]
Number of repeat examinations permitted: three 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: Students will learn the fundamentals of fluid dynamics, hydrodynamics on the micro- and nanoscale, wetting and capillarity and "life" at low Reynolds numbers. Students will also learn the how these topics are studied/applied in experiments, learn about device fabrication using soft lithography and the use of fluidics in biology and biophysics including "lab-on-a-chip" applications. After successfully completing this course, students will be familiar with basic hydrodynamics and their applications at scales applicable to biology, biophysics, material sciences and biotechnology.	**Workload:** Attendance time: 28 h Self-study time: 62 h
Course: Micro- and Nanofluidics (Lecture)	
Von den folgenden Prüfungen ist genau eine erfolgreich zu absolvieren:	
Examination: Written examination (60 minutes)	3 C
Examination: Oral examination (approx. 30 minutes)	3 C

Admission requirements: none	**Recommended previous knowledge:** Introduction to Biophysics and/or Physics of Complex Systems
Language: English	**Person responsible for module:** Prof. Dr. Sarah Köster
Course frequency: every 4th semester; summerterm, in even years	**Duration:** 1 semester[s]
Number of repeat examinations permitted: three 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: three times	**Recommended semester:** Bachelor: 4 - 6; Master: 1
Maximum number of students: 20	

Georg-August-Universität Göttingen **Module B.Phy.5613: Soft Matter Physics**	3 C 2 WLH

Learning outcome, core skills: **Learning objectives** After successfully finishing this course, students will be familiar with fundamental concepts of soft condensed matter physics and their applications. Topics include: intermolecular interactions; phase transitions; interface physics; amphiphilic molecules; colloids; polymers; polymer networks; gels; fluid dynamics; self-organization. **Learning outcomes:** Students will be able to apply these fundamental concepts independently to specific questions. They will be able to use the knowledge learned to critically evaluate the current literature.	**Workload:** Attendance time: 28 h Self-study time: 62 h

Course: Soft Matter Physics (Lecture)	2 WLH

Von den folgenden Prüfungen ist genau eine erfolgreich zu absolvieren:	
Examination: Written examinationwritten exam (120 minutes)	3 C
Examination: Oral examinationoral exam (approx. 30 minutes)	3 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: English	**Person responsible for module:** Prof. Dr. Sarah Köster
Course frequency: every 4th semester; summerterm, in odd years	**Duration:** 1 semester[s]
Number of repeat examinations permitted: three 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: three times	**Recommended semester:** Bachelor: 4 - 6; Master: 1 - 3
Maximum number of students: 14	

Georg-August-Universität Göttingen **Module B.Phy.5617: Seminar: Physics of soft condensed matter**	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: Physics of soft condensed matter	
Examination: Presentation with discussion (Bachelor approx. 30 min., Master approx. 60 min.) **Examination prerequisites:** Active participation **Examination requirements:** Intermolecular interactions; phase transitions; interface physics; amphiphilic molecules; colloids; polymers; polymer networks; gels; fluid dynamics; self-organization.	4 C

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

Georg-August-Universität Göttingen **Module B.Phy.5618: Seminar to Biophysics of the cell - physics on small scales**	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:** Physical principles in cells; adhesion; motility; cellular communication; signal transduction; biopolymers and networks; nerve cinduction; extracellular matrix; experimental methods; current research.	4 C

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

Georg-August-Universität Göttingen **Module B.Phy.5619: Seminar on Micro- and Nanofluidics**	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 on Micro- and Nanofluidics (Seminar)	
Examination: Presentation with discussion (Bachelor approx. 30 min., Master approx. 60 min.) **Examination prerequisites:** Active participation **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.	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: each summer semester	**Duration:** 1 semester[s]
Number of repeat examinations permitted: three times	**Recommended semester:** Bachelor: 5 - 6; Master: 1 - 4
Maximum number of students: 14	

Georg-August-Universität Göttingen **Module B.Phy.5620: Physics of Sports**	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.	**Workload:** 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: three times	**Recommended semester:** Bachelor: 5 - 6; Master: 1 - 4
Maximum number of students: 25	

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: three 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.	4 C

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: three times	**Recommended semester:** Bachelor: 4 - 6; Master: 1 - 4
Maximum number of students: 25	

Georg-August-Universität Göttingen Module B.Phy.5625: X-ray physics	6 C 4 WLH
Learning outcome, core skills: Knowledge in: • Radiation-matter interaction • Dosimetry, radiobiology and radiation protection • Scattering experiments: photons, neutrons and electrons • Fundamental concepts in diffraction and Fourier theory • Structure analysis in crystalline and non-crystalline condensed matter • Generation of x-rays and synchrotron radiation • X-rays optics and detection • X-ray spectroscopy, microscopy and imaging After taking the course, students • will integrate fundamental concepts of matter-radiation interaction . • are able to apply quantitative scattering techniques with short wavelength radiation for structure analysis of condensed matter, including problems in solid state, materials, soft matter, and biomolecular physics • are able to plan and carry out x-ray laboratory experiments • are prepared to participate in beamtimes at synchrotron, neutron or free-electron radiation sources • can solve analytical problems in x-ray optics, diffraction and imaging	**Workload:** Attendance time: 56 h Self-study time: 124 h
Course: X-ray Physics	
Examination: Written examination (120 minutes) or oral examination (ca. 30 min.) or presentation (ca. 30 min.) **Examination prerequisites:** none **Examination requirements:** • solve problems of the topics mentioned above on a quantitative level, including calculations of structure factor, correlation functions, • applications of Fourier theory to structure analysis and basic solutions to the phase problem, • solve problems of wave optical propagation and diffraction • knowledge about interaction mechanisms and order -of-magnitude estimations, • knowledge about theoretical concepts and experimental implementations of different techniques, • knowledge of laboratory skills (x-ray sources, detection, dosimetry)	6 C

Admission requirements: none	**Recommended previous knowledge:** none
Language: English, German	**Person responsible for module:** Prof. Dr. Tim Salditt

Course frequency: each summer semester	**Duration:** 1 semester[s]
Number of repeat examinations permitted: three times	**Recommended semester:** Bachelor: 6; Master: 1 - 2
Maximum number of students: 15	

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: each winter semester	**Duration:** 1 semester[s]
Number of repeat examinations permitted: three 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	4 C

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: three 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	4 C

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: three times	**Recommended semester:** Bachelor: 5 - 6; Master: 1 - 4
Maximum number of students: 15	

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	3 C

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: three 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 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.	3 C

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: three 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:	**Workload:**
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.	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.	6 C

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: three 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.	4 C

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: three 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**	4 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 with exercises 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. During the exercises, the knowledge presented in the lecture will be applied to practical examples to further deepen and strengthen the understanding. By completing homework sets, which will be distributed after each lecture, additional aspects of the addressed topics during the lecture shall be worked out. The homework sets will be collected during the corresponding exercises.	**Workload:** Attendance time: 28 h Self-study time: 92 h
Course: Theoretical and Computational Biophysics (Lecture, Exercise)	
Examination: Oral examination (approx. 30 minutes) **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.	4 C

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: three times	**Recommended semester:** Bachelor: 5 - 6; Master: 1 - 4
Maximum number of students:	

30	

Georg-August-Universität Göttingen **Module B.Phy.5649: Biomolecular Physics and Simulations**	4 C 2 WLH

Learning outcome, core skills:	**Workload:**
Learning objectives: This combined lecture and hands-on computer tutorial offers the possibility to deepen the knowledge about theory and computer simulations of biomolecular systems, particularly proteins, and can be understood as continuation of the lecture with exercises "Theoretical and Computational Biophysics" (usually taking place in the previous winter semester). During the exercises, the knowledge presented in the lecture will be applied to practical examples to further deepen and strengthen the understanding. By completing homework sets, which will be distributed after each lecture, additional aspects of the addressed topics during the lecture shall be worked out. The homework sets will be collected during the corresponding exercises. **Competencies:** Whereas the winter term lecture with exercises "Theoretical and Computational Biophysics" emphasized the principles of running and analysing simple atomistic force field-based simulations, this advanced course will broaden our view and introduce basic principles, concepts and methods in computational biophysics, particularly required to understand biomolecular function, namely thermodynamic quantities such as free energies and affinities. Further, inclusion of quantum mechanical simulation techniques will allow to also simulate chemical reactions, e.g., in enzymes.	Attendance time: 28 h Self-study time: 92 h

Course: Lecture with Exercises Biomolecular Physics and Simulations	
Examination: Oral examination (approx. 30 minutes) **Examination requirements:** Basic knowledge and understanding of the material covered in the course such as: Free energy calculations, Rate Theory, Non-equilibrium thermodynamics, Quantum mechanical methods (Hartree-Fock and Density Functional Theory), enzymatic catalysis; “handson” computational calculations and simulations	4 C

Admission requirements: none	**Recommended previous knowledge:** B.Phy.5648 Theoretical and Computational Biophysics
Language: English, German	**Person responsible for module:** Hon.-Prof. Dr. Karl Helmut Grubmüller
Course frequency: each summer semester	**Duration:** 1 semester[s]
Number of repeat examinations permitted: three 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	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: Advanced Computational Neuroscience I (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 semester	**Duration:** 1 semester[s]
Number of repeat examinations permitted: three 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: Advanced Computational Neuroscience II	
Examination: 4 Protocols (max. 3 Pages) and Presentations (ca. 10 Min.), 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: three times	**Recommended semester:** Bachelor: 5 - 6; Master: 1 - 4
Maximum number of students: 24	

Georg-August-Universität Göttingen **Modul B.Phy.5655: Komplexe Dynamik physikalischer und biologischer Systeme** *English title: Complex dynamics of physical and biological systems*	4 C 2 SWS
Lernziele/Kompetenzen: Nach erfolgreichem Absolvieren des Moduls sollen die Studierenden in Lage sein, sich ausgewählte Themen und Fragestellungen anhand von Publikationen in Fachzeitschriften oder Büchern zu erarbeiten und einem Vortrag vorzustellen.	**Arbeitsaufwand:** Präsenzzeit: 28 Stunden Selbststudium: 92 Stunden
Lehrveranstaltung: Komplexe Dynamik physikalischer und biologischer Systeme (Seminar)	
Prüfung: Vortrag (ca. 30 Minuten) **Prüfungsvorleistungen:** aktive Teilnahme **Prüfungsanforderungen:** Nichtlineare Dynamik, Biophysik, komplexe Netzwerke, erregbare Medien, Herzdynamik, Kardiomyozyten, Datenanalyse, experimentelle Techniken (z.B. Bildgebende Verfahren).	4 C

Zugangsvoraussetzungen: keine	**Empfohlene Vorkenntnisse:** Einführung in die Biophysik / Einführung in die Physik komplexer Systeme
Sprache: Deutsch, Englisch	**Modulverantwortliche[r]:** apl. Prof. Dr. Ulrich Parlitz
Angebotshäufigkeit: jedes Sommersemester	**Dauer:** 1 Semester
Wiederholbarkeit: dreimalig	**Empfohlenes Fachsemester:** Bachelor: 4 - 6; Master: 1 - 2
Maximale Studierendenzahl: 20	

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: 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.	**Workload:** 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, not graded **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.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:* each winter semester	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: three 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: three 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: 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. 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 exam (60 minutes) or oral exam (approx. 30 minutes) **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.	3 C

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

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 presentation (approx. 45 min.) and handout (4 pages max.) **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.	4 C

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: three 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.5664: Excursion to DESY and the European XFEL, Hamburg**	3 C 2 WLH
Learning outcome, core skills: **Learning goals:** Basic knowledge about mission of large scale reasearch facilities, user concept and mission of DESY and European Free-electron laser (XFEL). Basic concepts of modern accelerators (super conducting and conventional), generation of synchrotron and FEL radiation, and fields of applications. **Competencies:** Overview about research and career opportunities at DESY and XFEL and how large scale facilities can be used for research and study topics. Categorize interdisciplinary information gathered at the excursion (presentations, poster session, workshop) and place it in perspective with own study background.	**Workload:** Attendance time: 28 h Self-study time: 62 h
Course: Excursion to DESY and the European XFEL, Hamburg (Excursion)	
Examination: oral presentation of one of the scientific activities at DESY (approx. 20min+10min discussion), Poster on a corresponding research topic, or approx. 4 pages contribution to the excursion protocol., not graded **Examination prerequisites:** Participation in the excursion and discussion of prepared lerning material **Examination requirements:** Basic knowledge about mission of large scale reasearch facilities, user concept and mission of DESY and European Free-electron laser (XFEL). Basic concepts of modern accelerators (super conducting and conventional), generation of synchrotron and FEL radiation, and fields of applications.	3 C

Admission requirements: none	**Recommended previous knowledge:** B.Phy.5625: Röntgenphysik
Language: English, German	**Person responsible for module:** Prof. Dr. Tim Salditt Prof. Dr. Sarah Köster
Course frequency: each winter semester	**Duration:** 1 semester[s]
Number of repeat examinations permitted: three times	**Recommended semester:** Bachelor: 5 - 6; Master: 1 - 4
Maximum number of students: 10	

Georg-August-Universität Göttingen Module B.Phy.5665: Processing of Signals and Measured Data	3 C 2 WLH

Learning outcome, core skills: **Learning outcome**: • Errors, e.g. systematic vs. random, static vs. dynamic, error propagation • Extraction of relevant information (separating trends, stochastic data and affecting influences, such as noise) • Stationarity, statistical quantities and functions • Characteristics of estimators (e.g., sufficiency, ergodicity, bias freeness, efficiency), Cramer-Rao bound, Bessel's correction • Sampling (equidistant and non-uniform), Possibility of reconstruction, sampling theorem, aliasing • Signal transformations (e.g. cosine, Fourier, Hilbert, Laplace, wavelet, z transform) and signal decomposition (e.g. Proper Orthogonal Decomposition, Independent Component Analysis) • Correlation functions and spectra, Wiener-Khinchin theorem • preferred acquisition, sample weighting • Window functions, moving average **Core skills**: • Specification of a measurement (sampling rate, duration, amount of data) • Bias-free and most efficient signal and data processing of measured data • Programming in Matlab or Python	**Workload:** Attendance time: 28 h Self-study time: 62 h

Course: Processing of Signals and Measured Data	2 WLH
Examination: Presentation or oral exam (ca. 30 Min.) **Examination requirements:** Efficient use of signal and image processing methods as well as statistical analysis methods.	3 C

Admission requirements: none	**Recommended previous knowledge:** none
Language: English, German	**Person responsible for module:** Prof. Dr. Eberhard Bodenschatz
Course frequency: each summer semester	**Duration:** 1 semester[s]
Number of repeat examinations permitted: three times	**Recommended semester:** Bachelor: 5 - 6; Master: 1 - 4
Maximum number of students: 30	

Georg-August-Universität Göttingen **Module B.Phy.5666: Molecules of Life – from statistical physics to biological action**	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 to a wide audience. They should be also able to evaluate it critically.	**Workload:** Attendance time: 28 h Self-study time: 92 h

Course: Molecules of Life – from statistical physics to biological action (Seminar)	
Examination: Presentation, Bachelor approx. 30 min; Master approx. 60 min	4 C

Admission requirements: none	**Recommended previous knowledge:** • Thermodynamik und statistische Mechanik and/or • Introduction to Biophysics and/or • Introduction to Physics of Complex Systems and/or • Theoretical and Computational Biophysics and/or • Biomolecular Physics and Simulations
Language: English, German	**Person responsible for module:** Hon.-Prof. Dr. Karl Helmut Grubmüller Bert de Groot, Aljaz Godec
Course frequency: each semester	**Duration:** 1 semester[s]
Number of repeat examinations permitted: three times	**Recommended semester:** Bachelor: 5 - 6; Master: 1 - 4
Maximum number of students: 15	

Georg-August-Universität Göttingen Module B.Phy.5669: Seminar on Living Matter Physics	4 C 2 WLH
Learning outcome, core skills: **Learning objectives**: The seminar is a combination of presentations by external speakers and journal club presentations by students. The students will learn about state-of-the-art theoretical and experimental research in the physics of biological and biomimetic systems, as delivered by the invited speakers in the weekly seminars of the Department of Living Matter Physics of the MPI for Dynamics and Self-Organization. Seminars will be on a wide range of topics such as biological and artificial micro-swimmers and molecular motors; collective behaviour in cellular tissues, bacterial colonies, and dense active materials; chemical activity and self-organization at the sub-cellular scale; the physics of cellular and biomimetic membranes; or information flow and stochastic thermodynamics in living systems. The students will also learn how to conduct research, prepare and deliver journal club presentations about recently published articles in these topics. **Competences**: This course will give students a broad view of the latest research on the physics of living matter, and acquaint them with how practicing researchers communicate scientific findings to each other.	**Workload:** Attendance time: 28 h Self-study time: 92 h

Course: Seminar on Living Matter Physics	
Examination: One or more journal club presentations (approx. 30 mins each) depending on the number of participating students (30 minutes)	4 C

Admission requirements: none	**Recommended previous knowledge:** none
Language: English	**Person responsible for module:** Prof. Dr. Ramin Golestanian Dr. Jaime Agudo-Canalejo
Course frequency: once a year	**Duration:** 1 semester[s]
Number of repeat examinations permitted: three times	**Recommended semester:** Bachelor: 5 - 6; Master: 1 - 4
Maximum number of students: not limited	

Georg-August-Universität Göttingen **Module B.Phy.5670: Introduction to Magnetic Resonance Imaging**	6 C 4 WLH

Learning outcome, core skills: Introduction to magnetic resonance imaging. This includes basic knowledge about the underlying physics (e.g. nuclear spins, Larmor frequency, Zeeman effect, gyromagnetc ratio, Bloch equations, spin relaxation), technical details of an MRI scanner (e.g. static magnetic field, radio-frequency transmitter, magnetic gradient system, receiv- and transmitter coils), about acquisition and reconstruction methods and about specific medical applications (e.g. perfusion and diffusion imaging). The lecture is complemented by exercises and practical examples to strengthen the acquired knowledge.	**Workload:** Attendance time: 56 h Self-study time: 124 h

Course: Lecture: Introduction to Magnetic Resonance Imaging (Lecture)	WLH
Course: Exercises: Introduction to Magnetic Resonance Imaging (Exercise)	WLH
Examination: Written exam (120 min.), oral exam (ca. 30 min.), or practical project with presentation (ca. 20 min) and written report (10 pages max.), 4 weeks of preparation time **Examination requirements:** Basic knowledge about magnetic resonance imaging (physics, MRI scanner, data acquisition, reconstruction, and applications)	6 C

Admission requirements: none	**Recommended previous knowledge:** Electrodynamics, quantum mechanics
Language: English, German	**Person responsible for module:** Prof. Dr. Tim Salditt Prof. Dr. Uecker, Prof. Dr. Boretius
Course frequency: each winter semester	**Duration:** 1 semester[s]
Number of repeat examinations permitted: three times	**Recommended semester:** Bachelor: 5 - 6; Master: 1 - 4
Maximum number of students: 50	

Georg-August-Universität Göttingen Module B.Phy.5671: Dynamics of living systems	3 C 4 WLH
Learning outcome, core skills: The student will learn to simulate the dynamical changes observed in different living systems. Typically these systems have been already published in classical papers that develop simulations. These simulations will be reproduced as part of the course project. During the course we will use known system to translate biological functions to the underlying biochemistry. The biochemistry in turn is converted to rate equations, which typically form a system of coupled nonlinear differential equations that cannot be solved analytically. Using simple numerical approaches the students will simulate these systems to recover the behavior observed in the real, living systems. Typical examples are oscillations, pattern formations and bifurcations. The student will be able to model biological signaling cascades and diffusion problems by simple numerical approaches. This will train interdisciplinary skills, understanding of basic biological concepts, integration of physics, biology, chemistry and math. The problems are solved in groups of 2 training communication skills. Furthermore, critical analysis of the already published simulations will help understanding the strength and pitfalls of simulations in biology.	**Workload:** Attendance time: 56 h Self-study time: 34 h
Course: Lecture: Dynamics of Living Systems (Lecture)	1 WLH
Course: Computer Lab Course: Dynamics of Living Systems (Internship)	3 WLH
Examination: Oral presentation (ca. 30 min. including ca. 10 min. discussion), short report (max. 20 pages) on the project. **Examination prerequisites:** Active participation (computer lab). Generation of a running simulation. **Examination requirements:** The project prepared during the semester will be presented to the other students, hence all students have to be present during the presentations. A short report (15-20 pages) describing the project and the generated code, including a short discussion of the difficulties encountered.	3 C

Admission requirements: none	**Recommended previous knowledge:** none
Language: English, German	**Person responsible for module:** Alle Prof. Betz
Course frequency: once a year	**Duration:** 1 semester[s]
Number of repeat examinations permitted: three times	**Recommended semester:** Bachelor: 5 - 6; Master: 1 - 4
Maximum number of students: 16	

Georg-August-Universität Göttingen Module B.Phy.5672: Nonlinear Dynamics	3 C 2 WLH
Learning outcome, core skills: After successfully finishing this course, students will know about and understand typical features of nonlinear systems. Furthermore, they will be familiar with basic and advanced concepts and methods of nonlinear dynamics and their applications in physics and other fields of science. In particular, students will be able to implement suitable numerical algorithms or use existing software to simulate complex and chaotic dynamical processes and to perform different forms of analyses (stability and bifurcation analysis, time series analysis and prediction, control and synchronization, estimation of fractal dimension(s), computation of Lyapunov spectra, network analysis, ..).	**Workload:** Attendance time: 28 h Self-study time: 62 h

Course: Workshop and Lecture Nonlinear Dynamics	2 WLH
Examination: Oral exam (ca. 30 min.) or written exam (60 min.) or presentation (ca. 30 min, 2 weeks preparation time) **Examination requirements:** Knowledge of different topics and concepts in nonlinear dynamics covered in the course and understanding how to apply them to investigate, simulate and analyse dynamical systems, in particular using numerical tools.	3 C

Admission requirements: none	**Recommended previous knowledge:** Basic knowledge in physics; linear algebra and calculus; programming skills
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: three times	**Recommended semester:** Bachelor: 5 - 6; Master: 1 - 4
Maximum number of students: 30	

Georg-August-Universität Göttingen **Module B.Phy.5673: Cell Mechanics**	6 C 4 WLH

Learning outcome, core skills: **Learning outcome:** Basics in elasticity theory and fluid dynamics, viscoelastic materials, soft matter, polymers and complex filaments, 2D and 3D networks, passive and active microrheology, fluctuations dissipation theorem, bio membranes, membrane undulations, intermembrane and electrostatic forces, simplified cells and vesicles, dynamic filaments, growth and division, traction forces, mechanosensing, Life in crowded environments, 2D tissue dynamics, jamming, 3D tissue dynamics, mechanics in development **Core skills:** The core goal is to give a deep overview of the adaptive mechanics and coordinated force generation used by cells and cellular systems to perform various complex functions. We will focus on a deep physics understanding, coming from fundamental physical laws that are rooted in conservation laws and statistical physics.	**Workload:** Attendance time: 56 h Self-study time: 124 h

Course: Lecture and self-studies using literature: Cell Mechanics	
Examination: Oral examination (approx. 30 minutes) **Examination requirements:** Derivation of fundamental mechanics properties, including viscoelasticity, modelling of polymers and biopolymers, microrheology, membrane mechanics, 2D and 3D networks.	6 C

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

Georg-August-Universität Göttingen **Module B.Phy.5674: Modern Image Processing**	3 C 2 WLH
Learning outcome, core skills: **Learning outcome:** Enabling the student to extract meaningful data from scientific images using self-written Python programs. The syllabus starts with standard techniques of image processing and ends with more recent developments coming from the field of machine learning. This is a hands-on course; a significant part of the time will be used for coding exercises. **Core skills:** Concepts covered include: image acquisition, intensity transfomations, color, spatial and morphological filters, image registration, feature extraction, Fast Fourier Transform, segmentation, Convolutional Neural Networks, autoencoder, semantic segmentation, surface models, tomography, stereo vision.	**Workload:** Attendance time: 28 h Self-study time: 62 h
Course: Lecture Modern Image Processing with in-class exercises and homework	
Examination: Oral Presentation (approx. 30 minutes) **Examination requirements:** An image processing project, demonstrating mastery of the concepts taught in this course	3 C

Admission requirements: none	**Recommended previous knowledge:** none
Language: English, German	**Person responsible for module:** PD Dr. Matthias Schröter
Course frequency: each winter semester	**Duration:** 1 semester[s]
Number of repeat examinations permitted: three times	**Recommended semester:** Bachelor: 5 - 6; Master: 1 - 4
Maximum number of students: 30	

Georg-August-Universität Göttingen **Module B.Phy.5675: Machine Learning, hands-on**	4 C 3 WLH

Learning outcome, core skills: Learning outcome: Enabling the student to apply machine learning algorithms to solve scientific problems using self-written Python programs. The syllabus covers both more traditional techniques and deep neural networks. This is a hands-on course, a significant part of the time will be used for coding exercises. Core skills: Concepts covered include: data preprocessing, linear regression, regularization, logistic regression, Bayesian reasoning in ML, Gaussian Mixture Models, decision trees, random forests, support vector machines, clustering, principal component analysis, deep neural networks, convolutional neural networks, (variational) autoencoders, natural language processing, reinforcement learning, ethics and ML.	**Workload:** Attendance time: 42 h Self-study time: 78 h

Course: Machine Learning, hands-on *Contents*: Lecture with in-class exercises, quizzes and homework	3 WLH
Examination: Oral examination (approx. 30 minutes) **Examination requirements:** a machine learning project, demonstrating mastery of the concepts taught in this course	4 C

Admission requirements: none	**Recommended previous knowledge:** none
Language: English	**Person responsible for module:** Prof. Dr. Stefan Klumpp PD Dr. Matthias Schröter
Course frequency: each summer semester	**Duration:** 1 semester[s]
Number of repeat examinations permitted: three times	**Recommended semester:** Bachelor: 5 - 6; Master: 1 - 4
Maximum number of students: 30	

Georg-August-Universität Göttingen Module B.Phy.5676: Computer Vision and Robotics	9 C 6 WLH

Learning outcome, core skills: After successful completion of this module, students are familiar with • the basic concepts of computer vision (CV), • low level hardware components and their functions, • building and programming a robot, and • computer vision and robotics algorithms.	**Workload:** Attendance time: 84 h Self-study time: 186 h

Course: Introduction to Computer Vision and Robotics (Lecture) *Contents*: On-Off Controller, PID Controller, Moving Average Filter, Exponential Moving Average Filter, Kalman Filter, A*, Dijkstra, RRT, Q-Learning , Inverse and Forward Kinematics, Movement Generation Methods, Smoothing and Median Filtering, Bilateral Filtering, Non-Local Means, Connected Components , Morphological Operators , Line Detection, Circle Detection, Feature Detection, Advanced image segmentation algorithms.	2 WLH
Course: Practical Course on Computer Vision and Robotics (Lecture) *Contents*: Building a robot, solving a graph problem using the robot and executing the found solution by the robot in a real-world scenario involving perception and navigation	2 WLH
Course: Tutorial on Computer Vision and Robotics (Tutorial) *Contents*: In the accompanying tutorial sessions students deepen and broaden their knowledge from the lectures	2 WLH
Examination: Written report (approx. 10 p.) and Oral Exam (approx. 30 minutes) **Examination requirements:** Written report requirements: The students must be able • to describe their project in a written report • to explain given problems and used solutions for navigation- and perception problems of robots Oral Examination requirements: The students must be able • to repeat and explain lecture material • to explain control algorithms for a robot, and • to identify and understand low level hardware components as robot sensors and actuators.	9 C

Admission requirements: none	**Recommended previous knowledge:** Programming in Python
Language: English	**Person responsible for module:** Prof. Dr. Florentin Andreas Wörgötter
Course frequency: each winter semester	**Duration:** 1 semester[s]
Number of repeat examinations permitted:	**Recommended semester:**

three times	Bachelor: 5 - 6; Master: 1 - 4
Maximum number of students: 24	

Georg-August-Universität Göttingen Module B.Phy.5677: Seminar on Advanced Topics in Cellular Biophysics	4 C 2 WLH
Learning outcome, core skills: The aim of this course is for students to gain a profound knowledge in a selection of the following topics in cellular biophysics: - Cell studies (“top-down”) - In vitro experiments (“bottom-up”) - Cytoskeleton - Biopolymers and networks - Cell mechanics - Cell dynamics - Cell adhesion - Cell motility - Force generation in biological systems 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 on Advanced Topics in Cellular Biophysics	
Examination: Presentation with scientific discussion (ca. 30 min.) and scientific discussion with the other participants **Examination requirements:** Cell studies (“top-down”), in vitro experiments (“bottom-up”), cytoskeleton, biopolymers and networks, cell mechanics, cell dynamics, cell adhesion, cell motility, force generation in biological systems	4 C

Admission requirements: none	**Recommended previous knowledge:** Successful completion of the course "Introduction to Biophysics"; Bachelor studies in physics or a related field
Language: English	**Person responsible for module:** Prof. Dr. Sarah Köster
Course frequency: once a year	**Duration:** 1 semester[s]
Number of repeat examinations permitted: three times	**Recommended semester:** Bachelor: 6; Master: 1 - 4
Maximum number of students: 14	

Georg-August-Universität Göttingen Module B.Phy.5678: Seminar on Advanced Methods in Biophysics	4 C 2 WLH

Learning outcome, core skills:	**Workload:**
The aim of this course is for students to gain a profound knowledge in a selection of the following methods and their applications in biophysics: - Imaging: Fluorescence microscopy, x-ray imaging, x-ray scattering, atomic force microscopy - Force measurements: optical tweezers, atomic force spectroscopy, traction force microscopy - Modelling 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.	Attendance time: 28 h Self-study time: 92 h

Course: Seminar on Advanced Methods in Biophysics	
Examination: Presentation with scientific discussion (ca. 30 min.) and scientific discussion with the other participants **Examination requirements:** Fluorescence microscopy, x-ray imaging, x-ray scattering, optical tweezers, atomic force microscopy and spectroscopy, modelling: methods and applications in biophysics	4 C

Admission requirements: none	**Recommended previous knowledge:** Successful completion of the course "Introduction to Biophysics"; Bachelor studies in physics or a related field
Language: English	**Person responsible for module:** Prof. Dr. Sarah Köster
Course frequency: once a year	**Duration:** 1 semester[s]
Number of repeat examinations permitted: three times	**Recommended semester:** Bachelor: 6; Master: 1 - 4
Maximum number of students: 14	

Georg-August-Universität Göttingen **Module B.Phy.5679: Cell Biology Methods for Physicists**	3 C 2 WLH
Learning outcome, core skills: **Learning outcome** The aim of this course is for students to gain a profound theoretical and practical knowledge in the cell biology methods that are used in cell biophysics. Topics covered are: • Working in a sterile environment • E. coli transformation for DNA amplification, purification and sequence analysis, • Mammalian cell passaging and transfection • Cell fixation and antibody staining • Imaging by epifluorescence microscopy • Image processing. **core skills** After successfully completing this course, students will be able to • plan and perform cell biology experiments • understand and interpret microscopy images of cells	**Workload:** Attendance time: 28 h Self-study time: 62 h
Course: Cell Biology Methods for Physicists (Practical course)	2 WLH
Examination: written report (max. 10 pages) **Examination requirements:** Proficiency in: • Working in a sterile environment • E. coli transformation for DNA amplification, purification and sequence analysis, • Mammalian cell passaging and transfection • Cell fixation and antibody staining • Imaging by epifluorescence microscopy • Image processing	3 C

Admission requirements: none	**Recommended previous knowledge:** Successful completion of the course *Introduction to Biophysics*; Bachelor studies in physics or a related field (is useful, but not necessary)
Language: English, German	**Person responsible for module:** Prof. Dr. Sarah Köster Contact person: Dr. Ulrike Rölleke
Course frequency: each winter semester	**Duration:** 1 semester[s]
Number of repeat examinations permitted: three times	**Recommended semester:** Bachelor: 3 - 6; Master: 1 - 4
Maximum number of students:	

3	

Georg-August-Universität Göttingen Module B.Phy.5680: Biophysics across scales	6 C 4 WLH

Learning outcome, core skills: **learning outcome**: The aim of this course is for students to gain a profound knowledge in the following fields: • Basics in biology and chemistry (cellular components, physical chemistry, molecular biology); • Basics in soft matter physics (Random walks, Brownian motion, diffusion; polymer physics); • Methods (microscopy, scattering, optical tweezers, atomic force microscopy, microfluidics); • Biophysics across scales (structural biology – molecular scale; filaments and membranes – mesoscopic scale; active matter – mesoscopic scale; cellular scale, tissue and organ scale) **core skills:** After successfully completing this course, students will be able to • extract relevant information from scientific publications • plan biophysical experiments • analyze, plot and interpret model data sets • understand, solve and interpret physical models of biological systems • discuss state-of-the-art biophysics research results	**Workload:** Attendance time: 56 h Self-study time: 124 h

Course: Biophysics across scales (Lecture)	3 WLH
Examination: Oral exam (approx. 30 min.) or written exam (60 min.) **Examination requirements:** Proficiency in: • Basics in biology and chemistry (cellular components, physical chemistry, molecular biology); • Basics in soft matter physics (Random walks, Brownian motion, diffusion; polymer physics); • Methods (microscopy, scattering, optical tweezers, atomic force microscopy, microfluidics); • Biophysics across scales (structural biology; filaments and membranes; active matter; cells, cell ensembles and tissues)	6 C

Course: Biophysics across scales: hands-on-tutorial	1 WLH

Admission requirements: none	**Recommended previous knowledge:** Successful completion of the course *Introduction to Biophysics*; Bachelor studies in physics or a related field
Language:	**Person responsible for module:**

English	Prof. Dr. Sarah Köster
Course frequency: each summer semester	**Duration:** 1 semester[s]
Number of repeat examinations permitted: three times	**Recommended semester:** Bachelor: 6; Master: 1 - 4

Georg-August-Universität Göttingen **Module B.Phy.5681: Seminar CARA: Critical analysis of research articles of cell and tissue mechanics**	4 C 2 WLH
Learning outcome, core skills: After successfully finishing this course, students will be able to critically read a research paper on the subject of cell and tissue mechanics. They will be able to present such subjects in detail by identifying strengths and weaknesses. This will be done on articles that are currently only on the preprint servers. In the second part, the participants will prepare a brief presentation if a second paper where they learn how to efficiently transmit the highlights of a recent research paper. Master students and if interested also Bachelor students will practice the skill of Peer-Reviewing a paper by writing such a peer review of the paper they had presented in more detail.	**Workload:** Attendance time: 28 h Self-study time: 92 h
Course: Seminar CARA (Seminar)	2 WLH
Examination: Presentation with discussion (Bachelor approx. 30 min., Master approx. 60 min.) **Examination prerequisites:** Active participation **Examination requirements:** Soft matter, cell mechanics, rheology, tissue mechanics, active systems, membranes, cell motility	

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

Georg-August-Universität Göttingen Module B.Phy.5682: Seminar: Special Topics in Cell Mechanics	4 C 2 WLH
Learning outcome, core skills: The aim of this course is for students to gain profound knowledge in a selection of the following topics in cellular biophysics: • Biopolymers • Soft Matter • Active and Passive Rheology • Cell mechanics • Cell dynamics • Cell motility • Force generation in biological systems This will be done by presenting a short research project that will be performed in the context of the course. After successfully finishing this course, students will be able to work out or reproduce a specific question 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: Special Topics in Cell Mechanics (Seminar)	2 WLH
Examination: Presentation with a scientific discussion of a research project on the subject of cell mechanics (approx. 45 min.) **Examination prerequisites:** Active participation **Examination requirements:** Biopolymers, Soft Matter, Active and Passive Rheology, Cell mechanics, Cell dynamics, Cell motility, Force generation in biological systems.	

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

Georg-August-Universität Göttingen **Modul B.Phy.5702: Dünne Schichten** *English title: Thin Layers*	3 C 2 SWS

Lernziele/Kompetenzen: Nach erfolgreichem Absolvieren des Moduls sollten die Studierenden die grundlegenden Begriffe der Physik dünner Schichten und Schichtstrukturen anwenden können.	**Arbeitsaufwand:** Präsenzzeit: 28 Stunden Selbststudium: 62 Stunden

Lehrveranstaltung: Vorlesung mit Seminar (je zur Hälfte)	
Prüfung: Vortrag (ca. 30 Minuten) **Prüfungsvorleistungen:** Aktive Teilnahme im Seminar	3 C

Prüfungsanforderungen: Oberflächen; UHV; Dünnschichtverfahren; Keimbildung und Wachstum dünner Schichten; Epitaxie; Untersuchungsmethoden; spezielle Eigenschaften dünner Schichten.	

Zugangsvoraussetzungen: keine	**Empfohlene Vorkenntnisse:** keine
Sprache: Deutsch	**Modulverantwortliche[r]:** StudiendekanIn der Fakultät für Physik
Angebotshäufigkeit: unregelmäßig	**Dauer:** 1 Semester
Wiederholbarkeit: dreimalig	**Empfohlenes Fachsemester:** Bachelor: 6; Master: 1 - 4
Maximale Studierendenzahl: 24	

Georg-August-Universität Göttingen **Modul B.Phy.5707: Nanoscience** *English title: Nanoscience*	3 C 2 SWS
Lernziele/Kompetenzen: **Lernziele**: Electronic properties of electrons confined in low-dimensional nanostructures (2D, 1D and 0D). Experimental methods for the preparation and characterization of nanostrucures. Semiconductor materials will be on focus. **Kompetenzen**: After successful completion of the modul the students should be able to gain a knowledge basis of the relevant concepts and methods needed when dealing with nanostructures.	**Arbeitsaufwand:** Präsenzzeit: 28 Stunden Selbststudium: 62 Stunden
Lehrveranstaltung: Vorlesung	
Prüfung: Mündliche Prüfung oder Vortrag (je ca. 30 Min.)	3 C
Prüfungsanforderungen: The students should show a knowledge basis of the relevant concepts and methods needed when dealing with nanostructures. Student choice if in German or in English.	

Zugangsvoraussetzungen: keine	**Empfohlene Vorkenntnisse:** • Quantenmechanik I • Einführung in die Festkörperphysik • Einführung in die Materialphysik
Sprache: Englisch	**Modulverantwortliche[r]:** Prof. Dr. Angela Rizzi
Angebotshäufigkeit: jedes 4. Semester	**Dauer:** 1 Semester
Wiederholbarkeit: dreimalig	**Empfohlenes Fachsemester:** Bachelor: 5 - 6; Master: 1
Maximale Studierendenzahl: 40	

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	4 C
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: three 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:	**Workload:**
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.	Attendance time: 84 h Self-study time: 96 h

Course: lecture	4 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

Course: exercises	2 WLH

Admission requirements: keine	**Recommended previous knowledge:** Quantum mechanics I
Language: German, English	**Person responsible for module:** Prof. Dr. Stefan Kehrein
Course frequency: each winter semester	**Duration:** 1 semester[s]
Number of repeat examinations permitted: three 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

Course: Vorlesung	2 WLH
Course: 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: three 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: three 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: three 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, electro- 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: three times	**Recommended semester:** Bachelor: 6; Master: 1 - 2
Maximum number of students: 30	

Georg-August-Universität Göttingen **Module B.Phy.5720: Introduction to Ultrashort Pulses and Nonlinear Optics**	3 C 2 WLH

Learning outcome, core skills: After successful completion of this Module students will be able to work with advanced concepts, phenomena and models of ultrashort pulses and their applications in nonlinear optics.	**Workload:** Attendance time: 28 h Self-study time: 62 h

Course: Introduction to Ultrashort Pulses and Nonlinear Optics (Lecture)	
Examination: Oral (approx. 30 min.) or written (90 min.) **Examination requirements:** Matter-light interaction; rate equations; continuous and pulsed laser operation; mode coupling; properties of ultrashort pulses; nonlinear susceptibility and nonlinear response of bound electrons; frequency doubling; parametric amplification; self-focusing; self-phase modulation; high-harmonic generation	3 C

Admission requirements: none	**Recommended previous knowledge:** • Elektrodynamic (Experimentalphysics II) • Optic and waves (Experimentalphysics III)
Language: English, German	**Person responsible for module:** Prof. Dr. Stefan Mathias
Course frequency: every 4th semester	**Duration:** 1 semester[s]
Number of repeat examinations permitted: three times	**Recommended semester:** Bachelor: 5 - 6; Master: 1 - 4
Maximum number of students: 40	

Georg-August-Universität Göttingen Module B.Phy.5721: Information and Physics	6 C 6 WLH
Learning outcome, core skills: Understanding the concept of information in classical physics and quantum physics, in depth understanding of the second law of thermodynamics and its generalizations with the Landauer erasure principle, learning key elements of quantum information theory and quantum computation	**Workload:** Attendance time: 84 h Self-study time: 96 h
Course: Information and Physics (Lecture, Exercise)	
Examination: Written examination (120 minutes) **Examination requirements:** Understanding the concepts of classical and quantum information science, performing calculations in classical and quantum information science and interpreting the results	6 C

Admission requirements: none	**Recommended previous knowledge:** Analytical Mechanics, Quantum Mechanics and Statistical Physics
Language: English	**Person responsible for module:** Prof. Dr. Stefan Kehrein
Course frequency: every 4th semester	**Duration:** 1 semester[s]
Number of repeat examinations permitted: three times	**Recommended semester:** Bachelor: 6; Master: 1 - 4
Maximum number of students: 40	

Georg-August-Universität Göttingen Module B.Phy.5722: Seminar on Topics in Nonlinear Optics	4 C 2 WLH
Learning outcome, core skills: This seminar adresses some of the most important nonlinear optical phenomena and their application. Exemplary topics will be parametric processes and wave mixing, high harmonic generation, spatial and temporal solitons, supercontinuum generation, optical phase conjugation, stimulated Raman scattering, photorefractive phenomena, optical filamentation and electromagnetically induced transparency.	**Workload:** Attendance time: 28 h Self-study time: 92 h

Course: Seminar on Topics in Nonlinear Optics (Seminar)	
Examination: Presentation with discussion (Bachelor approx. 30 min., Master approx. 60 min.) **Examination prerequisites:** compulsory attendance **Examination requirements:** A fundamental understanding of nonlinear optical phenomena and their application.	4 C

Admission requirements: none	**Recommended previous knowledge:** none
Language: English, German	**Person responsible for module:** Prof. Dr. Claus Ropers
Course frequency: every 4th semester	**Duration:** 1 semester[s]
Number of repeat examinations permitted: three times	**Recommended semester:** Bachelor: 5 - 6; Master: 1 - 4
Maximum number of students: 14	

Georg-August-Universität Göttingen **Module B.Phy.5723: Hands-on course on Density-Functional calculations 1**	3 C 3 WLH

Learning outcome, core skills: Students will be able to perform first-principles electronic-structure and ab-initio molecular dynamics simulations, understand the results and judge their accuracy. They will have a basic knowledge of the underlying methods. They will know simple methods of anticipating and describing electronic and atomic structure and chemical bonds.	**Workload:** Attendance time: 40 h Self-study time: 50 h

Course: Hands-on course on Density-Functional calculations 1 (Block course) *Contents*: 1. Theoretical foundation of first-principles calculations (lecture 10 h) 2. Simple concepts of electronic structure and chemical binding (lecture 10 h) 3. Hands on Course with the CP-PAW code (Exercise 20 h)	
Examination: oral (approx 30 min), presentation (30 min) or report **Examination prerequisites:** regular participation **Examination requirements:** The student is able to describe topics from the course and to respond to questions. A presentation or a report will describe a specified home project.	3 C

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

Georg-August-Universität Göttingen **Module B.Phy.5724: Hands-on course on Density-Functional calculations 1+2**	6 C 6 WLH

Learning outcome, core skills: Students will be able to perform first-principles electronic-structure and ab-initio molecular dynamics simulations, understand the results and judge their accuracy. They will have a basic knowledge of the underlying methods. They will know simple methods of anticipating and describing electronic and atomic structure and chemical bonds.	**Workload:** Attendance time: 84 h Self-study time: 96 h

Course: Hands-on course on Density-Functional calculations 1+2 (Block course) *Contents*: 1. Theoretical foundation of first-principles calculations (lecture 10 h) 2. Simple concepts of electronic structure and chemical binding (lecture 10 h) 3. Hands on Course with the CP-PAW code (Exercise ~22 h) 4. Advanced topics of first-principles calculations (lecture ~8 h) 5. Hands on Course: guided projects (~26 h) 6. Seminar on guided projects (~12 h)	
Examination: oral (approx 30 min), presentation (30 min) or report **Examination prerequisites:** regular participation **Examination requirements:** The student is able to describe topics from the course and to respond to questions. A presentation or a report will describe a specified project.	6 C

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

Georg-August-Universität Göttingen **Module B.Phy.5725: Renormalization group theory and applications**	6 C 6 WLH
Learning outcome, core skills: **Learning outcome:** After successful completion of the modul students will be able to understand concepts of field theory and renormalization group in classical and quantum systems. **Core skills:** Students will be able to use the basics of field theory, including perturbation theory and renormalization, and be able to apply these tools to physical problems.	**Workload:** Attendance time: 84 h Self-study time: 96 h
Course: Renormalization group theory and applications (Lecture)	4 WLH
Course: Renormalization group theory and applications (Exercise)	2 WLH
Examination: Written or oral examWritten exam (120 min) or oral exam (approx. 30 min) **Examination prerequisites:** None **Examination requirements:** Theoretical concepts of field theory, renormalization techniques, and their physical interpretation.	6 C

Admission requirements: none	**Recommended previous knowledge:** • Thermodynamik und statistische Mechanik • Quantenmechanik I
Language: English, German	**Person responsible for module:** Prof. Dr. Matthias Krüger
Course frequency: every 4th semester	**Duration:** 1 semester[s]
Number of repeat examinations permitted: three times	**Recommended semester:** Bachelor: 5 - 6; Master: 1 - 4
Maximum number of students: 40	

Georg-August-Universität Göttingen **Modul B.Phy.5726: Kinetik und Phasenumwandlung in Materialien** *English title: Kinetics and phase transformation in materials*	3 C 2 SWS

Lernziele/Kompetenzen:	**Arbeitsaufwand:**
Nach erfolgreichem Absolvieren des Moduls sollten die Studierenden die grundlegenden Begriffe der Nicht-Gleichgewicht-Prozesse und des Transports auf materialphysikalische Fragestellungen anwenden können.	Präsenzzeit: 28 Stunden Selbststudium: 62 Stunden

Lehrveranstaltung: Vorlesung mit Übung	

Von den folgenden Prüfungen ist genau eine erfolgreich zu absolvieren:	
Prüfung: Klausur (120 Minuten)	3 C
Prüfung: Mündlich (ca. 30 Minuten)	3 C

Prüfungsanforderungen:	
Analytische Verfahren zur Vereinfachung und Lösung nicht-linearer partieller Differentialgleichungen. Nicht-Gleichgewichts Thermodynamik; Transport; Diffusion; Klassifizierung von Phasenumwandlungen; Grenzflächenbewegung; morphologische Instabilitäten; Keimbildung; Wachstum; spinodale Entmischung; kinetische Umwandlungen	

Zugangsvoraussetzungen: keine	**Empfohlene Vorkenntnisse:** Einführung in die Festkörperphysik Einführung in die Materialphysik
Sprache: Englisch, Deutsch	**Modulverantwortliche[r]:** Prof.in Cynthia Volkert
Angebotshäufigkeit: jedes Sommersemester	**Dauer:** 1 Semester
Wiederholbarkeit: dreimalig	**Empfohlenes Fachsemester:** Bachelor: 6; Master: 1 - 4
Maximale Studierendenzahl: 30	

Georg-August-Universität Göttingen Module B.Phy.5805: Quantum field theory I	6 C 6 WLH
Learning outcome, core skills: **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.	**Workload:** Attendance time: 84 h Self-study time: 96 h
Course: Quantum field theory I (Lecture)	4 WLH
Course: Quantum field theory I (Exercise)	2 WLH
Von den folgenden Prüfungen ist genau eine erfolgreich zu absolvieren:	
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
Examination: Oral examination (approx. 30 minutes)	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: three 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.	3 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: every 4th semester; unregular	**Duration:** 1 semester[s]
Number of repeat examinations permitted: three 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.	3 C

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: three times	**Recommended semester:** Bachelor: 5 - 6; Master: 1 - 4
Maximum number of students: not limited	

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.	3 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: every 4th semester; irregular	**Duration:** 1 semester[s]
Number of repeat examinations permitted: three 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: Statistical methods in data analysis (Lecture)	
Examination: oral exam (approx. 30 min.) or written exam (120 min.) **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.	3 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: irregular	**Duration:** 1 semester[s]
Number of repeat examinations permitted: three 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: 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.	**Workload:** 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.	3 C

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: three times	**Recommended semester:** Bachelor: 5 - 6; Master: 1 - 4
Maximum number of students: 30	

Georg-August-Universität Göttingen **Modul B.Phy.5815: Seminar zu einführenden Themen der Teilchenphysik** *English title: Seminar on Introductory Topics in Particle Physics*	4 C 2 SWS

Lernziele/Kompetenzen: Nach erfolgreichem Absolvieren des Moduls sollten die Studierenden anhand von Publikationen oder Buchkapiteln sich in Fragestellungen zu Themen der modernen Elementarteilchenphysik einarbeiten und in einem Seminarvortrag vorstellen können.	**Arbeitsaufwand:** Präsenzzeit: 28 Stunden Selbststudium: 92 Stunden

Lehrveranstaltung: Seminar	
Prüfung: Vortrag (ca. 30 Min.) mit schrifltlicher Ausarbeitung (max. 20 S.) **Prüfungsvorleistungen:** Aktive Teilnahme **Prüfungsanforderungen:** Selbständige Erarbeitung wissenschaftlicher Sachverhalte und deren Präsentation.	4 C

Zugangsvoraussetzungen: keine	**Empfohlene Vorkenntnisse:** Einführung in die Kern-/Teilchenphysik
Sprache: Deutsch, Englisch	**Modulverantwortliche[r]:** Prof. Dr. Arnulf Quadt
Angebotshäufigkeit: jedes Sommersemester	**Dauer:** 1 Semester
Wiederholbarkeit: dreimalig	**Empfohlenes Fachsemester:** 5 - 6
Maximale Studierendenzahl: 20	

Georg-August-Universität Göttingen **Module B.Phy.5816: Phenomenology of Physics Beyond the Standard Model**	3 C 2 WLH
Learning outcome, core skills: After successful completion of this module, students understand the shortcomings and limitations of the Standard Model of Particle Physics. Students also acquire insight into the phenomenology of physics beyond the Standard Model (BSM) at TeV energy scales, particularly from models with Supersymmetry and Extra dimensions. Students will also learn the experimental signatures of BSM phenomenology at colliders along with experimental techniques and statistical methods.	**Workload:** Attendance time: 28 h Self-study time: 62 h

Course: Phenomenology of Physics Beyond the Standard Model (Lecture)	
Examination: Oral examination (approx. 30 minutes) **Examination requirements:** Review of the Standard Model of particle physics; Limitations and Shortcomings of the Standard Model; Phenomenology of Supersymmetry; Phenomenology of Extra Dimensions; Other Models with New Physics; Collider Signatures of New Physics; Statistics for Experimental Searches	3 C

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

Georg-August-Universität Göttingen **Module B.Phy.5817: Nuclear Reactor Physics**	4 C 4 WLH

Learning outcome, core skills: After successful completion of the module students should be familiar with the physics concepts of nuclear reactors, nuclear fission and breeding, neutron kinetics, neutron diffusion and neutron balance, criticality and reactivity, delayed neutrons, temperature effects on reactivity, chemical shim and burnable poisons, fast breeders, high temperature reactors, research reactors, enrichment, nuclear fuel cycle and radioactive waste, risk management	**Workload:** Attendance time: 56 h Self-study time: 64 h

Course: Nuclear reactor physics in the field of Nuclear and Particle (Lecture)	2 WLH
Examination: Oral examination (approx. 30 minutes) **Examination requirements:** Physics of nuclear reactors and nuclear reactor concepts	4 C

Course: Tutorial Nuclear reactor physics in the field of Nuclear and Particle (Tutorial)	2 WLH

Admission requirements: none	**Recommended previous knowledge:** Introduction to nuclear and particle physics
Language: English, German	**Person responsible for module:** Prof. Dr. Hans Christian Hofsäss
Course frequency: every 4th semester	**Duration:** 1 semester[s]
Number of repeat examinations permitted: three times	**Recommended semester:** Bachelor: 5 - 6; Master: 1 - 4
Maximum number of students: 40	

Georg-August-Universität Göttingen Module B.Phy.5901: Advanced Computer Simulation	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: Advanced Computer Simulation	
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 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:** Prof. Dr. Marcus Müller
Course frequency: every 4th semester	**Duration:** 1 semester[s]
Number of repeat examinations permitted: three 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. Lecture with excercises 2. Lab (5 Experiments) 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.	6 C

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: three times	**Recommended semester:** Bachelor: 4 - 6; Master: 1 - 4
Maximum number of students: 20	

Additional notes and regulations: Block course

Georg-August-Universität Göttingen **Modul B.Phy.607: Akademisches Schreiben für Physiker/innen** *English title: Academic Writing for Physicists*	4 C 2 SWS
Lernziele/Kompetenzen: **Lernziele:** In diesem Workshop erlernen Studierende Grundkompetenzen des akademischen Schreibens in den beiden Schreibtraditionen des Deutschen und Englischen. Hierfür werden unterschiedliche Textarten (z.B. wissenschaftlicher Artikel, Essay, Protokoll, Bericht) sowie akademische Teiltexte (z.B. Einleitung – Introduction) in den beiden Schreibtraditionen analysiert und miteinander verglichen. Von diesem analytisch-rezeptiven Ansatz ausgehend vertiefen die Studierenden ihre Kenntnisse, indem sie selbst akademische Texte in beiden Schreibtraditionen verfassen, hierbei wird ein Schwerpunkt auf das Schreiben englischer akademischer Texte gelegt. **Kompetenzen:** Nach erfolgreichem Absolvieren des Moduls sollten die Studierenden über akademische Schreibkompetenzen in englischer und deutscher Schreibtradition, Reflexionsvermögen eigener akademischer Schreibprozesse sowie Feedbackkompetenzen verfügen.	**Arbeitsaufwand:** Präsenzzeit: 28 Stunden Selbststudium: 92 Stunden
Lehrveranstaltung: Akademisches Schreiben für Physiker/innen	
Prüfung: Portfolio (max. 20 Seiten) **Prüfungsvorleistungen:** Aktive, regelmäßige Teilnahme an dem Workshop, Erledigen schriftlicher Teilleistungen	
Prüfungsanforderungen: Verfassen deutscher und englischer wissenschaftlicher Texte	

Zugangsvoraussetzungen: keine	**Empfohlene Vorkenntnisse:** keine
Sprache: Deutsch	**Modulverantwortliche[r]:** StudiendekanIn der Fakultät für Physik
Angebotshäufigkeit: jedes Semester	**Dauer:** 1 Semester
Wiederholbarkeit: dreimalig	**Empfohlenes Fachsemester:** Bachelor: 4 - 6; Master: 1 - 4
Maximale Studierendenzahl: 20	

Georg-August-Universität Göttingen **Modul B.Phy.608: Scientific Literacy - Integration von Naturwissenschaften in die Gesellschaft und Politik** *English title: Scientific Literacy*	4 C 2 SWS
Lernziele/Kompetenzen: **Lernziele**: Dieses interdisziplinäre Modul soll die Kluft zwischen den Naturwissenschaften und den Geistes- und Gesellschaftswissenschaften überbrücken helfen. Die Studierenden aller Fachrichtungen sollen gemeinsam naturwissenschaftliche Erkenntniswege kennenlernen und sie anhand aktueller Themen (z.B. anthropogener Klimawandel) nachvollziehen. Hierzu werden auch Grundlagen der Wissenschaftstheorie vermittelt. **Kompetenzen**: Nach erfolgreichem Absolvieren des Moduls sollten Studierende ein Verständnis für Scientific Literacy (u.a. wissenschaftliche Nachprüfbarkeit, Unterscheidung zwischen naturwissenschaftlichen, politischen und gesellschaftlichen Komponenten einer Bewertung) entwickelt sowie Vermittlungskompetenz erworben haben.	**Arbeitsaufwand:** Präsenzzeit: 28 Stunden Selbststudium: 92 Stunden
Lehrveranstaltung: Seminar	
Prüfung: Portfolio (max. 10 Seiten) **Prüfungsvorleistungen:** Vortrag (ca. 30 Minuten) oder äquivalente Leistung sowie aktive Teilnahme **Prüfungsanforderungen:** Grundlagen der Wissenschaftstheorie; Unterscheidung zwischen naturwissenschaftlichen, politischen und gesellschaftlichen Komponenten einer Bewertung.	4 C

Zugangsvoraussetzungen: keine	**Empfohlene Vorkenntnisse:** keine
Sprache: Deutsch	**Modulverantwortliche[r]:** StudiendekanIn der Fakultät für Physik
Angebotshäufigkeit: unregelmäßig	**Dauer:** 1 Semester
Wiederholbarkeit: dreimalig	**Empfohlenes Fachsemester:** Bachelor: 3 - 6; Master: 1 - 4
Maximale Studierendenzahl: 24	

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: three 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 **Modul M.Che.1314: Biophysikalische Chemie** *English title: Biophysical Chemistry*	6 C 5 SWS

Lernziele/Kompetenzen:	**Arbeitsaufwand:**
Nach erfolgreichem Abschluss des Moduls ... • sollen die Studierenden in der Lage sein, die wesentlichen physikochemischen Zusammenhänge biologischer Materie zu verstehen • die generellen Triebkräfte biologischer Reaktionen kennen • Spektroskopische Methoden zur Strukturbestimmung biologischer Makromoleküle verstehen und anwenden können • die Grundzüge moderner optischer Mikroskopie sowie der Sondenmikroskopie verstanden haben • die Mechanik und Dynamik biologischer Systeme ausgehend vom Einzelmolekül bis zur einzelnen Zelle erörtern können	Präsenzzeit: 70 Stunden Selbststudium: 110 Stunden

Lehrveranstaltung: Biophysikalische Chemie (Vorlesung)	3 SWS
Prüfung: Klausur (180 Minuten)	6 C

Lehrveranstaltung: Biophysikalische Chemie (Übung)	2 SWS

Prüfungsanforderungen:	
• Übertragung genereller physikochemischer Prinzipien, wie zum Beispiel der Reaktionsdynamik, (statistischen) Thermodynamik und Quantentheorie auf die Beschreibung biologischer Phänomene • Beschreibung biologisch relevanter Wechselwirkungskräfte, stochastischer Prozesse wie Diffusion, physikalischer Biopolymer-Modelle, der Eigenschaften von Biomembranen und der Visikoelastizität von weicher Materie. • Kenntnisse der wesentlichen Methoden, wie z.B. UV-Vis, Circulardichroismus, Rasterkraftmikroskopie, optische Fallen, Fluoreszenz, und optische Mikroskopie.	

Zugangsvoraussetzungen: keine	**Empfohlene Vorkenntnisse:** keine
Sprache: Deutsch, Englisch	**Modulverantwortliche[r]:** Prof. Dr. Andreas Janshoff
Angebotshäufigkeit: jedes Sommersemester	**Dauer:** 1 Semester
Wiederholbarkeit: dreimalig	**Empfohlenes Fachsemester:** 1 - 2
Maximale Studierendenzahl: 64	

Georg-August-Universität Göttingen **Ruprecht-Karls-Universität Heidelberg** **Module M.MtL.1006: Modern Experimental Methods**	6 C 6 WLH
Learning outcome, core skills: Knowledge about advanced applied optics, radiation-matter interaction, spectroscopy, microscopy and imaging techniques in biophysics After taking this course, students will have quantitative insight into modern experimental techniques for biophysics, in particular optical techniques from basic to advances microscopy including confocal, light sheet and nanoscopy, optical spectroscopy including time-resolved techniques (transient absorption), single molecule techniques (e.g. FCS), electron microscopy, neutron and x-ray diffraction (including protein crystallography), NMR spectroscopy, and X-ray imaging. Students have the competence to reduce the complexity to underlying physics of radiation-matter interaction, to use Fourier-based methods in signal theory, concepts of wave and quantum optics, as well as quantitative data analysis. Hand-on examples of experimental applications and data recording will be introduced by short teaching units in the laboratory along with the courses, and a deeper unit of a 3 days practical in one of the technquies.	**Workload:** Attendance time: 84 h Self-study time: 96 h
Course: Modern Experimental Methods (Lecture, Exercise)	6 WLH
Examination: written examination (120 min.) or oral exam (approx. 30 min.) or presentation (approx. 30 min., 2 weeks preparation time) **Examination requirements:** Theoretical and practical knowledge of modern methods of experimental methods of biophysics.	6 C

Admission requirements: none	**Recommended previous knowledge:** Introduction to Biophysics
Language: English	**Person responsible for module:** Prof. Dr. Tim Salditt
Course frequency: each summer semester	**Duration:** 1 semester[s]
Number of repeat examinations permitted: once	**Recommended semester:** 2
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: After successful completion of the module, students have • familiarised themselves independently with complex issues, • performed experimental tasks under guidance in a team, • and have written scientific protocols within good scientific practice.	**Workload:** Attendance time: 84 h Self-study time: 96 h
Course: Advanced Lab Course I	
Examination: Oral examination (approx. 30 minutes) **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: three 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: After successful completion of the module, students have • familiarised themselves independently with complex issues, • performed experimental tasks under guidance in a team, • and have written scientific protocols within good scientific practice.	**Workload:** Attendance time: 84 h Self-study time: 96 h

Course: Advanced Lab Course II	
Examination: Oral examination (approx. 30 minutes) **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: English, German	**Person responsible for module:** StudiendekanIn der Fakultät für Physik
Course frequency: each summer semester	**Duration:** 1 semester[s]
Number of repeat examinations permitted: three 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: Posterpresentation (approx. 30 min.) **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: three times	**Recommended semester:** 2

Georg-August-Universität Göttingen Module M.Phy.1404: Methods of Computational Physics	6 C 6 WLH
Learning outcome, core skills: After successful completion of the module students will be familiar with the key methods and algorithms of computational physics. Students will be able to select and deploy appropriate computational approaches in order to model and analyse a range of classical and quantum systems.	**Workload:** Attendance time: 84 h Self-study time: 96 h
Course: Computational lab course	2 WLH
Course: Methods of Computational Physics (Lecture)	4 WLH
Examination: written (120 min.) or oral exam (approx. 30 min.) **Examination prerequisites:** Successful completion of 4 computational projects **Examination requirements:** Projects may include: Monte Carlo for phase transitions, rare event simulations, exact numerics for quantum systems, quantum Monte Carlo, simulations of disordered/glassy systems.	6 C

Admission requirements: none	**Recommended previous knowledge:** Basic knowledge of equilibrium statistical mechanics and 1-particle quantum mechanics.
Language: English, German	**Person responsible for module:** Prof. Dr. Fabian Heidrich-Meisner
Course frequency: each winter semester	**Duration:** 1 semester[s]
Number of repeat examinations permitted: three times	**Recommended semester:** 1 - 3
Maximum number of students: 30	

Georg-August-Universität Göttingen **Module M.Phy.1405: Advanced Computational Physics**	6 C 6 WLH

Learning outcome, core skills: After successful completion of the module students should be familiar with the complete project cycle of advanced computational physics work. Students will be able to build and refine appropriate models for solutions of specific physical problems, select and implement advanced computational approaches using both existing software and own codes, and analyse the resulting data.	**Workload:** Attendance time: 84 h Self-study time: 96 h

Course: Computational lab course	
Examination: Oral examination (approx. 30 minutes) **Examination prerequisites:** Successful completion of 3 problem-driven computational projects (50% of the achievable score in each project) **Examination requirements:** Projects may include: Monte Carlo for phase transitions, rare event simulations, exact numerics for quantum systems, quantum Monte Carlo, simulations of disordered/glassy systems.	6 C

Admission requirements: none	**Recommended previous knowledge:** • *Methods of Computational Physics* • *Advanced Statistical Physics* • *Advanced Quantum Mechanics*
Language: English, German	**Person responsible for module:** Prof. Dr. Marcus Müller
Course frequency: each semester	**Duration:** 1 semester[s]
Number of repeat examinations permitted: three times	**Recommended semester:** 2
Maximum number of students: 30	

Georg-August-Universität Göttingen Module M.Phy.1601: Development and Realization of Scientific Projects in Astro-/Geophysics	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 in Astro-/Geophysics	
Examination: written report (max. 30 S.)	9 C
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: three times	**Recommended semester:** 3 - 4
Maximum number of students: 150	

Georg-August-Universität Göttingen **Module M.Phy.1602: Development and Realization of Scientific Projects in Biophysics/Complex Systems**	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 in Biophysics/ Complex Systems	
Examination: written report (max. 30 S.)	9 C

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: three times	**Recommended semester:** 3 - 4
Maximum number of students: 150	

Georg-August-Universität Göttingen **Module M.Phy.1603: Development and Realization of Scientific Projects in Solid State/Materials Physics**	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 in Solid State/ Materials Physics	
Examination: written report (max. 30 S.)	9 C
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: three times	**Recommended semester:** 3 - 4
Maximum number of students: 150	

Georg-August-Universität Göttingen **Module M.Phy.1604: Development and Realization of Scientific Projects in Nuclear/Particle Physics**	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 in Nuclear/Particle Physics	
Examination: written report (max. 30 S.)	9 C

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: three times	**Recommended semester:** 3 - 4
Maximum number of students: 150	

Georg-August-Universität Göttingen **Module M.Phy.1605: Networking in Astro-/Geophysics**	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 in Astro-/Geophysics	
Examination: written report (max. 10 S.), not graded	3 C

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: three times	**Recommended semester:** 3 - 4
Maximum number of students: 150	

Georg-August-Universität Göttingen Module M.Phy.1606: Networking in Biophysics/Physics of Complex Systems	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 in Biophysics/Physics of Complex Systems	
Examination: written report (max. 10 S.), not graded	3 C
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: three times	**Recommended semester:** 3 - 4
Maximum number of students: 150	

Georg-August-Universität Göttingen **Module M.Phy.1607: Networking in Solid State/Materials Physics**	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 in Solid State/Materials Physics	
Examination: written report (max. 10 S.), not graded	3 C

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: three times	**Recommended semester:** 3 - 4
Maximum number of students: 150	

Georg-August-Universität Göttingen **Module M.Phy.1608: Networking in Nuclear/Particle Physics**	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 in Nuclear/Particle Physics	
Examination: written report (max. 10 S.), not graded	3 C
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: three times	**Recommended semester:** 3 - 4
Maximum number of students: 150	

Georg-August-Universität Göttingen Module M.Phy.1609: Networking in Theoretical Physics	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 in Theoretical Physics	
Examination: written report (max. 10 p.), not graded	3 C
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: three times	**Recommended semester:** 3 - 4
Maximum number of students: 30	

Georg-August-Universität Göttingen **Module M.Phy.1610: Development and Realization of Scientific Projects in Theoretical Physics**	9 C
Learning outcome, core skills: After successful completion of the module, students should be able to carry out the planning and the implementation of scientific research projects independently. They should ... • tbe able to 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 in Theoretical Physics	
Examination: written report (max. 30 p.)	9 C
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: three times	**Recommended semester:** 3 - 4
Maximum number of students: 30	

Georg-August-Universität Göttingen Module M.Phy.405: Research Lab Course in Astro- and Geophysics	18 C
Learning outcome, core skills: **Learning Outcome:** By working independently within a current scientific research project students are fostered to familiarize themselves with a new advanced topic in the field of Astro-/Geophysics. They will learn to successfully perform a sub-task and finally present the reults to a professional audience. **Core skills:** Students will be able to organize, conduct, evaluate and present small, manageable projects in the field of Astro-/Geophysics, obeying the rules of good scientific practice.	**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.	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 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: **Learning Outcome:** By working independently within a current scientific research project students are fostered to familiarize themselves with a new advanced topic in the field of Biophysics/ Complex Systems. They will learn to successfully perform a sub-task and finally present the reults to a professional audience. **Core skills:** Students will be able to organize, conduct, evaluate and present small, manageable projects in the field of Biophysics/Complex Systems, obeying the rules of good scientific practice.	**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: **Learning Outcome:** By working independently within a current scientific research project students are fostered to familiarize themselves with a new advanced topic in the field of Solid State/ Materials Physics. They will learn to successfully perform a sub-task and finally present the reults to a professional audience. **Core skills:** Students will be able to organize, conduct, evaluate and present small, manageable projects in the field of Solid State/Materials Physics, obeying the rules of good scientific practice.	**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.	18 C

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 Nuclear and Particle Physics**	18 C
Learning outcome, core skills: **Learning Outcome:** By working independently within a current scientific research project students are fostered to familiarize themselves with a new advanced topic in the field of Course in Nuclear and Particle Physics. They will learn to successfully perform a sub-task and finally present the reults to a professional audience. **Core skills:** Students will be able to organize, conduct, evaluate and present small, manageable projects in the field of Nuclear and Particle Physics, obeying the rules of good scientific practice.	**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.	18 C

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.	4 C

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.	4 C

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.	4 C

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.	4 C

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.	4 C

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.414: Research Lab Course in Theoretical Physics**	18 C
Learning outcome, core skills: **Learning Outcome:** By working independently within a current scientific research project students are fostered to familiarize themselves with a new advanced topic in the field of Theoretical Physics. They will learn to successfully perform a sub-task and finally present the reults to a professional audience. **Core skills:** Students will be able to organize, conduct, evaluate and present small, manageable projects in the field of Theoretical Physics, obeying the rules of good scientific practice.	**Workload:** Attendance time: 0 h Self-study time: 540 h

Course: Research Lab Course in Theoretical 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.	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 semester	**Duration:** 1 semester[s]
Number of repeat examinations permitted: twice	**Recommended semester:** 3 - 4
Maximum number of students: 30	

Georg-August-Universität Göttingen Module M.Phy.415: Research Seminar Theoretical Physics	4 C 2 WLH
Learning outcome, core skills: After successful completion of the module, students are able to 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 Theoretical 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.	4 C

Admission requirements: none	**Recommended previous knowledge:** none
Language: English, German	**Person responsible for module:** Prof. Laura Covi
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.5002: Contemporary Physics	4 C 2 WLH

Learning outcome, core skills:	Workload:
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.	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: three times	**Recommended semester:** 1 - 4
Maximum number of students: 20	

Georg-August-Universität Göttingen Module M.Phy.5401: Advanced Statistical Physics	6 C 6 WLH
Learning outcome, core skills: After successful completion of the module students will be familiar with the core concepts and mathematical methods of statistical physics both in and out of equilibrium. Students will be able to model and analyse interacting or fluctuation-dominated systems using methods from statistical physics, and be aware of a range of application domains including soft matter, biophysics and network dynamics.	**Workload:** Attendance time: 84 h Self-study time: 96 h
Course: Advanced Statistical Physics (Lecture)	4 WLH
Examination: written (120 min.) or oral exam (approx. 30 min.) **Examination prerequisites:** At least 50% of the homework of the excercises have to be solved successfully.	6 C
Course: Advanced Statistical Physics (Exercise)	2 WLH

Admission requirements: none	**Recommended previous knowledge:** Basic knowledge of statistical mechanics of equilibrium
Language: English	**Person responsible for module:** Prof. Dr. Matthias Krüger
Course frequency: each winter semester	**Duration:** 1 semester[s]
Number of repeat examinations permitted: three times	**Recommended semester:** 1
Maximum number of students: 80	

Georg-August-Universität Göttingen **Module M.Phy.5403: Seminar Classical-Quantum Connections in Theoretical Physics**	4 C 2 WLH
Learning outcome, core skills: After successful completion of the module students should be familiar with core concepts and mathematical methods that find use in the study of both classical and quantum systems. Students will be able to explore 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 Classical-Quantum Connections in Theoretical Physics	
Examination: Oral Presentation (approx. 45 minutes) **Examination prerequisites:** regular participation **Examination requirements:** Topics will typically include: Classical & quantum path integrals, diagrammatics and perturbation theory, universality and phase transitions, effective field theories and coarse graining, quantum versus classical fluctuations theorems, quantum-classical mappings (d to d+1 dim.)	4 C

Admission requirements: none	**Recommended previous knowledge:** Advanced statistical mechanics and quantum mechanics equivalent to modules: • *Advanced Statistical Physics* • *Advanced Quantum Mechanics*
Language: English	**Person responsible for module:** Prof. Dr. Steffen Schumann
Course frequency: every 4th semester; summer term	**Duration:** 1 semester[s]
Number of repeat examinations permitted: three times	**Recommended semester:** 2 - 4
Maximum number of students: 28	

Georg-August-Universität Göttingen **Module M.Phy.5404: Computational Quantum Many-Body Physics**	6 C 4 WLH
Learning outcome, core skills: **Lernziele**: After successful completion of the module students should be familiar with advanced computational methods for quantum many-body systems and their application to problems from condensed matter theory. **Kompetenzen**: Students are able to implement advanced computational algorithms for computational many-body physics and are familiar with the theory of the algorithms and standard applications.	**Workload:** Attendance time: 56 h Self-study time: 124 h

Course: Computational Many-Body Physics (Lecture)	4 WLH
Course: Computational Many-Body Physics (Exercise)	2 WLH
Examination: Oral exam (approx. 30 min.) or written exam (120 min.) and term paper (max. 5 pages)	6 C

Admission requirements: none	**Recommended previous knowledge:** basic knowledge of statistical mechanics of equilibrium and quantum mechanics, second quantization, advanced quantum mechanics
Language: English	**Person responsible for module:** Prof. Dr. Fabian Heidrich-Meisner
Course frequency: every 4th semester	**Duration:** 1 semester[s]
Number of repeat examinations permitted: three times	**Recommended semester:** 2
Maximum number of students: 30	

Georg-August-Universität Göttingen **Module M.Phy.5405: Non-equilibrium Statistical Physics**	6 C 6 WLH

Learning outcome, core skills: After successful completion of the module students will be able to understand advanced methods and concepts of non-equilibrium statistical physics to current research topics. Students will be able to describe and discuss state-of-the-art issues and problems in non-equilibrium statistical physics.	**Workload:** Attendance time: 84 h Self-study time: 96 h

Course: A course in the field of Non-equilibrium Statistical Physics	
Examination: Oral exam (approx. 30 min.) or written exam (120 min.) or presentation (approx. 30 min.) **Examination requirements:** Advanced topics in non-equilibrium statistical physics	6 C

Admission requirements: none	**Recommended previous knowledge:** Solid background in equilibrium and basic non-equilibrium statistical physics at the level of the module „Advanced Statistical Physics“
Language: English	**Person responsible for module:** Prof. Dr. Peter Sollich
Course frequency: every 4th semester	**Duration:** 1 semester[s]
Number of repeat examinations permitted: three times	**Recommended semester:** 1 - 4
Maximum number of students: 80	

Georg-August-Universität Göttingen Module M.Phy.5406: Current topics in theoretical physics	4 C 4 WLH
Learning outcome, core skills: After successful completion of the module students will be familiar with a range of advanced concepts and methods from modern theoretical physics. Students will be able to deploy advanced methods to analyse systems and models that are of interest to current theoretical physics research, covering topics from classical to quantum and from equilibrium to non-equilibrium systems.	**Workload:** Attendance time: 56 h Self-study time: 64 h
Course: Current topics in theoretical physics (Lecture)	
Examination: oral exam (approx. 30 Min.) or written report (max. 15 p.) **Examination prerequisites:** none **Examination requirements:** At least 2 topics from 4-6 lecture blocks (to be announced at the start of the lectures) will be assessed. Topics will be taken from soft condensed matter, theor. biophysics, statistical mech., cond. matter theory, quantum many-body physics, quantum field theory, particle physics, theor. astrophysics, complex systems modelling.	4 C

Admission requirements: none	**Recommended previous knowledge:** • *Advanced Statistical Physics* • *Advanced Quantum Mechanics*
Language: English	**Person responsible for module:** Prof. Laura Covi
Course frequency: every 4th semester; summer term	**Duration:** 1 semester[s]
Number of repeat examinations permitted: three times	**Recommended semester:** 2 - 4

Georg-August-Universität Göttingen **Module M.Phy.541: Advanced Topics in Classical Theoretical Physics I**	6 C 6 WLH

Learning outcome, core skills: **Learning outcome:** After successful completion of the modul students will be able to understand and apply advanced concepts of Classical Theoretical Physics to current research topics. **Core skills:** Students will be able to describe and discuss state-of-the-art problems of Classical Theoretical Physics.	**Workload:** Attendance time: 84 h Self-study time: 96 h

Course: A Course (6 C) in the field of Classical Theoretical Physics *Course frequency:* each semester	
Examination: Written examination (120 Min.) or oral examination approx. 30 Min.) or talk (approx. 30 Min.),2 weeks preparation time **Examination requirements:** Advanced techniques and models in Classical Theoretical Physics	6 C

Admission requirements: none	**Recommended previous knowledge:** none
Language: English, German	**Person responsible for module:** Prof. Dr. Peter Sollich
Course frequency: every 4th semester	**Duration:** 1 semester[s]
Number of repeat examinations permitted: three times	**Recommended semester:** 1 - 4
Maximum number of students: 40	

Georg-August-Universität Göttingen **Module M.Phy.542: Advanced Topics in Classical Theoretical Physics II**	6 C 4 WLH

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

Course: A Course (3 C) in the field of Classical Theoretical Physics *Course frequency:* each semester	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 techniques and models in Classical Theoretical Physics	3 C

Course: A Course (3 C) in the field of Classical Theoretical Physics *Course frequency:* each semester	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 techniques and models in Classical Theoretical Physics	3 C

Admission requirements: none	**Recommended previous knowledge:** none
Language: English, German	**Person responsible for module:** Prof. Dr. Peter Sollich
Course frequency: every 4th semester	**Duration:** 2 semester[s]
Number of repeat examinations permitted: three times	**Recommended semester:** 1 - 4
Maximum number of students: 40	

Georg-August-Universität Göttingen **Module M.Phy.543: Advanced Topics in Theoretical Quantum Physics I**	6 C 6 WLH

Learning outcome, core skills: **Learning outcome:** After successful completion of the modul students will be able to understand and apply advanced concepts of Theoretical Quantum Physics to current research topics. **Core skills:** Students will be able to describe and discuss state-of-the-art problems of Theoretical Quantum Physics .	**Workload:** Attendance time: 84 h Self-study time: 96 h

Course: A Course (6 C) in the field of Theoretical Quantum Physics *Course frequency:* each semester	
Examination: Written examination (120 Min.) or oral examination approx. 30 Min.) or talk (approx. 30 Min.),2 weeks preparation time **Examination requirements:** Advanced Advanced techniques and models in Theoretical Quantum Physics	6 C

Admission requirements: none	**Recommended previous knowledge:** none
Language: English, German	**Person responsible for module:** Prof. Dr. Stefan Kehrein
Course frequency: every 4th semester	**Duration:** 1 semester[s]
Number of repeat examinations permitted: three times	**Recommended semester:** 1 - 4
Maximum number of students: 40	

Georg-August-Universität Göttingen **Module M.Phy.544: Advanced Topics in Theoretical Quantum Physics II**	6 C 4 WLH

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

Course: A Course (3 C) in the field of Theoretical Quantum Physics *Course frequency:* each semester	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 techniques and models in Theoretical Quantum Physics	3 C

Course: A Course (3 C) in the field of Theoretical Quantum Physics *Course frequency:* each semester	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 techniques and models in Theoretical Quantum Physics	3 C

Admission requirements: none	**Recommended previous knowledge:** none
Language: English, German	**Person responsible for module:** Prof. Dr. Steffen Schumann
Course frequency: every 4th semester	**Duration:** 2 semester[s]
Number of repeat examinations permitted: three times	**Recommended semester:** 1 - 4
Maximum number of students: 40	

Georg-August-Universität Göttingen Module M.Phy.546: Seminar Advanced Topics in Theoretical Physics	4 C 2 WLH
Learning outcome, core skills: After successful completion of this module, students will 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 Theoretical Physics	
Examination: Lecture4 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: every 4th 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.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 in computing stellar models and solving oscillation eigenvalue problems.	**Workload:** Attendance time: 28 h Self-study time: 62 h

Course: Numerical experiments in stellar astrophysics (Lecture)	
Examination: Oral examination (approx. 30 minutes) **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: three 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: **Learning outcome:** After successful completion of the modul students will be able to understand and apply advanced concepts of astro- and geophysics to current research topics. **Core skills:** Students will be able to describe and discuss state-of-the-art problems of astro-/ 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	6 C

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: three 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: three 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 complex 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: Lecture4 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 ... • 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; • are able to deal with (English-language) literature; • are able to present an informatic topic; • are able to lead a scientific discussion.	**Workload:** Attendance time: 28 h Self-study time: 92 h
Course: Seminar (Seminar) *Course frequency:* each semester	
Examination: Presentation (approx. 45 Min.) with written report (max. 7 S.) **Examination prerequisites:** regular 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:** Prof. Dr. Florentin Andreas Wörgötter
Course frequency: each winter 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: three 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: three times	**Recommended semester:** 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.5609: Turbulence Meets Active Matter	4 C 4 WLH

Learning outcome, core skills: **Lernziele**: This course introduces elements from turbulence theory and active matter theory. In particular, we will focus on emergent behavior of active agents as well as their collective behavior in disordered environments such as turbulent flows. The essential background will be conveyed in introductory lectures. The major part of the course is dedicated to hands-on projects, in which we will address the following questions: What are the challenges in describing and predicting turbulent flows? How can simple mathematical rules give rise to large-scale order and emergent behavior? How can complex patterns emerge in non-equilibrium systems and how can we describe them mathematically? How does spatio-temporal disorder impact emergent behavior? As part of the projects, the students will set up and conduct numerical experiments in small groups. The progress of the individual projects will be discussed in weekly meetings. Finally, the students will present their findings at the end of the semester. **Kompetenzen:** The students gain an understanding of fundamental aspects of fluid mechanics and turbulence, agent-based models for collective behavior as well as elements of pattern formation. Furthermore, they acquire a basic understanding of numerical integration of partial differential equations, post-processing and statistical analysis of simulation data, and scientific visualization of simulation results.	**Workload:** Attendance time: 56 h Self-study time: 64 h

Course: Turbulence Meets Active Matter (Lecture)	2 WLH
Examination: Oral Presentation (approx. 45 minutes) **Examination prerequisites:** none **Examination requirements:** Understanding of the fundamentals taught in the fields of fluid physics and active matter, implementation of the acquired knowledge in accompanied research and programming projects, preparation of the presentation of the results and their classification in existing literature.	4 C

Course: Turbulence Meets Active Matter (Exercise)	2 WLH

Admission requirements: none	**Recommended previous knowledge:** Basic knowledge in mechanics and continuum mechanics, background in complex systems and stochastic processes
Language: English, German	**Person responsible for module:** Prof. Dr. Eberhard Bodenschatz
Course frequency: every 4th semester; Wintersemester	**Duration:** 1 semester[s]
Number of repeat examinations permitted: three times	**Recommended semester:** 1 - 4

Maximum number of students: not limited	

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: **Learning outcome:** After successful completion of the modul students will be able to understand and apply advanced concepts of Biophysics/Physics of complex systems to current research topics. **Core skills:** Students will be able to describe and discuss state-of-the-art problems of Biophysics/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 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: three times	**Recommended semester:** 1 - 4
Maximum number of students: 40	

<table>
<tr><td>Georg-August-Universität Göttingen
Module M.Phy.5610: X-ray Tomography for Students of Physics and Mathematics</td><td>3 C
2 WLH</td></tr>
<tr><td>Learning outcome, core skills:
Knowledge in:
• Principles of Radiography and Tomography
• Radiation Safety / Reconstruction Algorithms and practical Implementation of algorithms, testing of algorithms, cone beam reconstruction
• phase retrieval and phase contrast
• treatment of artefacts, filters
• quantitative assessment of image quality
• image segmentation
Taking the course students will be able to :
• operate laboratory equipment, perform tomographic alignment and to setup tomographic scans
• to reconstruct data based on Matlab toolbox (Salditt Group)
• to analyse data, perform segmentation</td><td>Workload:
Attendance time:
28 h
Self-study time:
62 h</td></tr>
<tr><td>Course: Course: X-ray Tomography
Contents:
• one week self-study in preparation based on tutorials and the textbook by Salditt/ Aspelmeier /Aeffner (De Gruyter 2017),
a full one week course with
• morning lectures including Matlab tutorials
• afternoon tomography practice in the laboratory using three different instruments (liquid metal jet, rotating anode, high energy),
• overnight scans
• Matlab-based reconstruction (Server IRP, Toolbox Salditt Group)</td><td></td></tr>
<tr><td>Examination: Oral examination (approx. 45 minutes)
Examination requirements:
• Presentation of a successful scan and reconstruction,
• oral discussion of the data and analysis</td><td>3 C</td></tr>
</table>

Admission requirements: none	**Recommended previous knowledge:** Electrodynamics, Matlab/Python
Language: English	**Person responsible for module:** Prof. Dr. Tim Salditt
Course frequency: each winter semester	**Duration:** 1 semester[s]
Number of repeat examinations permitted: three times	**Recommended semester:** 1 - 4
Maximum number of students:	

15	

Additional notes and regulations: 1 week in October before start of lectures. Partial overlap with Physicists’ tomography course.

<table>
<tr><td>Georg-August-Universität Göttingen
Modul M.Phy.5613: Vorlesung: Principles and Applications of Synchrotron and Free Electron Laser Radiation
English title: Lecture: Principles and Applications of Synchrotron and Free Electron Laser Radiation</td><td>3 C
4 SWS</td></tr>
<tr><td>Lernziele/Kompetenzen:
Lernziele:
Ziel der Lehrveranstaltung ist die enge Verknüpfung der Lehre auf dem Gebiet der Röntgenphysik mit der Arbeit an Großforschungseinrichtungen, insbesondere der Forschung im Bereich Photon Science bei DESY.
In der Vorlesung erhalten die Studierenden eine Einführung in die Forschung mit Synchrotronstrahlung und Strahlung von Freien Elektronen Lasern: Erzeugung der Strahlung und Charakteristika der Quellen, Grundlagen der Beschleunigerphysik, Experimentieraufbauten (Strahlrohre), Grundlagen der Röntgenbeugung und der Röntgenspektroskopie, Röntgenkurzzeitphysik.
Im Blockkursus erlernen sie die Anwendung röntgenphysikalischer Methoden (mit jährlich wechselnden Schwerpunkten): kohärente Abbildung, mathematische Beschreibung, Anwendungen in der Biophysik, Molekülphysik, Kristallographie, Kurzzeitphysik, etc. (jeweils als Einführung).
Kompetenzen:
Nach erfolgreichem Absolvieren des Moduls sollten die Studierenden...
• über fundamentales Wissen über die Prinzipien der Erzeugung von Synchrotronstrahlung und der Strahlung von Freien Elektronenlasern deren Anwendungen verfügen;
• Fähigkeiten in der mathematischen Beschreibung von Röntgenbeugung an ausgewählten, aktuellen Beispielen aus der Biophysik, Molekülphysik, Kristallographie etc. entwickelt haben.</td><td>Arbeitsaufwand:
Präsenzzeit:
88 Stunden
Selbststudium:
2 Stunden</td></tr>
<tr><td>Lehrveranstaltung: Vorlesung (Vorlesung)
Inhalte:
Einführung in die Forschung mit Synchrotronstrahlung und Strahlung von Freien Elektronen Lasern: Erzeugung der Strahlung und Charakteristika der Quellen, Grundlagen der Beschleunigerphysik, Experimentieraufbauten (Strahlrohre), Grundlagen der Röntgenbeugung und der Röntgen-spektroskopie, Röntgenkurzzeitphysik.</td><td>SWS</td></tr>
<tr><td>Lehrveranstaltung: Blockkurs Desy Campus, Hamburg (2,5 Tage)
Inhalte:
Einführung in die Anwendungen röntgenphysikalischer Methoden (mit jährlich wechselnden Schwerpunkten) unter Anwendung hochenergetischer Strahlung: Einführung in die kohärente Abbildung, mathematische Beschreibung der Röntgenbildgebung, Anwendungen in der Biophysik, Molekülphysik, Kristallographie, Kurzzeitphysik, etc.</td><td></td></tr>
<tr><td>Prüfung: Mündlich (ca. 45 Minuten)
Prüfungsvorleistungen:</td><td>3 C</td></tr>
</table>

Aktive Teilnahme **Prüfungsanforderungen:** Verständnis über die physikalischen Grundlagen der Forschung mit Synchrotronstrahlung und mit Strahlung von Freien Elektronen Lasern: Erzeugung der Strahlung und Charakteristika der Quellen, Grundlagen der Beschleunigerphysik, Experimentieraufbauten (Strahlrohre), Grundlagen der Röntgenbeugung, der Röntgenbildgebung und der Röntgenspektroskopie; Grundlagen der Röntgenkurzzeitphysik, Anwendung röntgenphysikalischer Methoden (mit jährlich wechselnden Schwerpunkten): kohärente Abbildung, mathematische Beschreibung, Anwendungen in der Biophysik, Molekülphysik, Kristallographie, Kurzzeitphysik, etc. (jeweils Einführung).	

Zugangsvoraussetzungen: keine	**Empfohlene Vorkenntnisse:** Einführung in die Röntgenphysik
Sprache: Englisch	**Modulverantwortliche[r]:** Prof. Dr. Simone Techert
Angebotshäufigkeit: jedes Wintersemester	**Dauer:** 1 Semester
Wiederholbarkeit: dreimalig	**Empfohlenes Fachsemester:** Master: 1 - 4
Maximale Studierendenzahl: 30	

Bemerkungen: Einbringbar in folgende Schwerpunkte: Biophysik/komplexe Systeme, Festkörper/Materialphysik

Georg-August-Universität Göttingen **Modul M.Phy.5614: Praktikum: Principles and Applications of Synchrotron and Free Electron Laser Radiation** *English title: Lab Course: Principles and Applications of Synchrotron and Free Electron Laser Radiation*	3 C 2 SWS

Lernziele/Kompetenzen: Lernziele: Ziel des Praktikums ist die enge Verknüpfung der praktisch orientierten Röntgenphysik-Hochschulausbildung mit der wissenschaftsorientierten, experimentellen Arbeit an Großforschungseinrichtungen, insbesondere der Forschung im Bereich Photon Science bei DESY. Im Blockpraktikum sollen die Studierenden ein praktisches Verständnis für komplexe Röntgenexperimente an Hochenergiestrahlungsquellen entwickeln, insbesondere an den (exemplarisch aufgelisteten) Strahlrohren P04, P08, P11, P24 des Speicherrings Petra III und der Strahlrohre PES und CAMP des Freien Elektronenlasers FLASH und FLASH II. Kompetenzen: Nach erfolgreichem Absolvieren des Moduls sollten die Studierenden... • experimentelle Fähigkeiten und Basiswissen in Röntgenexperimenten entwickelt haben an ausgewählten, wissenschaftlich aktuellen Beispielen aus der Biophysik, Molekülphysik, Kristallographie etc., • grundlegende experimentelle Expertise in Röntgenexperimenten an Hochenergiestrahlungsquellen erworben haben, u.a. auf dem Gebieten der Biophysik, Molekülphysik, Kristallographie, Kurzzeitphysik, etc.	**Arbeitsaufwand:** Präsenzzeit: 88 Stunden Selbststudium: 2 Stunden

Lehrveranstaltung: Einwöchiges Blockpraktikum am Desy *Inhalte*: Inhalte: Erlangung von experimentellen Fähigkeiten und Expertise von komplexen Röntgenexperimenten mit Hochenergiestrahlungsquellen; tieferes Verständnis von Röntgensynchrotron-Strahlungs-Experimente exemplarisch an Experimenten der Strahlrohre P04, P08, P11 oder P24 des Speicherrings Petra III und der Strahlrohre PES und CAMP des Freien Elektronenlasers FLASH oder FLASH II (wechselnde Schwerpunkte); Einführung in die Praxis röntgenphysikalischer: kohärente Abbildung, mathematische Beschreibung, Anwendungen in der Biophysik, Molekülphysik, Kristallographie, Kurzzeitphysik, etc.	2 SWS
Prüfung: Mündlich (ca. 45 Minuten) **Prüfungsvorleistungen:** Aktive Teilnahme **Prüfungsanforderungen:** Vorliegendes Protokoll zum Blockpraktikum mit eigenständig erarbeitetem Auswerteinhalt (Einführungsniveau). Grundlegende Kenntnisse zu Experimenten mit Synchrotronstrahlung und Strahlung von Freien Elektronen Lasern. Exemplarisch: Grundlegendes Verständnis an aktueller	3 C

Beispiele von Röntgenexperimenten aus den Gebieten der Biophysik, Molekülphysik, Biophysik, Molekülphysik, Kristallographie, Kurzzeitphysik, etc. (je nach Praktikumort an P04, P08, P11 oder P24 des Speicherrings Petra III und der Strahlrohre PES und CAMP des Freien Elektronenlasers FLASH oder FLASH II). Nachweis experimenteller Fähigkeiten, Nachweis von mathematische Expertise (weitreichendere Grundlagen) zur Auswertung von Röntgenexperimenten, Reflektion der durchgeführten Experimente.	

Zugangsvoraussetzungen: keine	**Empfohlene Vorkenntnisse:** Einführung in die Röntgenphysik
Sprache: Englisch	**Modulverantwortliche[r]:** Prof. Dr. Simone Techert
Angebotshäufigkeit: jedes Wintersemester	**Dauer:** 1 Semester
Wiederholbarkeit: dreimalig	**Empfohlenes Fachsemester:** Master: 1 - 4
Maximale Studierendenzahl: 10	

Bemerkungen: Einbringbar in folgende Schwerpunkte: Biophysik/komplexe Systeme, Festkörper/Materialphysik

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: three 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: Lecture4 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
Course: Lecture	4 WLH
Examination: written exam (90 min.) or oral exam (approx. 30 min.) **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
Course: Exercises	2 WLH

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: three times	**Recommended semester:** Master: 2 - 3
Maximum number of students: 40	

Georg-August-Universität Göttingen **Modul M.Phy.5703: Materialforschung mit Elektronen** *English title: Materials research with electrons*	6 C 4 SWS

Lernziele/Kompetenzen: Nach erfolgreichem Absolvieren des Moduls sollten die Studierenden die grundlegenden elektronenoptischen und spektroskopischen Methoden kennen und in der Auswertung von Untersuchungsergebnissen anwenden können.	**Arbeitsaufwand:** Präsenzzeit: 56 Stunden Selbststudium: 124 Stunden

Lehrveranstaltung: Vorlesung mit Seminar	

Von den folgenden Prüfungen ist genau eine erfolgreich zu absolvieren:	
Prüfung: Mündlich (ca. 30 Minuten)	6 C
Prüfung: Vortrag (ca. 60 Minuten) **Prüfungsvorleistungen:** Aktive Teilnahme im Seminar	6 C

Prüfungsanforderungen: Kenntnisse grundlegender elektronenoptischer und –spektroskopischer Methoden und ihrer praktischen Anwendung auf materialphysikalische Fragestellungen Grundlagen der Transmissionselektronenmikroskopie, Wechselwirkung von Elektronen mit Materialien, Elektronenbeugung, Hochauflösung, Rastertransmissionselektronenmikroskopie Analytische Methoden wie EDX und EELS, In-situ Verfahren, Dynamische und ultraschnelle Elektronenmikroskopie.	

Zugangsvoraussetzungen: keine	**Empfohlene Vorkenntnisse:** Quantenmechanik I Einführung in die Materialphysik Einführung in die Festkörperphysik
Sprache: Deutsch	**Modulverantwortliche[r]:** StudiendekanIn der Fakultät für Physik
Angebotshäufigkeit: 2jährig (SoSe)	**Dauer:** 1 Semester
Wiederholbarkeit: dreimalig	**Empfohlenes Fachsemester:** Master: 1 - 3
Maximale Studierendenzahl: 25	

Georg-August-Universität Göttingen **Module M.Phy.5705: Materials Physics I: Microstructure-Property-Relations**	4 C 3 WLH
Learning outcome, core skills: AAfter successful completion of this Module, the student will have obtained an overview about the realistic structure of materials (realistic = including defects and irregularities). Inaddition, a deepened understanding of the relation between micro-structure andfundamental material properties will have been gained via the discussion of theoreticalmodels and experimental results.	**Workload:** Attendance time: 42 h Self-study time: 78 h
Course: Materials Physics I: Microstructure-Property-Relations *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:** At least 50% of the homework problems need to be solved correctly. **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: three 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: Materials Physics II: Kinetics and Phase Transformations *Contents*: Fundamentals and specific examples of the behavior of condensed mattersystems in non-equilibrium situations.	
Examination: Presentation (approximately 30 minutes) or written exam (120 minutes) or oral examination (approximately 30 minutes) **Examination prerequisites:** At least 50% of the homework problems need to be solved correctly. **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: three 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: 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.	**Workload:** 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: three times	**Recommended semester:** Master: 1 - 4
Maximum number of students: 30	

Georg-August-Universität Göttingen Module M.Phy.5708: Physics of Semiconductor Devices	4 C 2 WLH
Learning outcome, core skills: After successful completion of this module the students will be able to understand basic and advanced concepts of the physics of electronic and opto-electronic semiconductor devices.	**Workload:** Attendance time: 28 h Self-study time: 92 h
Course: Physics of Semiconductor Devices (Lecture with seminar)	2 WLH
Examination: Oral examination (approx. 45 minutes) **Examination prerequisites:** active participation in seminar **Examination requirements:** Basic and advanced concepts of the physics of semiconductors and their devices.	4 C

Admission requirements: none	**Recommended previous knowledge:** Einführung in die Festkörperphysik, Solid State Physics II
Language: English	**Person responsible for module:** apl. Prof. Dr. Michael Seibt
Course frequency: each winter semester	**Duration:** 1 semester[s]
Number of repeat examinations permitted: three times	**Recommended semester:** 1 - 3
Maximum number of students: 20	

Georg-August-Universität Göttingen **Module M.Phy.5709: Physics of Semiconductors**	3 C 2 WLH

Learning outcome, core skills: After successful completion of this module the students will be able to understand basic and advanced concepts of the physics of semiconductors and their devices with emphasis on: • **electronic transport** • **doping** • **electronic states** • **optical properties** • **semiconductor junctions** • **nanostructures**	**Workload:** Attendance time: 28 h Self-study time: 62 h

Course: Physics of Semiconductors (Lecture)	
Examination: Oral examination (approx. 30 minutes) **Examination requirements:** Basic and advanced concepts of the physics of semiconductors.	3 C

Admission requirements: none	**Recommended previous knowledge:** Einführung in die Festkörperphysik, Solid State Physics II
Language: English	**Person responsible for module:** apl. Prof. Dr. Michael Seibt
Course frequency: each winter semester	**Duration:** 1 semester[s]
Number of repeat examinations permitted: three times	**Recommended semester:** 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: **Learning outcome:** After successful completion of the modul students will be able to understand and apply advanced concepts of Solid State/Materials Physics to current research topics. **Core skills:** Students will be able to describe and discuss state-of-the-art problems 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	6 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: three times	**Recommended semester:** Master: 1 - 4
Maximum number of students: 40	

Georg-August-Universität Göttingen Module M.Phy.5710: Physics of Semiconductors and Semiconductor Devices	6 C 4 WLH
Learning outcome, core skills: After successful completion of this module the students will be able to understand basic and advanced concepts of the physics of semiconductors and their devices with emphasis on: • electronic transport • doping • electronic states • optical properties • semiconductor junctions • nanostructures • physics of electronic and opto-electronic devices	**Workload:** Attendance time: 56 h Self-study time: 124 h
Course: Physics of Semiconductors and Semiconductor Devices (Lecture with seminar) (Lecture, Seminar)	4 WLH
Examination: Presentation (approx. 60 min.) or oral examination (approx. 30 min.) **Examination prerequisites:** regular attendance in seminar **Examination requirements:** Basic and advanced concepts of the physics of semiconductors and their devices.	6 C

Admission requirements: none	**Recommended previous knowledge:** Einführung in die Festkörperphysik, Solid State Physics II
Language: English	**Person responsible for module:** apl. Prof. Dr. Michael Seibt
Course frequency: each winter semester	**Duration:** 1 semester[s]
Number of repeat examinations permitted: three times	**Recommended semester:** 1 - 4
Maximum number of students: 20	

Georg-August-Universität Göttingen **Module M.Phy.5711: Surface Physics**	3 C 2 WLH

Learning outcome, core skills:	**Workload:**
Learning outcome: After having successfully completed the module students should understand the fundamental concepts of the rapidly evolving field of surface physics. They should be able to transfer this knowledge to other areas like the physics of nanostructures and interfaces. More specifically, the students will have basic knowledge in the following topics: 1. Geometry of surfaces (e.g. relaxation, reconstruction, Wood's notation) 2. Electronic states of surfaces (e.g. surface states, projected band structure) 3. Processes at surfaces (e.g. adsorption, growth, diffusion) 4. Preparation and analysis of surfaces (e.g. UHV techniques, STM, LEED, PES) 5. Surface Excitations (e.g. surface phonons, surface plasmons) 6. Interfaces, Nanostructures **Core skills:** The students will have a fundamental understanding of the general structural and electronic properties of solid state surfaces. They will have a basic knowledge of current surface preparation and surface analysis methods.	Attendance time: 28 h Self-study time: 62 h

Course: Surface Physics (Lecture)	
Examination: Oral examination (approx. 30 minutes) **Examination requirements:** Basic knowledge and understanding of surface physics, i.e. atomic and electronic structure of solid surfaces including concepts like e.g. reconstruction, surface states, surface phonons, adsorption, experimental methods.	3 C

Admission requirements: none	**Recommended previous knowledge:** B.Phy.1521: Introduction to Solid State Physics
Language: English, German	**Person responsible for module:** Prof. Dr. Martin Wenderoth
Course frequency: every 4th semester	**Duration:** 1 semester[s]
Number of repeat examinations permitted: three times	**Recommended semester:** 1 - 4
Maximum number of students: 30	

Georg-August-Universität Göttingen **Module M.Phy.5712: Topology in Condensed Matter Physics**	6 C 6 WLH
Learning outcome, core skills: After a successful completion of the course, the students will be familiar with the basic concepts and properties of topological states of matter in condensed matter physics and representative examples.	**Workload:** Attendance time: 84 h Self-study time: 96 h
Course: Topology in Condensed Matter Physics (Lecture)	4 WLH
Examination: Written or oral examWritten exam (120 min.) or oral exam (ca. 30 min.) - determination of exam type: see UniVZ **Examination requirements:** Basic concepts of topological states of matter in condensed matter physics and knowledge and understanding of representative examples.	6 C
Course: Topology in Condensed Matter Physics (Exercise)	2 WLH

Admission requirements: none	**Recommended previous knowledge:** • Solid State Physics, • Introduction to Solid State Theory, • Quantum mechanics I
Language: English	**Person responsible for module:** Prof. Dr. Fabian Heidrich-Meisner
Course frequency: every 4th semester	**Duration:** 1 semester[s]
Number of repeat examinations permitted: three times	**Recommended semester:** 1 - 4
Maximum number of students: 30	

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: three 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: Lecture4 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 bfamiliar 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: Detectors for particle physics and imaging	
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: three 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: 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. 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
Course: Tutorial Simulation methods for theoretical particle physics	1 WLH
Course: Lecture Simulation methods for theoretical particle physics (Lecture)	2 WLH
Examination: Written exam (30 Min.) or oral exam (approx. 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:** Prof. Dr. Steffen Schumann
Course frequency: every 4th semester	**Duration:** 1 semester[s]
Number of repeat examinations permitted: three 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. 45 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: three times	**Recommended semester:** Master: 1 - 3
Maximum number of students: not limited	

Georg-August-Universität Göttingen **Module M.Phy.581: Advanced Topics in Nuclear and Particle Physics I**	6 C 6 WLH
Learning outcome, core skills: **Learning outcome:** After successful completion of the modul students will be able to understand and apply advanced concepts of Nuclear and Particle Physics to current research topics. **Core skills:** Students will be able to describe and discuss state-of-the-art problems of Nuclear and Particle Physics.	**Workload:** Attendance time: 84 h Self-study time: 96 h
Course: A Course (6 C) in the field of Nuclear and 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 Nuclear and 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: three times	**Recommended semester:** 1 - 4
Maximum number of students: 40	

Georg-August-Universität Göttingen **Module M.Phy.5810: Physics and Applications of Ion solid interaction**	6 C 6 WLH
Learning outcome, core skills: After successful completion of the module students should be familiar with theoretical background and advanced concepts of ion solid interaction, electronic and nuclear energy loss, thermal spikes, ion sputtering, ion beam analysis techniques, ion implantation, ion accelerators and ion sources, simulation of ion solid interaction, ion induced surface pattern formation, ion microscopy and focused ion beam techniques.	**Workload:** Attendance time: 84 h Self-study time: 96 h
Course: Physics and Applications of Ion solid interaction in the field of Solid State/Materials Physics (Lecture)	4 WLH
Course: Practical lab excercises Physics and Applications of Ion solid interaction in the field of Solid State/Materials Physics	2 WLH
Examination: Oral examination (approx. 30 minutes) **Examination requirements:** Advanced experimental techniques and theoretical models in ion-solid interaction	6 C

Admission requirements: none	**Recommended previous knowledge:** Introduction to solid state physics
Language: English, German	**Person responsible for module:** Prof. Dr. Hans Christian Hofsäss
Course frequency: each summer semester	**Duration:** 1 semester[s]
Number of repeat examinations permitted: three times	**Recommended semester:** 1 - 4
Maximum number of students: 40	

Georg-August-Universität Göttingen **Module M.Phy.5811: Nuclear Solid State Physics**	4 C 2 WLH
Learning outcome, core skills: After successful completion of the module students should be familiar with the physics of hyperfine interactions and interaction of nuclear moments with external magnetic and electric fields, Mössbauer spectroscopy and perturbed angular correlation of gamma radiation, nuclear magnetic resonance techniques, myon spin rotation, positron annihilation spectroscopy, neutron scattering and electron emission channeling.	**Workload:** Attendance time: 28 h Self-study time: 92 h
Course: Nuclear solid state physics in the field of Nuclear and Particle Physics and/or Solid State and Materials Physics (Lecture)	4 WLH
Course: Exercises in the field of Nuclear and Particle Physics and/or Solid State and Materials Physics (Exercise)	2 WLH
Examination: Oral examination (approx. 30 minutes) **Examination requirements:** Nuclear solid state physics concepts and techniques, physics of hyper fine interactions, interaction of neutrons with matter, physics of nuclear resonance techniques, application of positrons, myons and decay electrons to materials characterization.	4 C

Admission requirements: none	**Recommended previous knowledge:** Introduction to nuclear and particle physics Introduction to solid state physics
Language: English, German	**Person responsible for module:** Prof. Dr. Hans Christian Hofsäss
Course frequency: each winter semester	**Duration:** 1 semester[s]
Number of repeat examinations permitted: three times	**Recommended semester:** 1 - 4
Maximum number of students: 20	

Georg-August-Universität Göttingen **Module M.Phy.582: Advanced Topics in Nuclear and 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 Nuclear and Particle Physics	**Workload:** Attendance time: 56 h Self-study time: 124 h

Course: A Course (3 C) in the field of Nuclear and 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 Nuclear and Particle Physics	3 C

Course: A Course (3 C) in the field of Nuclear and 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 Nuclear and 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: three times	**Recommended semester:** 1 - 4
Maximum number of students: 40	

Georg-August-Universität Göttingen **Module M.Phy.586: Seminar Advanced Topics in Nuclear and 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 Nuclear and Particle Physics	
Examination: Lecture4 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.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
Course: Workshop	1 WLH
Course: 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: three times	**Recommended semester:** 1 - 4
Maximum number of students: not limited	