

**Modulbezeichnung:** **Advanced theoretical physics: Solid state physics (TV-B)** **10 ECTS**  
(Advanced theoretical physics: Solid state physics)

Modulverantwortliche/r: Martin Eckstein

Lehrende: Martin Eckstein, Dozenten der theoretischen Physik

Startsemester: SS 2020

Dauer: 1 semester

Turnus: jährlich (SS)

Präsenzzeit: 105 Std.

Eigenstudium: 195 Std.

Sprache: Englisch

### Lehrveranstaltungen:

Advanced theoretical physics: Solid state physics (SS 2020, Vorlesung, 4 SWS, Martin Eckstein)

Advanced theoretical physics: Solid state physics (Exercise class) (SS 2020, Übung, 3 SWS, Martin Eckstein et al.)

### Inhalt:

#### Contents:

- **Structure of solids**

Bravais lattices, reciprocal lattice, Brillouin zone

- **The solid as a many-body problem**

Hamiltonian of a solid, electron-electron interaction, electron-ion interaction, separation of electronic and ionic motion (Born-Oppenheimer approximation), types of bonding

- **Lattice dynamics: Phonons**

Harmonic approximation, classical solution, dispersion relation, acoustic and optical modes, Debye and Einstein model, quantum theory of lattice vibrations, phonons, density of states, van Hove singularities, thermal properties, anharmonic effects

- **Electrons in a periodic potential**

Bloch theorem, band structure, nearly free electrons, tight-binding method, Wannier functions, metals, insulators, semiconductors, density of states, Fermi surface, quantum statistics, thermal properties, Fermi distribution

- **Electron-electron interaction**

Hartree-Fock method, density functional theory, homogeneous electron gas

- **Topics of current research**

### Lernziele und Kompetenzen:

#### Learning goals and competences:

Students

- comprehend, outline and explain the theory of structure and many-body properties of solids, phonons, electrons in a periodic potential and their interaction as well as transport theory
- apply the methods of advanced theoretical solid-state physics to specific problems

### Literatur:

#### Literature:

- U. Rössler, Solid State Theory: An Introduction
- G. Czycholl, Theoretische Festkörperphysik
- N.W. Ashcroft, N.D. Mermin, Solid State Physics
- L. Kantorovich, Quantum Theory of the Solid State: An Introduction
- C. Kittel, Quantum Theory of Solids
- J.M. Ziman, Principles of the theory of solids

### Verwendbarkeit des Moduls / Einpassung in den Musterstudienplan:

Das Modul ist im Kontext der folgenden Studienfächer/Vertiefungsrichtungen verwendbar:

[1] **Physics (Master of Science)**

(Po-Vers. 2018w | NatFak | Physics (Master of Science) | Gesamtkonto | Advanced theoretical physics)

Dieses Modul ist daneben auch in den Studienfächern "Materials Physics (Master of Science)" verwendbar.

### Studien-/Prüfungsleistungen:

Advanced theoretical physics 2: Solid state physics (Prüfungsnummer: 69611)

(englische Bezeichnung: Advanced theoretical physics 2: Solid state physics)

Prüfungsleistung, Klausur, Dauer (in Minuten): 120

Anteil an der Berechnung der Modulnote: 100% Prüfungssprache: Englisch

Erstablingung: SS 2020, 1. Wdh.: SS 2020 (nur für Wiederholer)

1. Prüfer: Martin Eckstein (060608)

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**Bemerkungen:**

May be applied to specialisation 'Theoretical physics' or 'Condensed matter physics' in the physics master program starting winter term 2018/19.