Solid State Physics I

Vorlesung / Lectures: Wednesdays 13h00 – 14h45 & Fridays 10h00 – 11h45
https://www.uzh.ch/cmsssl/physik/de/lehre/PHY210/FS2018.html
Raum / Room: see webpage

Johan Chang
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Übungen / Exercise class: Approximately Every Second Friday
Raum / Room: see webpage

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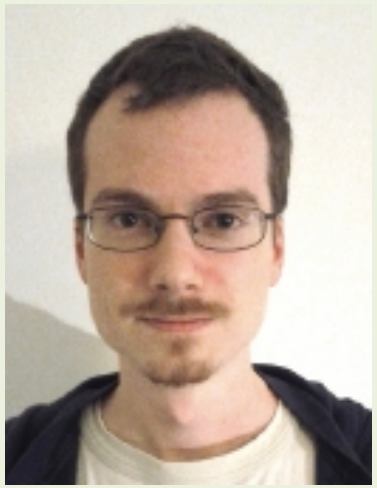


This Weeks Program

Today

- Introduction
- Motivation: Why is condensed matter interesting?
- How are we going to do this course?
- Tasks for Friday

Friday

- 5 min. Student presentation
- Crystal Structures: Lego of condensed matter.
- Your tasks for next week.

Why is Condensed Matter interesting?

1. It makes us understand basic materials in nature.

2. It is useful!

3. It is anti-reductionistic: Many-body concepts needed

Examples of condensed matter

Material?

Optical property?

Electrical property?

Heat conduction?

Examples of condensed matter

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Optical property?

Electrical property?

Heat conduction?

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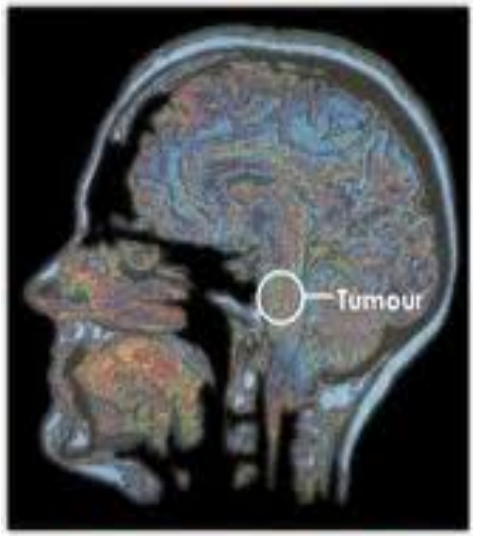
Historical periods

Bronze age

Iron age

Silicon age

Conducting Materials



An MRI Scan of Human Brain

Conductors

Copper

Semi-conductors

Silicon

Super-conductors

Nb_3Sn

Interesting Material Properties

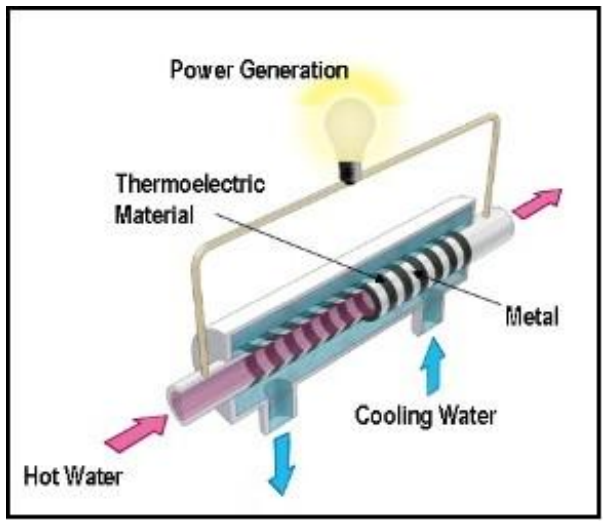
Superconductivity

http://www.ccas-web.org/superconductivity/renewableenergy/

Smart Insulators

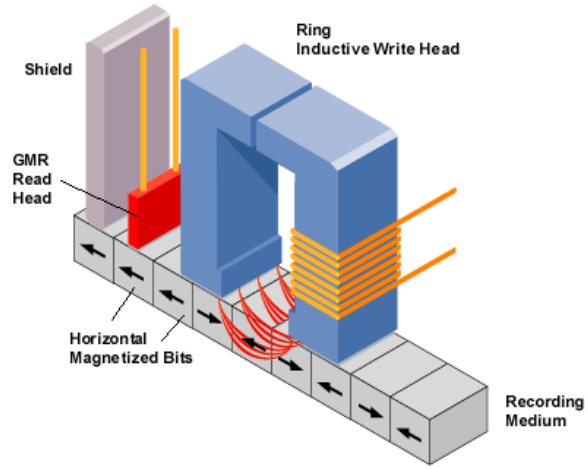
http://phys.org/news/2012-09-intelligent-windows-future.html

Thermoelectricity



http://www.green-energy-news.com/arch/nrgs2011/20110051.html

Magneto-resistance



http://www.yourdictionary.com/magnetoresistance

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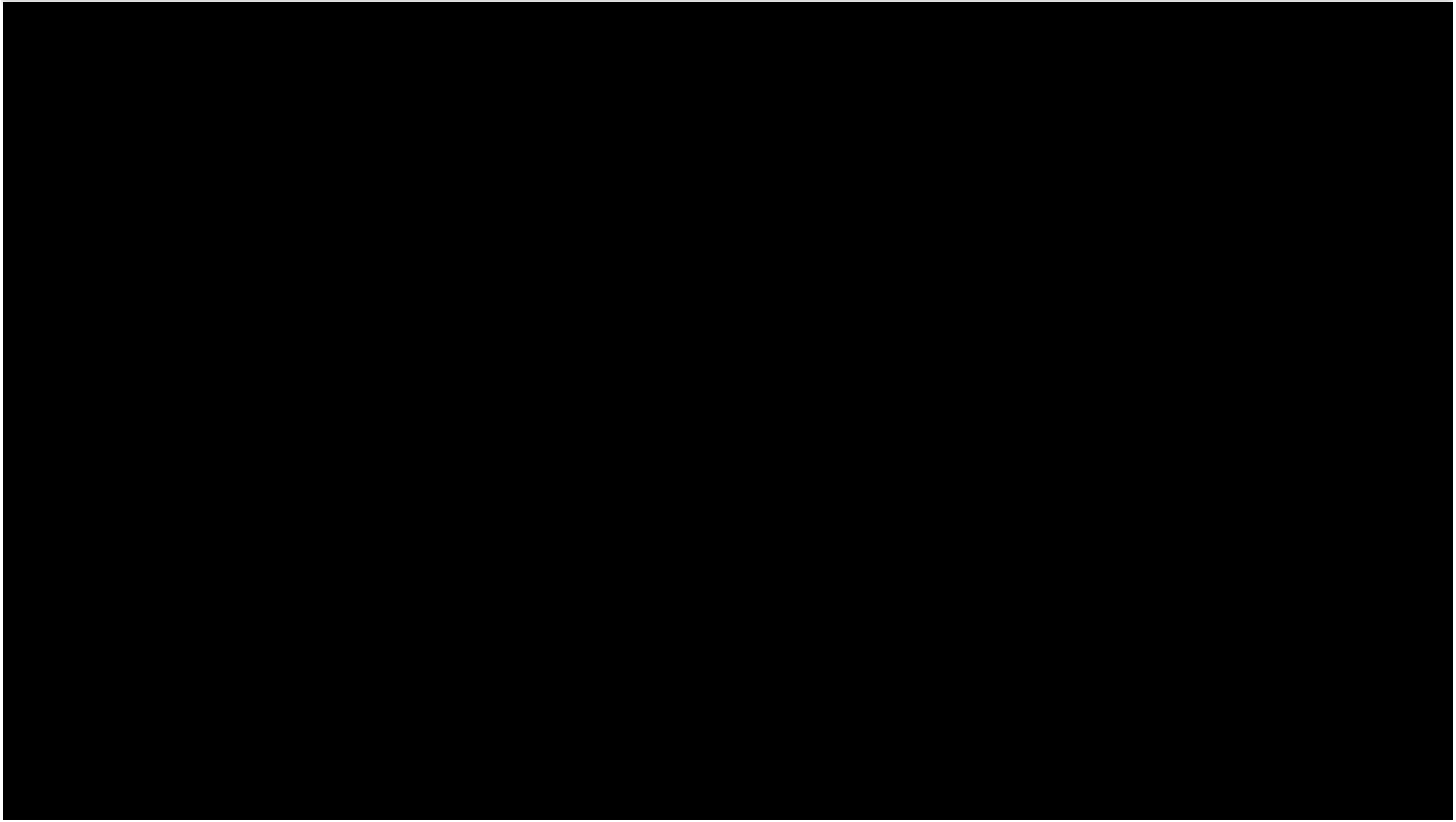
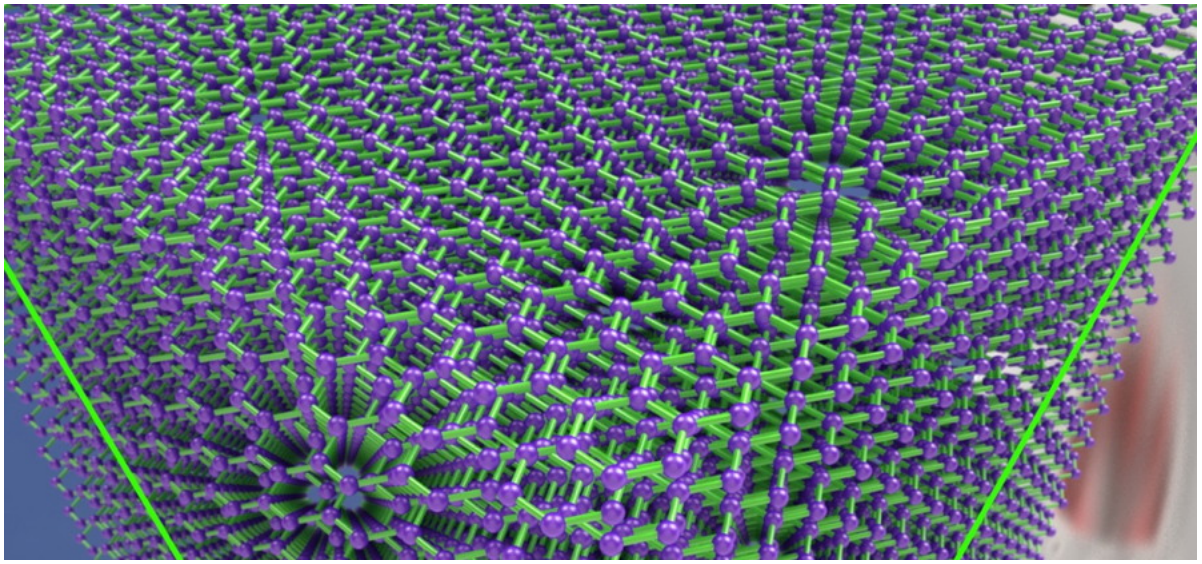
Migrating Birds

Schwarze Sonne



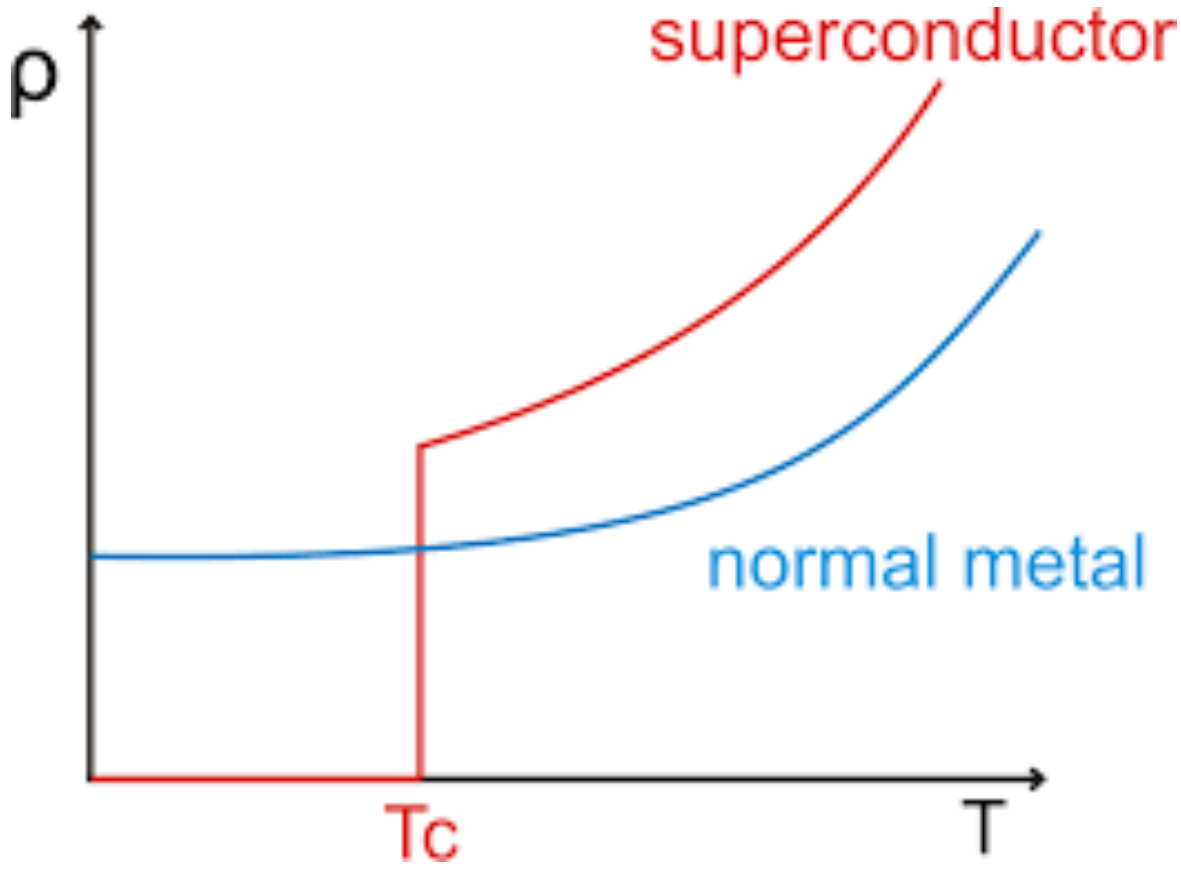
Many-Body Physics

http://web.physics.ucsb.edu/~weld/



http://web.physics.ucsb.edu/~weld/

Example: Superconductivity



This Weeks Program

Today

- Introduction
- Motivation: Why is condensed matter interesting?
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- Crystal Structures: Lego of condensed matter.
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New study plan.

Possibility – Next PHY210 Fall 2019

Implications:

(a) If you wish to finish the bachelor before end 2019 the course should be taken this semester

(b) It would be useful if as many as possible accomplish the course this semester.

Course Content

I. Crystal structures

II. Structures in reciprocal space

III. Crystal bindings

IV. Crystal vibrations

Crystal structures and Lattice Vibrations

VI. Free electron gasses

VII. Electronic band structure

VIII. Semiconductors

Electronic properties

#		Title	C - index
1	21.2	Introduction	**2-3**
2	23.2	Crystal structures	**4**
3	28.2	Crystal structures + Reciprocal space	**6**
4	2.03	Exercise	
5	7.03	Reciprocal space	**7**
6	9.03	Scattering theory	**8-9**
7	14.03	Scattering theory	**8-9**
8	16.03	Exercise	
9	21.03	Crystal bindings	**5-6**
10	23.03	Phonons	**7**
11	28.03	Phonons	**7**
12	11.04	Thermal properties	**7**
13	13.04	Exercise	
14	18.04	Electron gasses	**6-7**
15	20.04	Specific heat	**6**
16	25.04	Thermal conductivity	**6**
17	27.04	Exercise	
18	02.05	Electronic band structure	**7**
19	04.05	Fermi surfaces	**8-9**
20	09.05	Magneto-transport	**7**
21	11.05	Exercise	
22	16.05	Tight – binding	**7**
23	18.05	Semi-conductors	**7**
24	23.05	Semi-conductors	**7**
25	25.05	Exercise	
26	30.05	Repetition	**4**
28	01.06	Repetition	**4**

Teaching principle:

Constructive Alignment

Goals:

- Understanding of concepts
- General knowledge of condensed matter
- Develop problem solving skills

Exam:

- Testing understanding of concepts
- Testing general knowledge
- Testing problem solving skills

Course Evaluation (Exam)

Exam structure:

(1) 10 min student presentation of 1 one out of 8 pre-defined topics

(2) 10 min discussion of one of the exercises

(3) 10 min questions spread over the material covered during the lecture

Exam Purpose:

(1) Testing understanding of concepts.

(2) Testing problem solving skills.

(3) Testing general knowledge.

Most likely exam dates: To-be-announce

Teaching principle:

Constructive Alignment

Goals:

- Understanding of concepts
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- Develop problem solving skills

Exam:

- Testing understanding of concepts
- Testing general knowledge
- Testing problem solving skills

Activities:

- Lectures
- Exercise classes
- Student presentations
- Home studies

Exercise Class

- Hand in the exercises on their due date.

- Exercise class is mandatory. Write to Stefan, Denys, and Daniel in case of justified absence.

- You need at least 60% of points to qualify for the exam.

- Exam questions can be related to exercises.

- Students are presenting solutions during the exercise class.

Lectures: Student presentation

Every lecture has 1-2 student presentations (5-10 min)

A. Summary presentation (Beginning of each lecture)

B. Perspective presentation

C. Derivation presentation

Practical information

Solid State Physics course + Praktikum = 8 ETCS points

Final grade = 3/4 and 1/4 weighted average

30 ETCS points per semester $\Longrightarrow$ 8 ETCS points $\approx$ 8-9 hours per week

Proposed work-load distribution

Lectures + Ex. Class	Reading / Studying	Solve Exercises
4 hours	~2 hours	~2 hours

Strategy / Advice

(1) Solve the exercises your self.

(2) Read and study continuously

(3) Be active during the lecture and exercise class

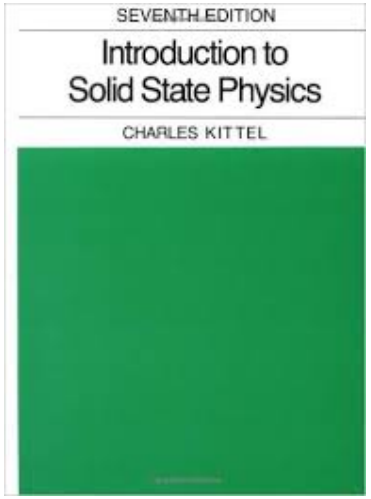
Computer - Exercises

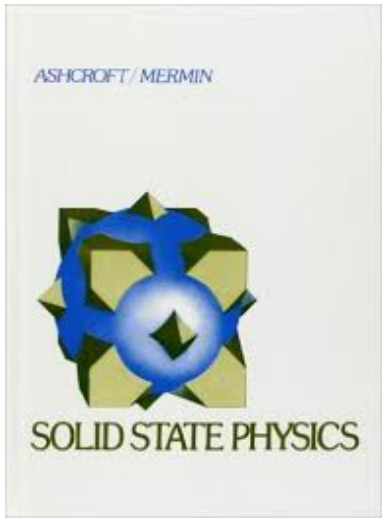
Crystal structure visualization - VESTA

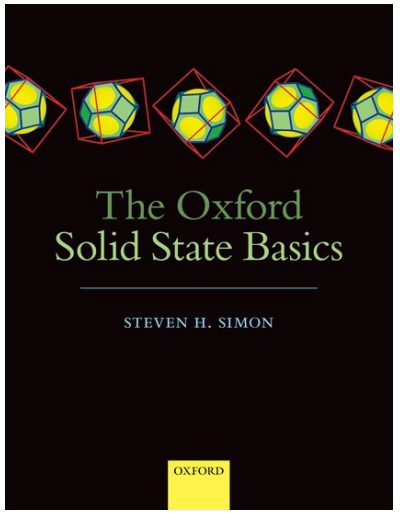
Analytical Computation – Mathematica or Maple

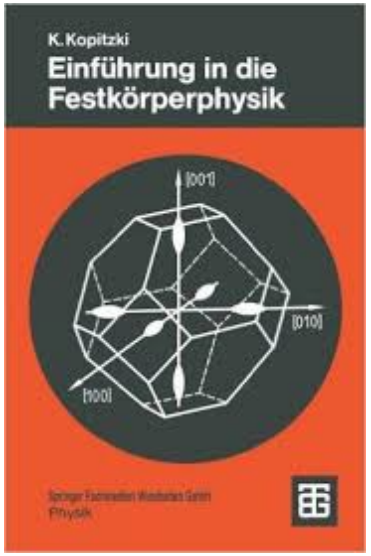
Numerical calculations – Matlab or Python

Literature

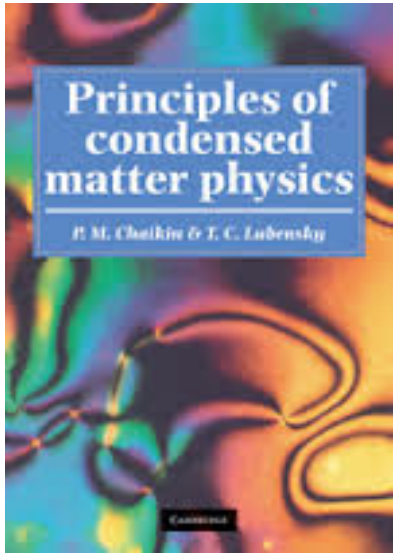

SEVENTH EDITION
Introduction to
Solid State Physics
CHARLES KITTEL


ASHCROFT / MERMIN
SOLID STATE PHYSICS


The Oxford
Solid State Basics
STEVEN H. SIMON
OXFORD


K. Kopitzki
Einführung in die
Festkörperphysik


K.-H. Hellwege
Einführung
in die
Festkörperphysik
Springer-Verlag
Berlin Heidelberg New York


Principles of
condensed
matter physics
P. M. Chaikin & T. C. Lubensky

Your task for this week

1. **Read chapter 1 of Kittel.**

2. **Checkout the exercise sheet on the course webpage.**

3. **Install the VESTA program on your labtop.**
http://jp-minerals.org/vesta/en/download.html

Crystals found in the Swiss Alps

Quartz found in the Swiss Alps

https://www.pinterest.com/pin/157485318197523216/

Crystals found in the Swiss Alps

Pink calcite

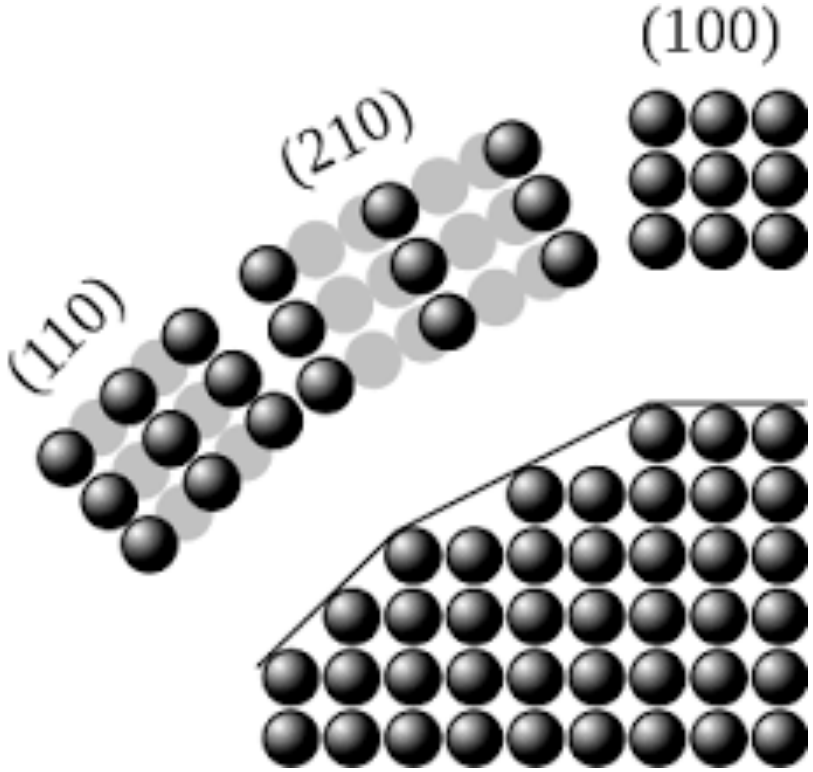
Topaz

Ice crystals

Cinnabar

Metals found in nature

How are crystals / materials build?



Crystal structures