Solid State Physics I

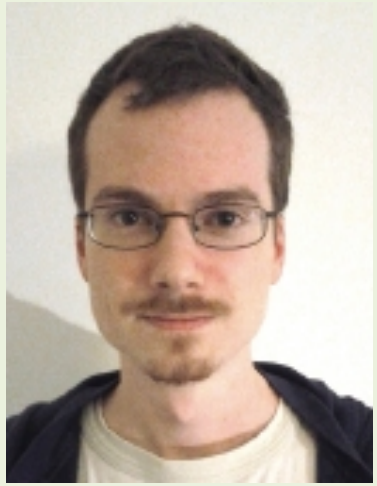
Vorlesung / Lectures: Wednesday 13h00 – 15h45
Raum / Room: Y36-K-08
https://www.uzh.ch/cmsssl/physik/de/lehre/PHY210/FS2017.html

Johan Chang
johan.chang@physik.uzh.ch

Übungen / Exercise class: Wednesday 16h00 – 17h00
Raum / Room: Y36-K-08

Daniel Destraz
destraz@physik.uzh.ch

Stefan Holenstein
stefan.holenstein@psi.ch



Todays Program

1. Motivation - why is condensed matter interesting?
2. How are we going to do this course?
3. Lego of condensed matter.
4. Your tasks for next week.
5. Exercise class

Why is Condensed Matter interesting?

1. It makes understand basic materials in nature.

2. It is useful!

3. It is anti-reductionistic

4. Play-ground for many-body concepts

Examples of condensed matter

Material?

Optical property?

Electrical property?

Heat conduction?

Examples of condensed matter

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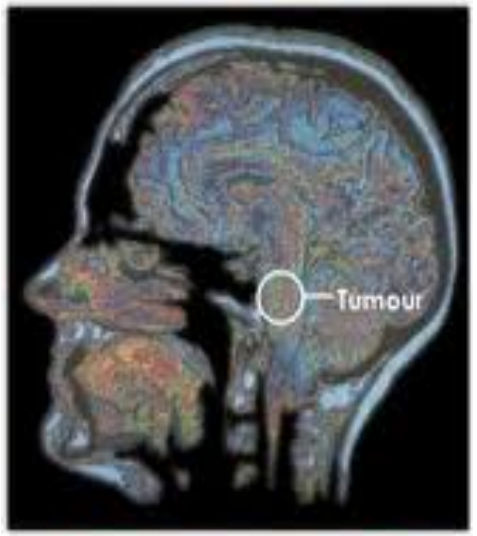
Historical periods

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

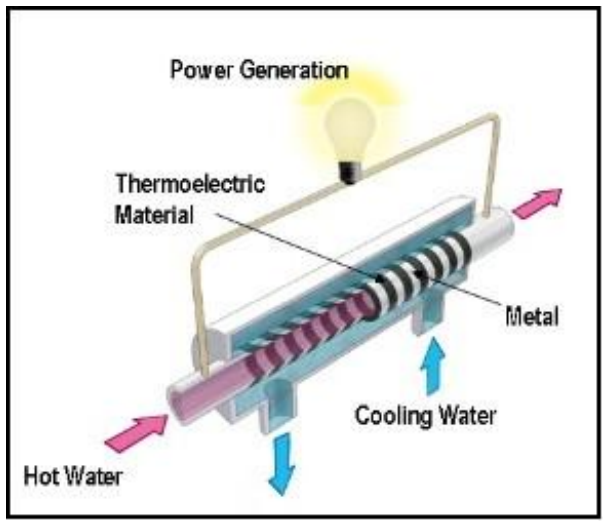
Superconductivity

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

Smart Insulators

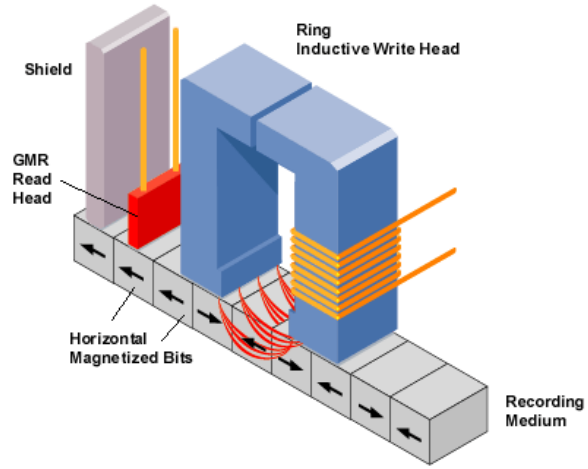
http://phys.org/news/2012-09-intelligent-windows-future.html

Thermoelectricity



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

Magneto-resistance



http://www.yourdictionary.com/magnetoresistance

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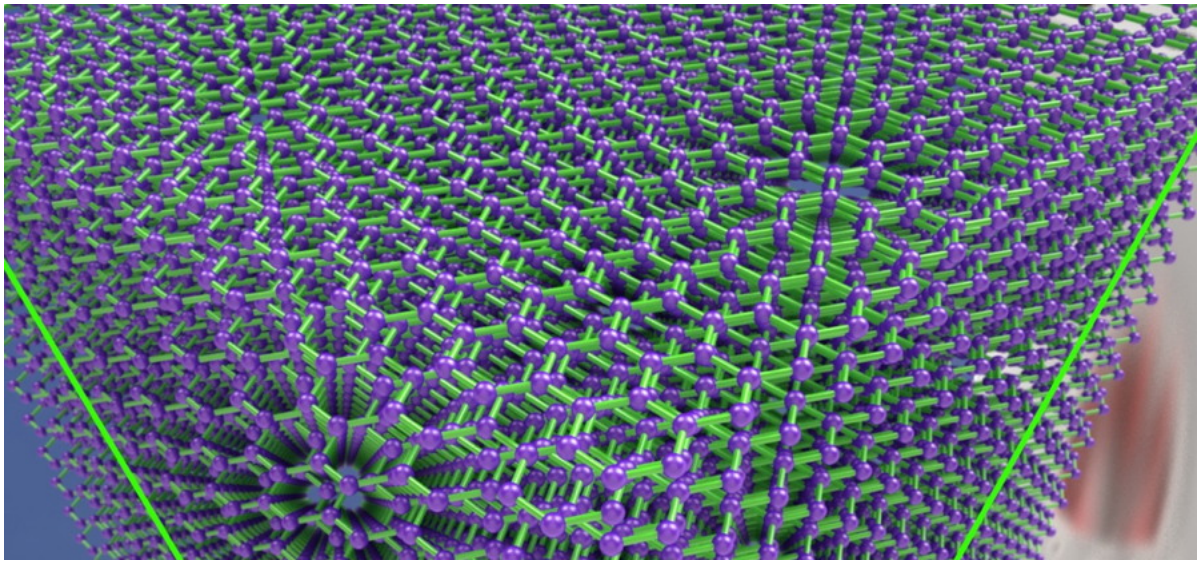
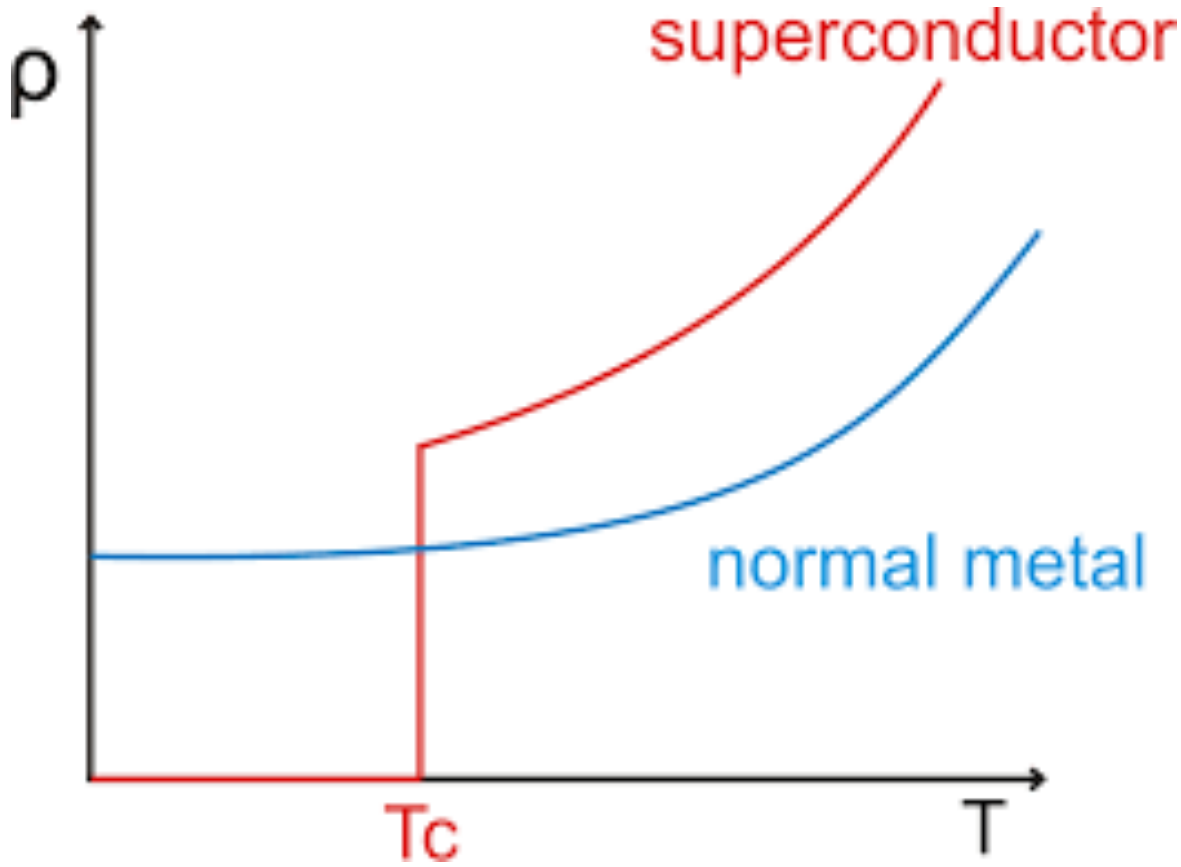
Many-Body Physics

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



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

Example: Superconductivity



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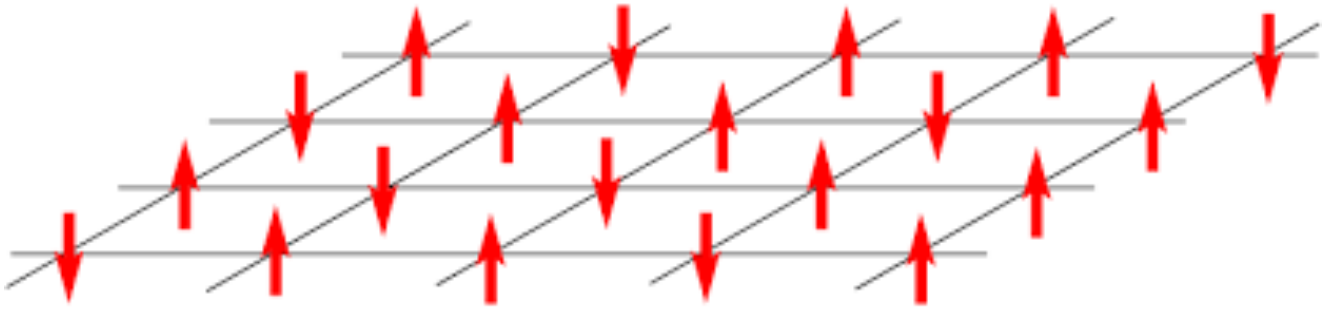
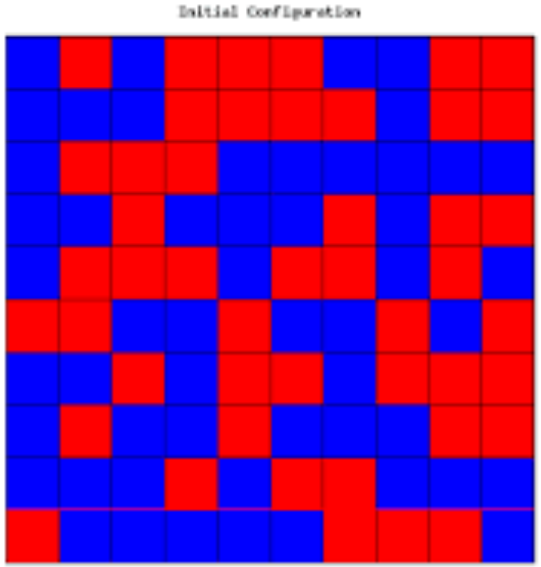
Ising model of magnetism?



2–D Ising Model



Todays Program

1. Motivation - why is condensed matter interesting?
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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)

Last years exam structure:

(1) 7.5 min student presentation of 1 one out of 8 pre-defined topics

(2) 7.5 min discussion of one of the exercises

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

This years exam: (written or oral)

(1) Testing understanding of concepts.

(2) Testing problem solving skills.

(3) Testing general knowledge.

Most likely exam dates: 8 & 9th of June.

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

Activities:

- Lectures
- Exercise classes
- Student presentations
- Home studies

Exercise Class

From the course webpage:

1. Hand in the exercises every Wednesday.

2. Exercise class is mandatory. *Write to Stefan and Daniel in case of justified absence*.

3. No minimal point requirement, but hand in every exercise sheet.

4. Exam questions can be related to exercises.

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

Course Content

I. Crystal structures

II. Structures in reciprocal space

III. Crystal bindings

IV. Crystal vibrations

Crystal structures and Vibrations

VI. Free electron gasses

VII. Electronic band structure

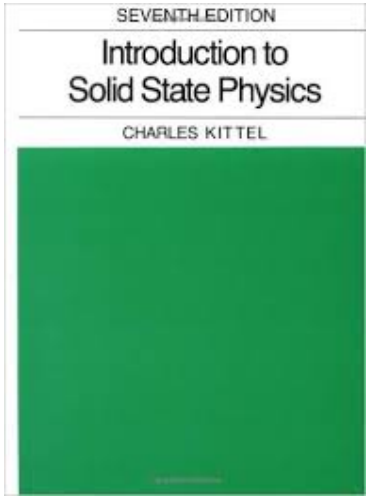
VIII. Semiconductors

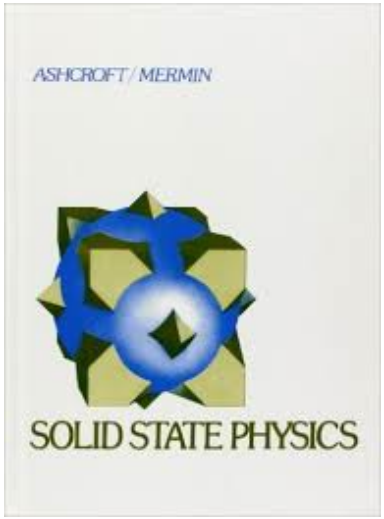
Electronic properties

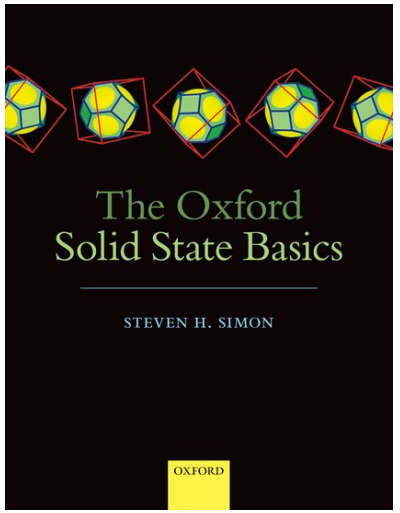
#	Dates	Title	Exercise	Challenge index (1=easy, 10=hard)
1	22.2	Introduction	VESTA	**2-3**
2	01.3	Crystal structures	Daniel - info	**4**
3	08.03	Reciprocal space	Discuss Ex. 1	**6**
4	15.03	Scattering Theory	Discuss Ex. 2	**8-9**
5	22.03	Crystal bindings	Discuss Ex. 3	**5**
6	29.03	Phonons	Discuss Ex. 4	**5-6**
7	05.04	Thermal properties	Discuss Ex. 5	**5-6**
8	12.04	Electron gasses	Discuss Ex. 6	**5-6**
9	26.04	Specific heat	Discuss Ex. 7	**5-6**
10	03.05	Electronic band struc.	Discuss Ex. 8	**7**
11	10.05	Fermi surfaces	Discuss Ex. 9	**8**
12	17.05	Guest lecture	Discuss Ex. 10	**?**
13	24.05	Semi-conductors	Discuss Ex. 11	**6**
14	31.05	Repetition		

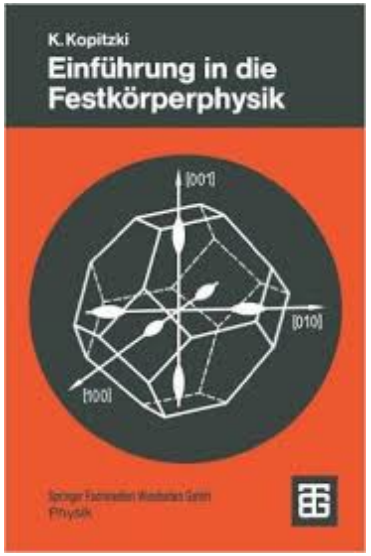
#	Dates	Title	Exercise	Your tasks
1	22.2	Introduction	VESTA	Read Chapter 1
2	01.3	Crystal structures	Daniel - info	Read Chap. 2 + Solve Ex. sheet 1
3	08.03	Reciprocal space	Discuss Ex. 1	
4	15.03	Scattering Theory	Discuss Ex. 2	
5	22.03	Crystal bindings	Discuss Ex. 3	
6	29.03	Phonons	Discuss Ex. 4	
7	05.04	Thermal properties	Discuss Ex. 5	
8	12.04	Electron gasses	Discuss Ex. 6	
9	26.04	Specific heat	Discuss Ex. 7	
10	03.05	Electronic band struc.	Discuss Ex. 8	
11	10.05	Fermi surfaces	Discuss Ex. 9	
12	17.05	Guest lecture	Discuss Ex. 10	
13	24.05	Semi-conductors	Discuss Ex. 11	
14	31.05	Repetition		

Literature

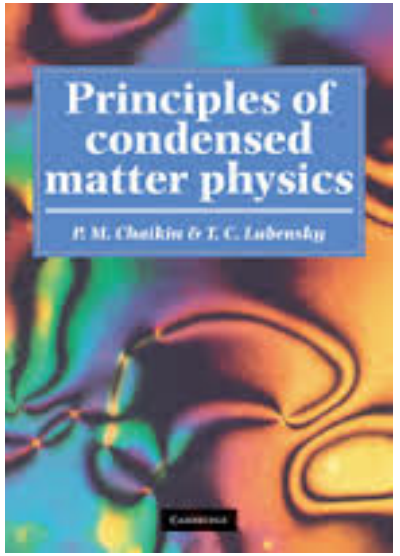

SEVENTH EDITION
Introduction to
Solid State Physics
CHARLES KITTEL


ASHCROFT / MERMIN
SOLID STATE PHYSICS


The Oxford
Solid State Basics
STEVEN H. SIMON
OXFORD


K. Kopitzki
Einführung in die
Festkörperphysik
[001]
[010]
[100]


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


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

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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

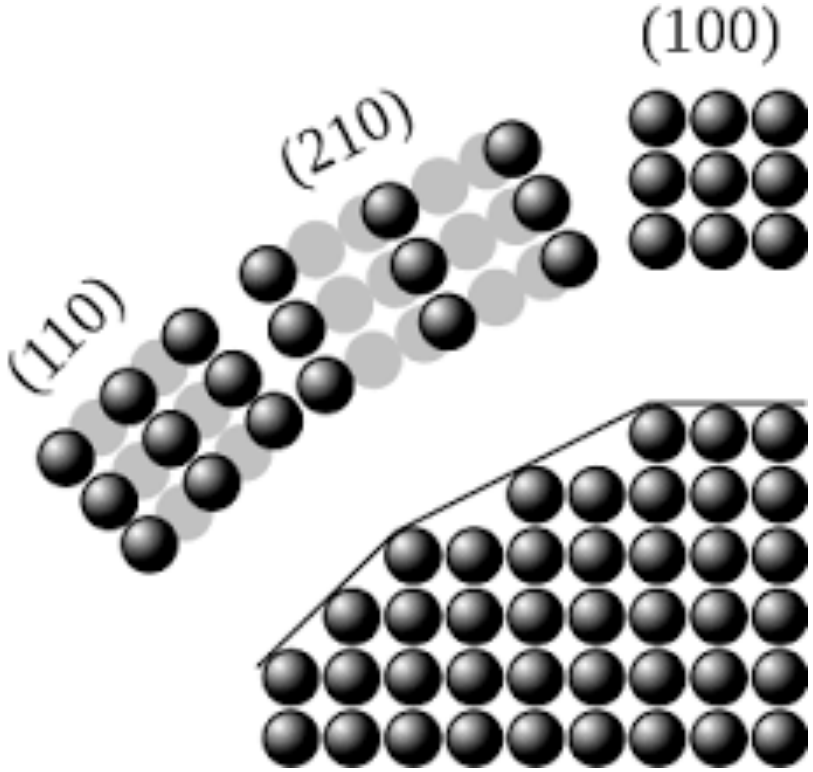
Topaz

Ice crystals

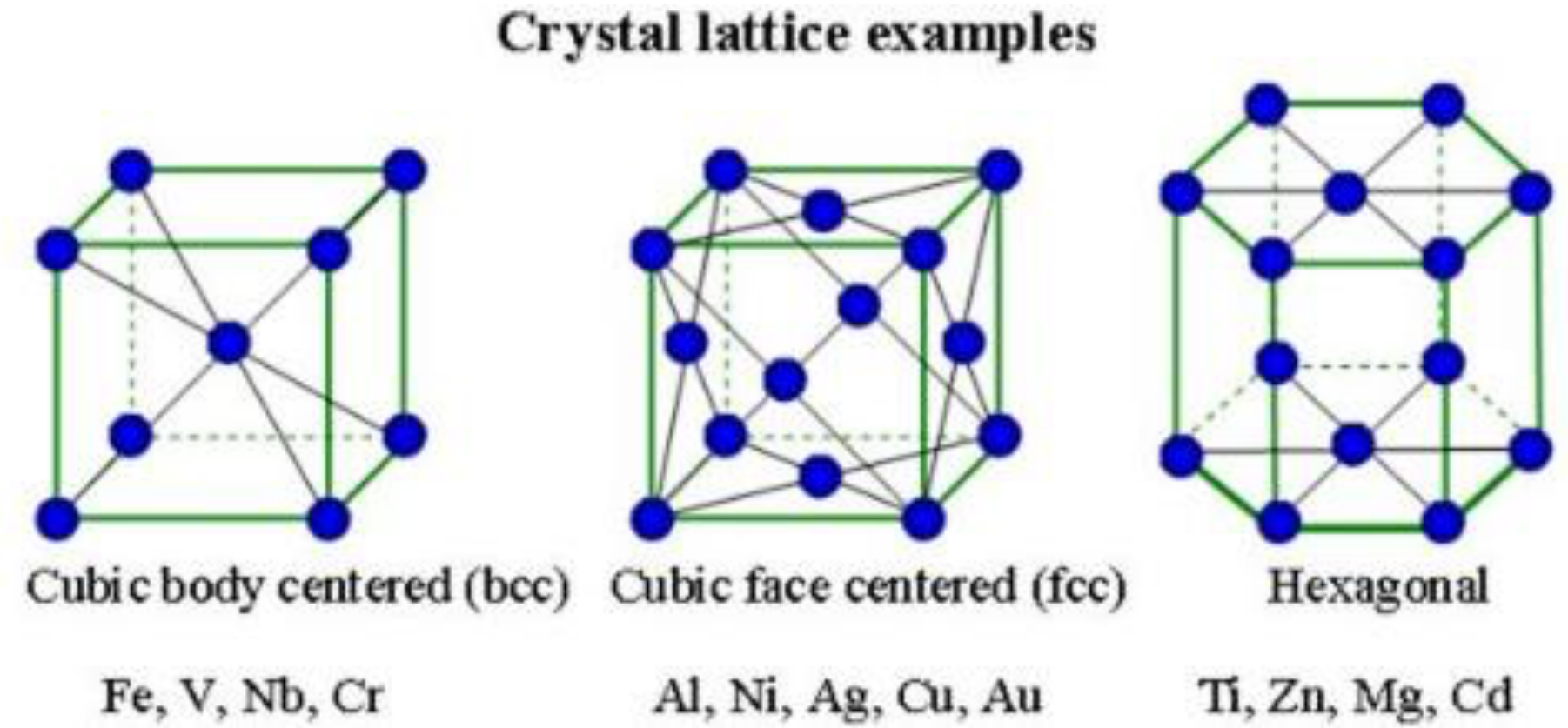
Cinnabar

Metals found in nature

How are crystals / materials build?



Crystal structures



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Your task for this week

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

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

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FABER-CASTELL