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Exercises Condensed Matter Physics (Experimentalphysik 5c), WS16/17

1. Reciprocal lattice (2 credits)

Show that the reciprocal lattice of the reciprocal lattice is the direct lattice.

2. Scattering at a crystal with basis (**3 credits**)

Consider a CsCl-structure (cubic primitive, lattice constant a, basis atoms: Cs at $\mathbf{a}_1$ = (0,0,0)a and Cl at $\mathbf{a}_2$ = (½, ½, ½)), consisting of positive and negative ions with form factors f_1 and f_2. Calculate the structure factor for all points of the reciprocal lattice.

$$F(\mathbf{G}_{hkl}) = \sum_{j=1}^{N} f_j \exp\left(i\mathbf{G}_{hkl} \cdot \mathbf{a}_j\right)$$

What happens for $f_1 = f_2$?
Calculate the structure factor of silicon (Si atoms on a fcc lattice)

3. Lattice constants by powder diffraction (**3 credits**)

Using powder x-ray diffraction three different samples (A,B,C) were investigated and the following diffraction angles 2Θ were observed (Only the first four are given) :

A	B	C
42.2°	28.8°	42.8°
49.2°	41.0°	73.2°
72.0°	50.8°	89.0°
87.3°	59.6°	115.0°

From the samples is known, that they represent different, monoatomic cubic crystal structures (bcc, fcc, diamond). The wavelength used was 0.15nm.
a) Assign the samples to the crystal structures
b) Determine the lattice constants
(Hints for solution: Consider extinction conditions of the structure factor from lecture and previous task; What are the ratios of the observed $(\Delta k)^2$ in each sample?)

4. Brillouin zone of the fcc crystal (optional)

Build a 3d model from the student project of the University of Graz by Mathias Leitner and Klinser Gregor (next page) and bring it along to the exercise.
Specify at least four different symmetry elements (axes of rotation, mirror planes, etc) and compare to that of a simple cube!

University of Graz, Mathias Leitner and Klinser Gregor