UNIVERSITÄT SIEGEN
FESTKÖRPERPHYSIK

Crystallography (*winter term 2015/2016*)

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Exercise sheet 5: Crystal systems, Bravais types of lattices, non-primitive cells

0. Two dimensional Bravais lattices (3 points)

Explain the meaning of the terms "crystal system" and "Bravais types of lattices". Why are there more types of Bravais lattices than the crystal systems? How many 2D and3D crystal systems and Bravais types of lattices do you know?

1. Recognizing the Bravais type of a lattice (5 points)

The crystal lattice is built by two basis vectors $\boldsymbol{a_1}$ and $\boldsymbol{a_2}$ such that $a_1 = a_2$ and $\alpha=90°$. The unit cell is non-primitive: it carries additional lattice point at [1/2 1/2]. Draw (very carefully) this lattice by taking at least 8 *non-primitive* unit cells in each direction and find (visually) all the symmetry elements (rotation axes and mirror planes). Specify the crystal system and Bravais type of the lattice. Draw conventional basis vectors, corresponding to this crystal system.

2. Recognizing the Bravais type of lattice (5 points)

Do exactly the same as in the previous task, however this time, assuming that the lattice with $a_1 = a_2$, $\alpha \neq 90°$ and the unit cell is primitive.

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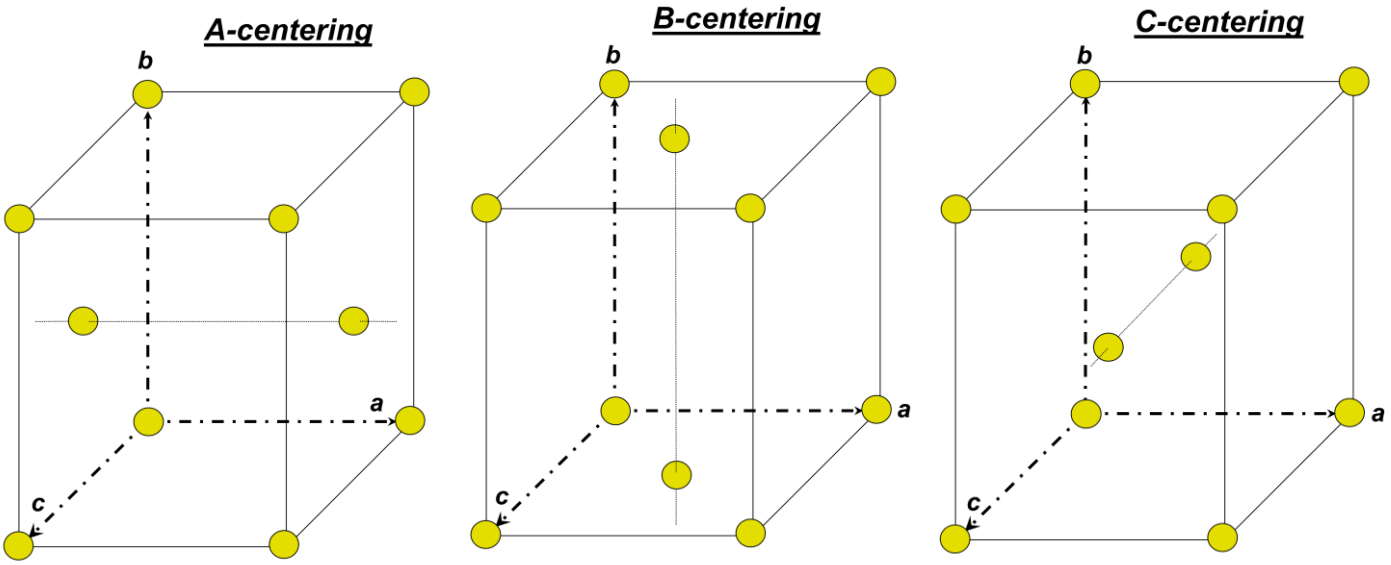
3. Base-centring of the lattice (4 points)

The figures below show non-primitive unit cells of A-, B- and C-centred (e.g. tetragonal) lattices. Prove that the double-base unit cells (AB, BC and AC) do not exist because, any double centring is equivalent to the F (=ABC) -centring.



Hint: Remember that these centrings means the presence of additional lattice translation. These translations are $[0\ \frac{1}{2}\ \frac{1}{2}]$ for A-, $[\frac{1}{2}\ 0\ \frac{1}{2}]$ for B-, $[\frac{1}{2}\ \frac{1}{2}\ 0]$ for C-centred non-primitive unit-cells. Show that, e.g. combination of $[0\ \frac{1}{2}\ \frac{1}{2}]$ and $[\frac{1}{2}\ 0\ \frac{1}{2}]$ with the normal integer lattice translations, $[u_1 u_2 u_3]$ would give $[\frac{1}{2}\ \frac{1}{2}\ 0]$).

4. Reciprocal of the face-centred lattice (6 points).

The parameters of a orthorhombic face-centred lattice (conventional non-primitive unit cell is chosen) are $a=4;\ b=5$ and $c=6$. Find the Bravais type of the corresponding reciprocal lattice and its (conventionally defined) reciprocal lattice parameters.

5. Reciprocal of body-centred lattice (4 points).

Use the result of the task 4 to find the Bravais type and the conventional lattice parameters of the body-centred orthorhombic lattice.

Please return on 07/12/2015