University of Zurich[UZH]

Solid State Physics
Exercise Sheet 1
Crystal Structure

HS19
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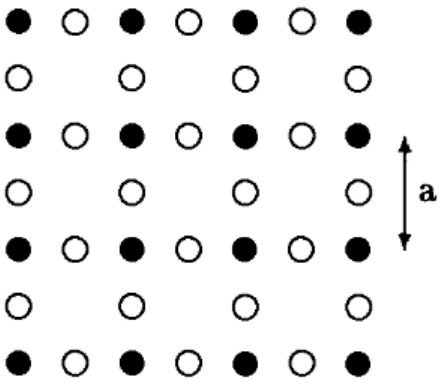
Two-dimensional lattices

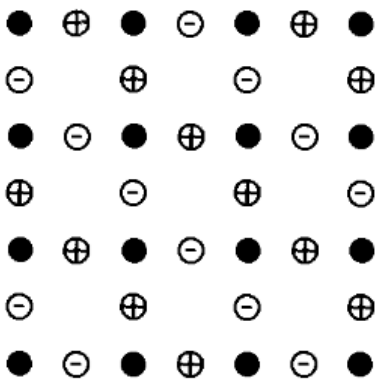
Exercise 1 *Wigner-Seitz cell*
Construct the Wigner-Seitz cell of the 5 Bravais lattices (BL) that exist in two dimensions.

Exercise 2 *Primitive unit cells*
The common building blocks for most high temperature superconductors are copper oxide (CuO_2) layers (Left figure, Cu in black, O in white).
In La_2CuO_4, the CuO_2 lattice is not flat, but the oxygen atoms are moved a small amount out of the plane ("up" or "down") in an alternating fashion (Right figure, a + means up and a - means down).

CuO_2 lattice



Distorted CuO_2 lattice



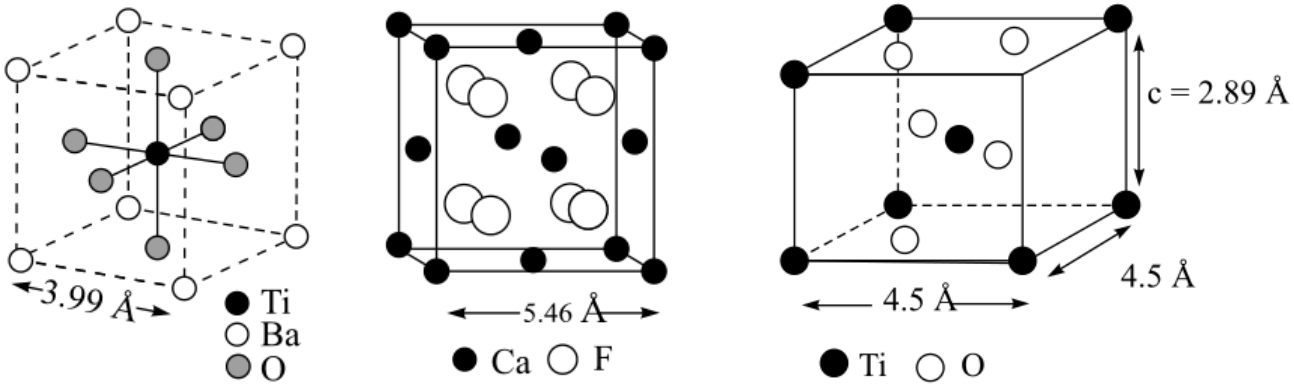
1. Sketch the Bravais lattice, the unit cell, the basis and the primitive vectors of the CuO_2 lattice.
2. Repeat the previous steps for the distorted CuO_2 planes. What are the main differences?

Three-dimensional lattices

Exercise 3 *Crystal structures*

Describe the crystal structures represented in the following.
In particular, indicate Bravais lattice, basis and chemical formula.

Structure #1 Structure #2 Structure #3



Exercise 4 *Lattice systems*

Assume a lattice constant of a and that atoms are hard spheres of radius r.

1. Calculate the packing fraction, volume of the conventional unit cell and volume of the primitive unit cell for the following structures:
   (a) simple cubic (sc)
   (b) body-centered cubic (bcc)
   (c) face-centered cubic (fcc)
   (d) diamond

Questions

1. Why is there no tetragonal base-centred crystal lattice? (Draw a figure!)