Some real materials

- NaCl
- MgO
- KF

Some ionic crystals

Lattice: ?

Face, not SE

basis:
- Cl\(^-\) in \(1,1,0\)
- Na\(^+\) in \(0,0,0\)

Atoms in conventional unit cell

"NaCl structure" = name of this structure \(\Phi\), also used by other crystals


- LiF
- AlF
- MgO
- KCl
- KBr

NaCl 1:1 stoichiometry
Cesium Chloride - like ke, but different in middle

\[ e = Cs^+ \]
\[ x = Cl^- \]

How many Cl- ions for each Cs+ ion? (Just 1)

What is lattice? SC

lattice: Cs+ at \( \frac{2}{2} \\) 000
Cl- at \( \frac{2}{2} \) 2 1

CsCl structure used by

Be, Cu
Al, Ni
Cu Zn (p-matrix)
Cu Pd
Ag Mg

LiF
NH₄Cl (?)
Tl Br
(CsCl)
Tl I

1:1 which match

Question: do compounds with just one element have to have 1 atom in unit cell?

\( \rightarrow \) No! Ex: bec, he already discussed.

Ok, that's "enough" because you have unit cells for bec, he have only 1 atom in them.

\( \rightarrow \) still No! Next structure (kep) is an example.
HCP hexagonal closest packed

\[ \text{fig 19 pg 15} \]

Accomplished ABAB = "hcp"
ACAC = "fcc", surprisingly
(best use of "has"
(best use of "has"

Note dense elements
(ex. Au, Pb
are all fcc)

Pressure packing
(close packing)

\[ \text{fig 21 pg 16} \]

HCP

\[ \frac{2}{\sqrt{3}} \text{ atoms/unit cell} \]

Creating closest packed, still related. Just different by radius

| Atom | \( \text{Hg} \) | \( \text{Zn} \) | \( \text{Cd} \) | \( \text{Cd} \)
|------|-------------|-------------|-------------|-------------
| \( \text{Mg} \) | \( \text{Co} \) | \( \text{La} \)
| \( \text{Ti} \) | \( \text{Y} \)

Need to fully understand difference between

<table>
<thead>
<tr>
<th>lattice</th>
<th>structure</th>
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Only in case of 1 atom/cell (Hg, Zn etc.)

Class obviously one type of atom only.

In general they are very different.
**Diamond structure**

- tetrahedral bonds

**Figure 23**

Lattice? fcc

2a^2 = 4 \( \sqrt{3} \times 4 \sqrt{3} \)

8 atoms in "conventional" unit cell
(Stern's Handbook)

relative empty:

34.7% packing factor
(less than 2/3 fcc site)

Why? covalent bonding
4 valence electrons

**Zinc blende**

2nS structure

- nearly like diamond, but 2 types of atoms

**Figure 24**

FCC still

basis: \( \frac{a}{4} \) \( \frac{A}{4} \)

1:1 stoichiometry

(crysls)

- Si, C
- Ga, As
- Al, P
- Ge, P
- In, Sb
last comments on Ch 1

1) Lattice energy somewhat depends on Temp + pressure

Ex: very strong Br2, can get almost anything to sublime + close contact

(-l Gos Haar's research)

So don't take my info as gospel

2) Table 4 pg 21

a) density or atomic concentration

\[
\frac{\text{atoms}}{\text{cm}^3}
\]

b) nearest neighbor - a few angstroms

\[1\text{nm} = 10^{-10} \text{m}
\]

3) Not mentioned in Helvel

There are an infinite number of crystals that can be formed (because eg. the basic atoms can be located at any real numbers).

However, there are not an infinite number of ways of classifying these crystals by symmetry.

(rotations, translations, etc.)

There are 230 distinct "space groups"

(of which the Bernal lattice is 1)

(cubical, tetragonal, hexagonal)

They are usually divided into 32 "crystal classes" (subgroups)

(a, b, c, etc., diamond which share "p-group symmetries" (rotation, reflection, inversion, Carbo, etc.))