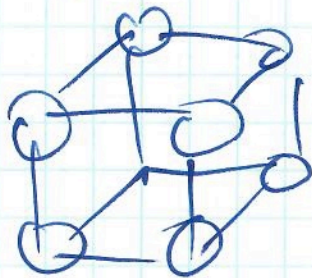


Class 7

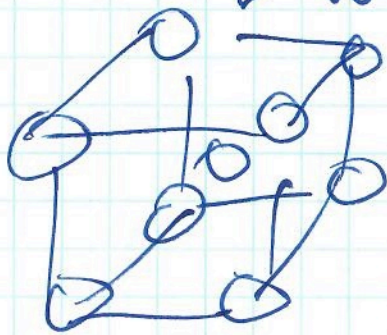
①

Po, simple cubic



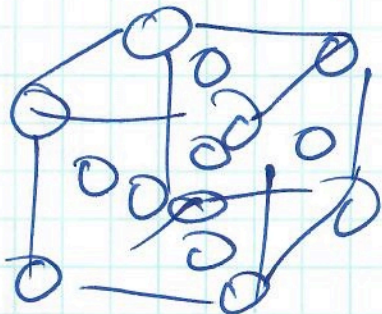
1 atom per cell
6 neighbors (nearest)
 $2r = a$

Fe, body-centered cubic



2 atoms per cell
8 neighbors
 $4r = \sqrt{3}a$

Ar, face-centered cubic



4 atoms per cell
12 neighbors
 $4r = \sqrt{2}a$

X-ray diffraction. How do we understand the structure of matter?

1895: Wilhelm Conrad Röntgen discovers X-rays

→ soon thereafter, folks figure out that typical X-ray wavelengths ($\lambda \approx 1 \text{ \AA} = 10^{-8} \text{ cm} = 10^{-10} \text{ m}$) are

similar to spacings between atoms in crystals (which they could find from density measurements)

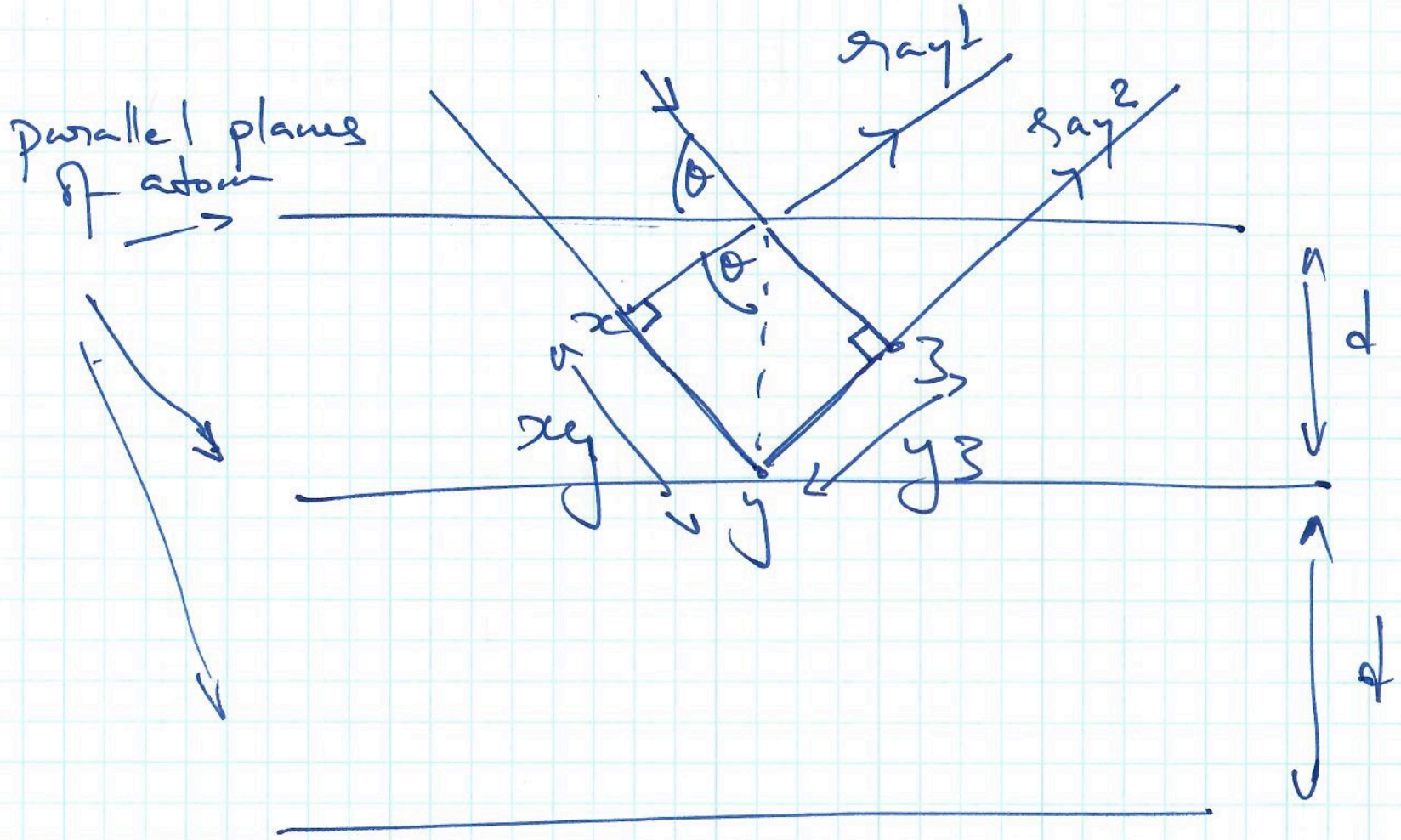
3

Max von Laue in 1912 showed that crystals diffract X-rays (Nobel in 1914)

Young W.L. Bragg in 1912 saw the von Laue paper & came up with the famous Law
$$2d \sin \theta = n \lambda$$

His father W.H. Bragg verified the formula experimentally & they shared the Nobel in 1915 (W.L. Bragg was 25!)

The Bragg Law



ray 2 has a longer path than ray 1
 by $\overline{xy} + \overline{y3}$ (the path difference)
 by $\overline{xy} = d \sin \theta$ & $\overline{y3} = d \sin \theta$

∴ The path difference is

$$d \sin \theta + d \sin \theta = 2d \sin \theta$$

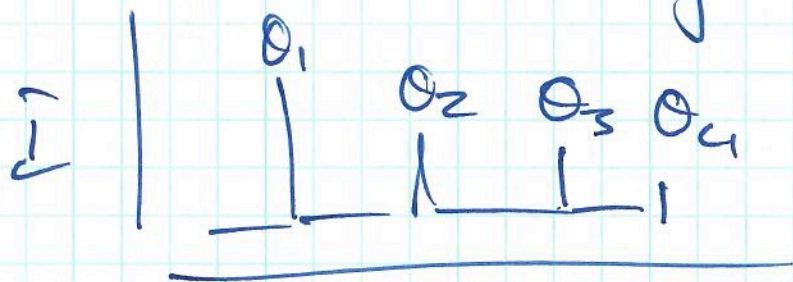
From wave theory, constructive interference occurs when the path difference is an integral multiple of the wavelength

$$2d \sin \theta = n \lambda \leftarrow \text{x-ray wave length}$$

↑
integer

x-ray diffractogram

$$\left. \begin{array}{l} 2d_1 \sin \theta_1 = n \lambda \\ 2d_2 \sin \theta_2 = n \lambda \end{array} \right\} \text{etc.}$$

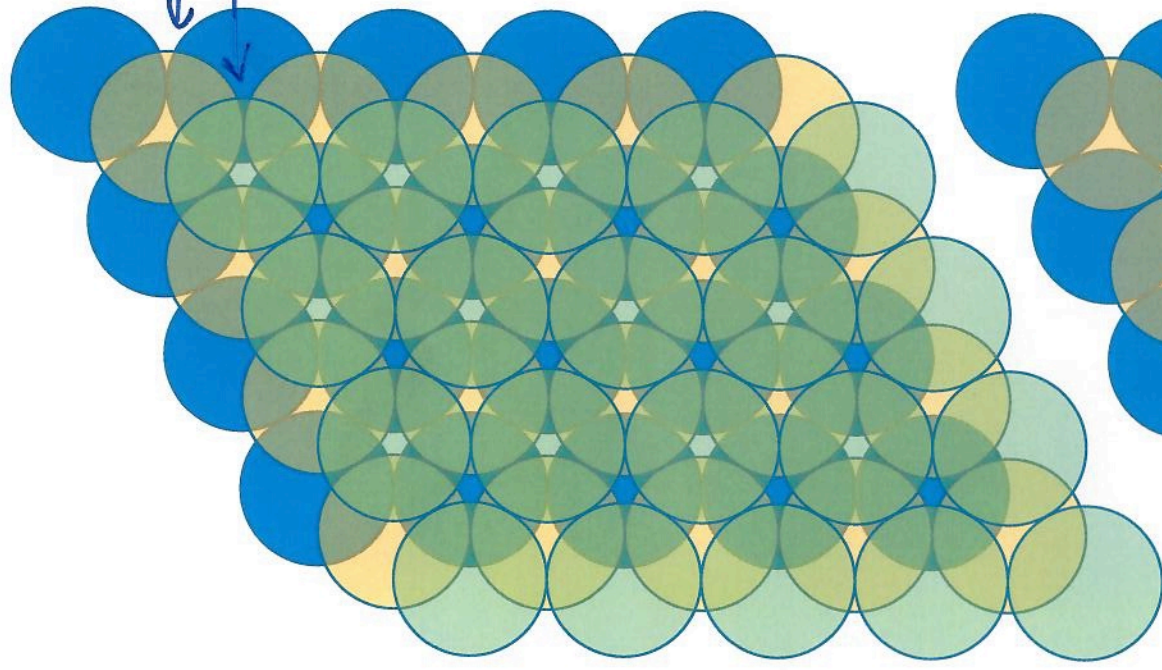


A knowledge of all d -spacings ^{2 θ} allows the structure to be known.

Cubic close packing

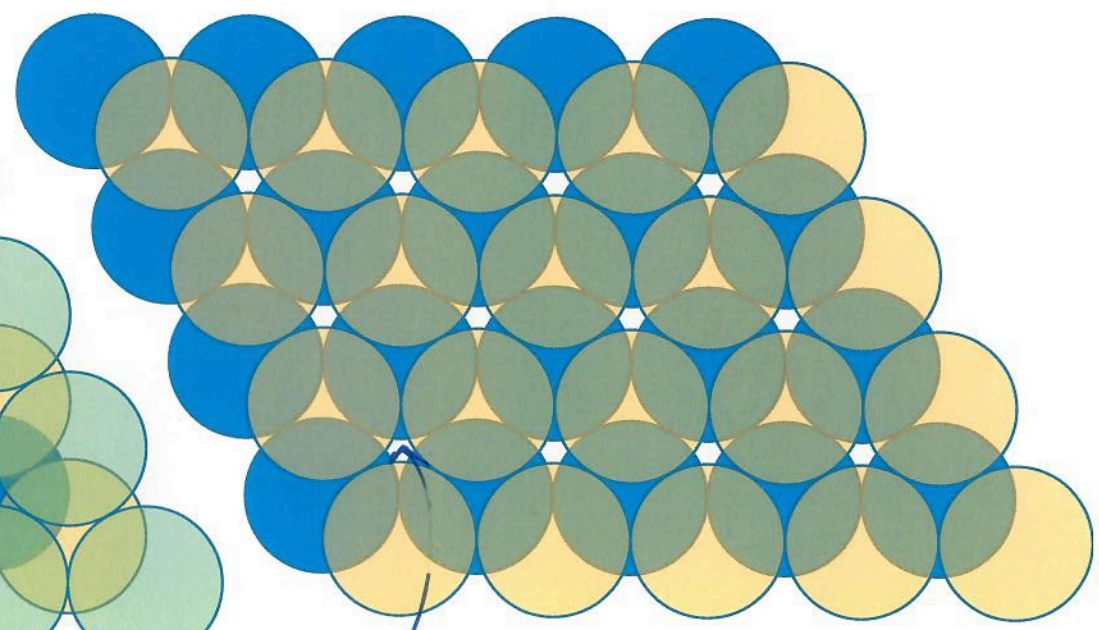
ABCABCABC
stacking

A
B
C



Hexagonal close packing

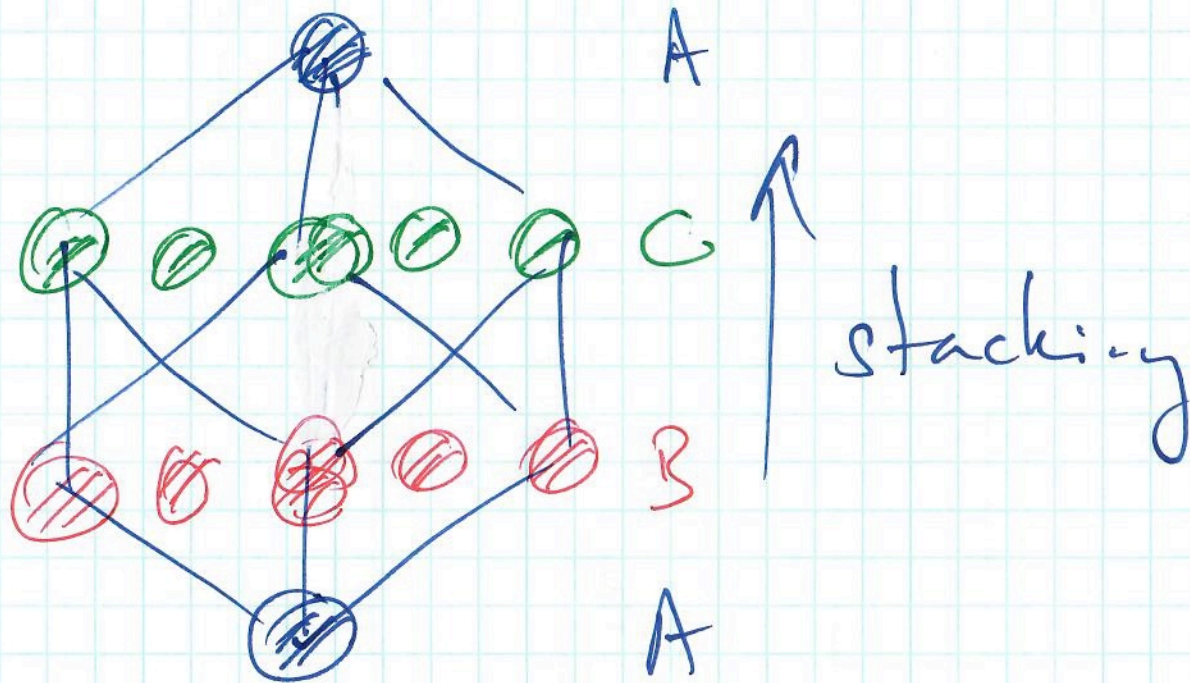
ABABAB
stacking



these holes always exist

Cubic-close packing is the same as face-centered cubic

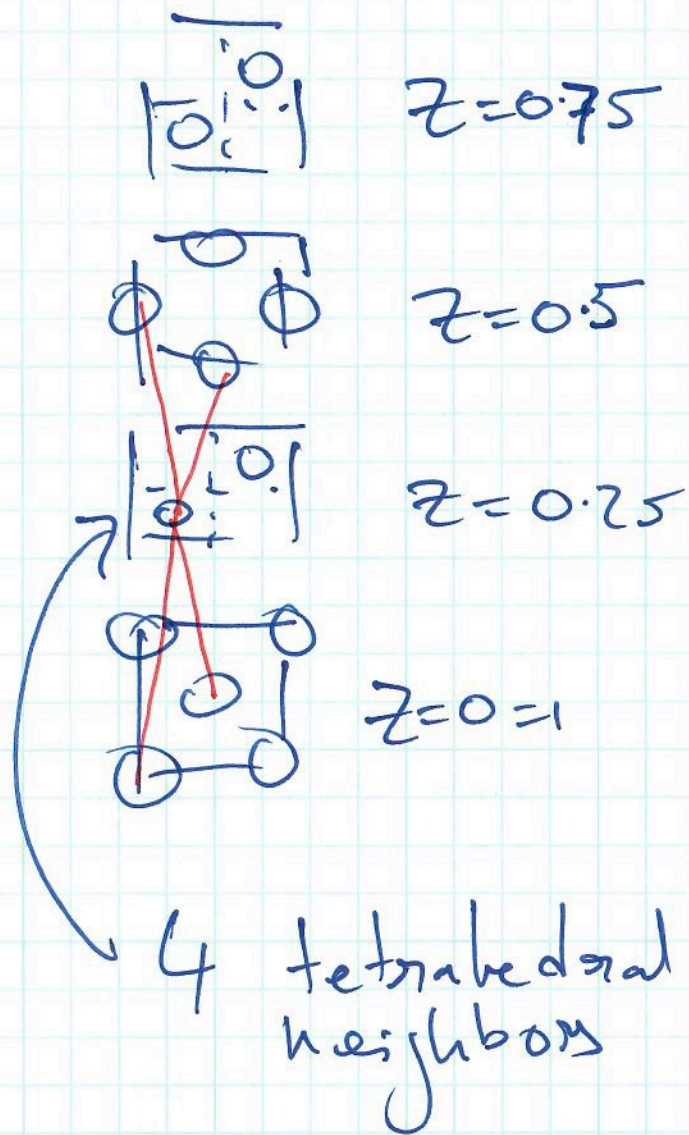
⑦



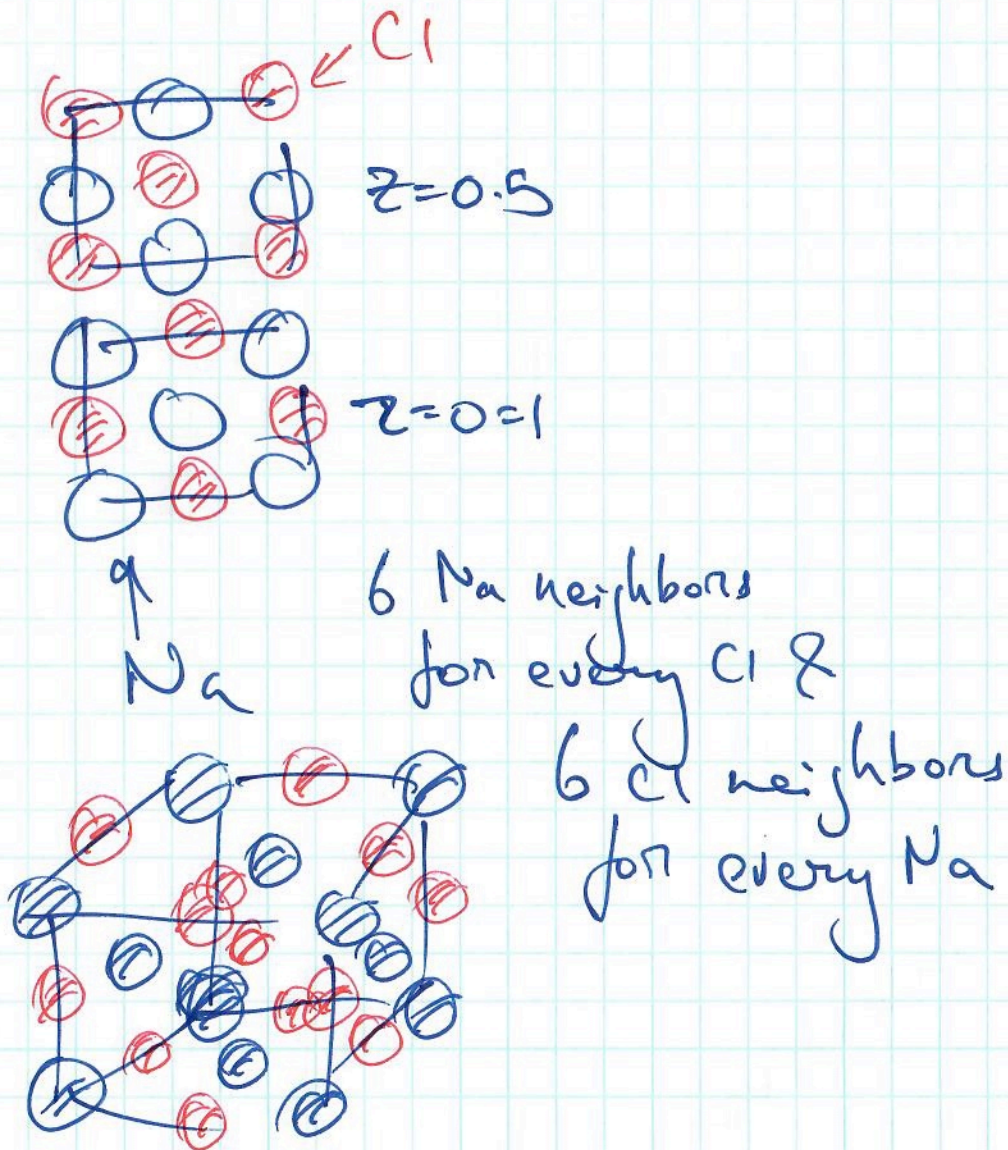
Some other structures

8

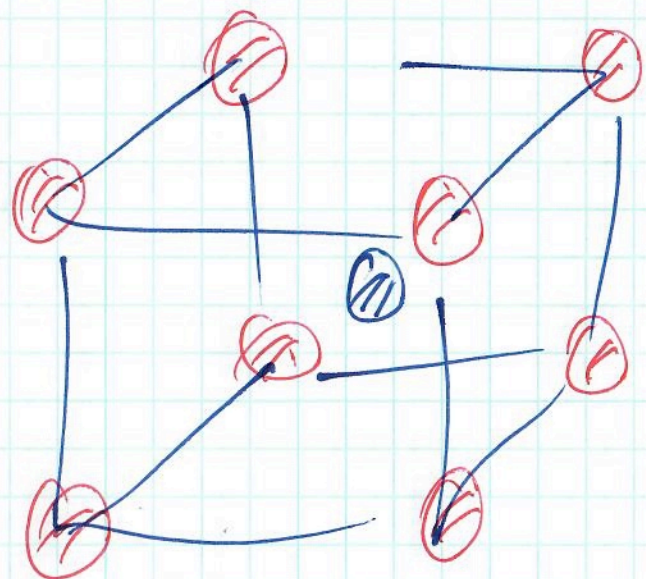
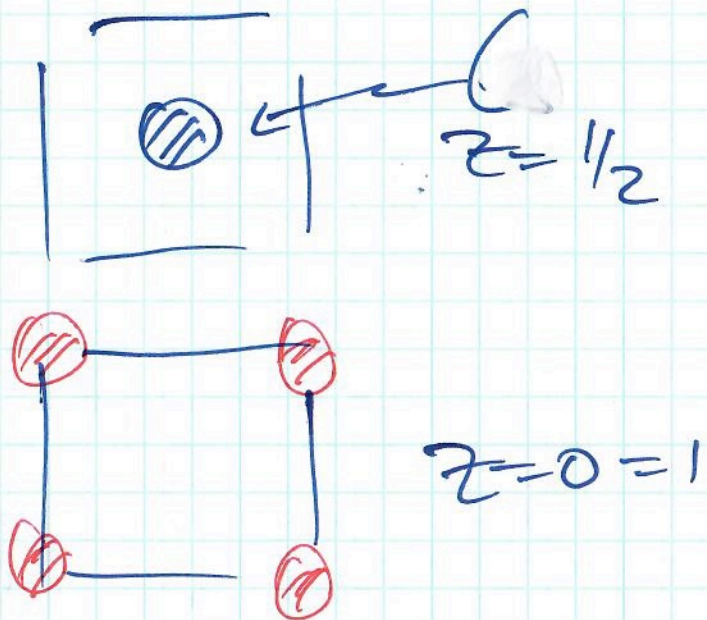
Diamond



NaCl (rock salt)



CsCl



8 + 8 neighbors
Cs for Cl Cl for Cs