PHY 491, Problem 5
October 7-14, 2011

Problem 5.1

In each of the following cases indicate whether the structure is a Bravais lattice. If it is then give the three primitive vectors. If it is not, then describe it as a Bravais lattice with as small basis as possible.

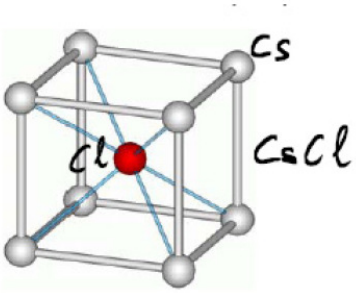
(i) Base centered cubic lattice (simple cubic with two additional lattice points at the center of the horizontal faces)

(ii) Side centered cubic lattice (simple cubic lattice with additional lattice points at the center of four vertical faces)

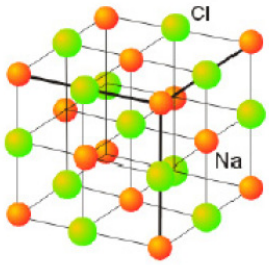
(iii) Edge centered cubic lattice (simple cubic lattice with additional lattice points at the centers of the 12 edges of the cube)

Problem 5.2

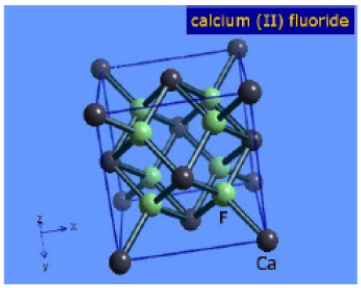
For the four crystal structures below, identify (i) the type of the lattice type (simple cubic, fcc, bcc etc) , (ii) three primitive vectors, (iii) position of the atoms the basis, (iv) concentration of atoms expressed in units of a, the side of the unit cube.



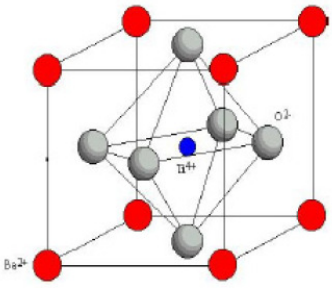
CsCl



NaCl



CaF_2



$BaTiO_3$

Problem 5.3

Consider a two-dimensional hexagonal lattice described by the two primitive vectors (in an orthogonal coordinate system)

$$\vec{a}_1 = a(1,0);\ \vec{a}_2 = a\left(\frac{1}{2},\frac{\sqrt{3}}{2}\right).$$

Find the two primitive vectors $\vec{b}_1;\ \vec{b}_2$ describing the reciprocal lattice. Find the area of the 1st Brillouin zone and find its relation with the area of the direct lattice unit cell.