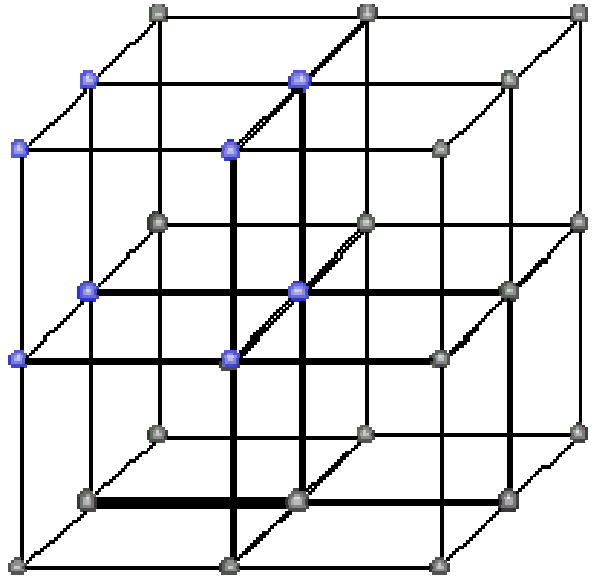
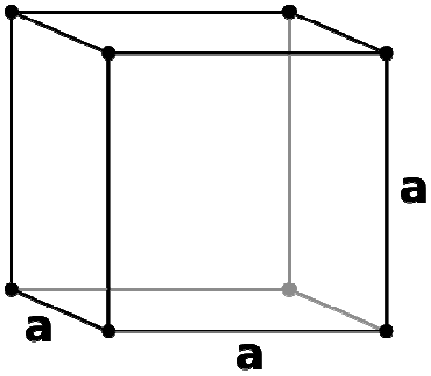
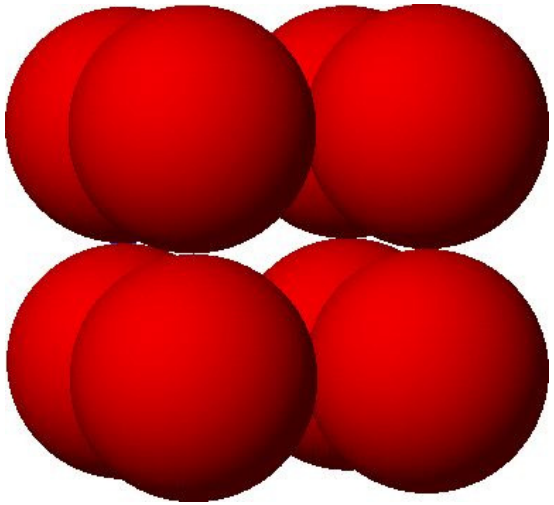
Slides
Condensed Matter Physics
Lecture 10

Simple (Primitive) Cubic Lattice (Notated Cubic-P)

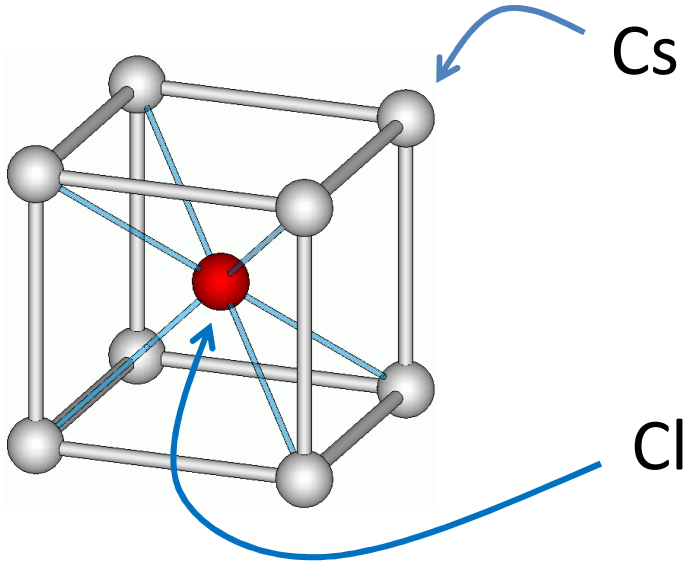


Simple Cubic Unit Cell





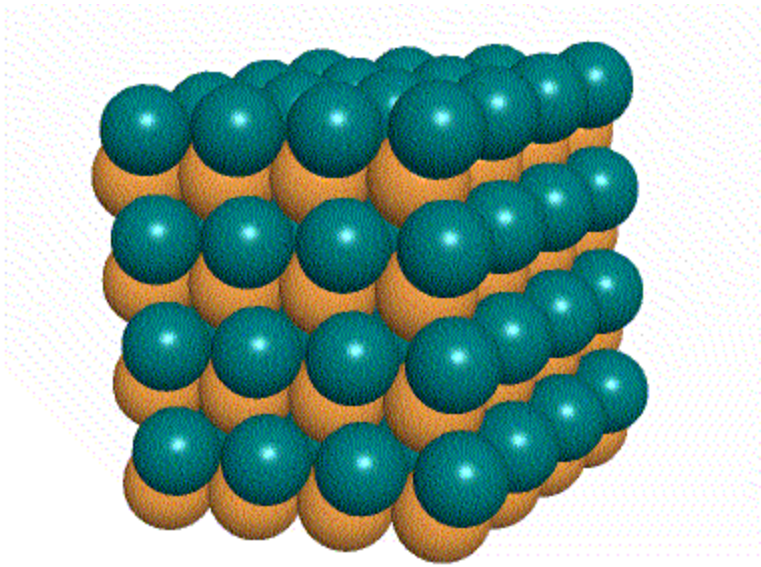
Atoms arranged in Simple Cubic Lattice (very unusual)

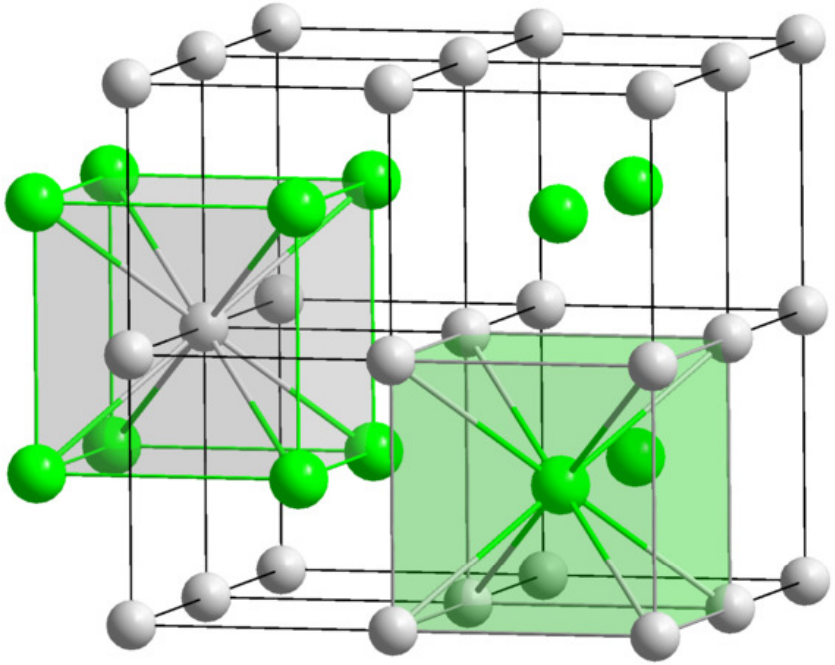


Cesium Chloride (CsCl): A simple cubic Lattice with a Basis

Basis:

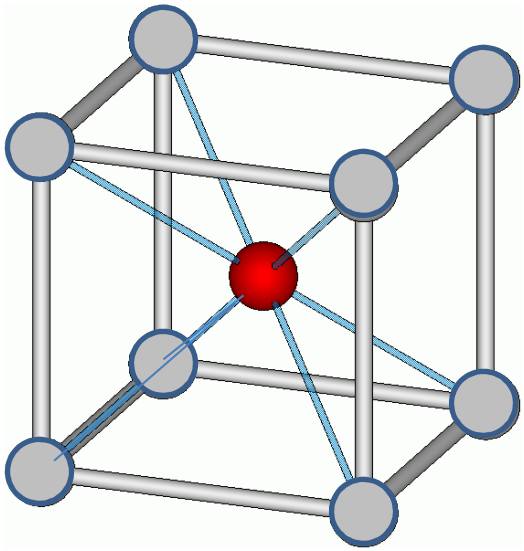
Cs at[0, 0, 0] (i.e., on the simple cubic)
Cl at [½, ½, ½] (i.e., in the middle of each cube)





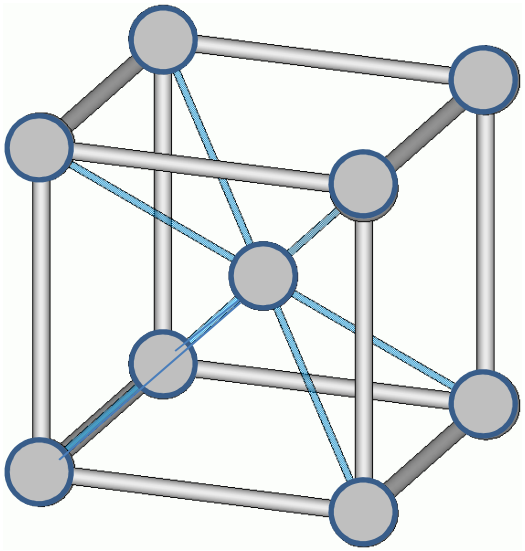
Two depictions of the CsCl lattice structure =

Two interlocking simple cubics



CsCl =Simple Cubic with Basis

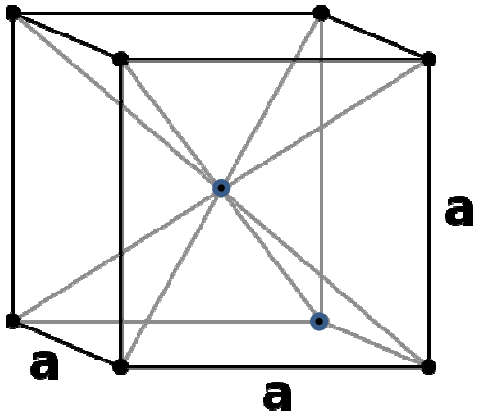
Cs at [0, 0, 0]
Cl at [½, ½, ½]



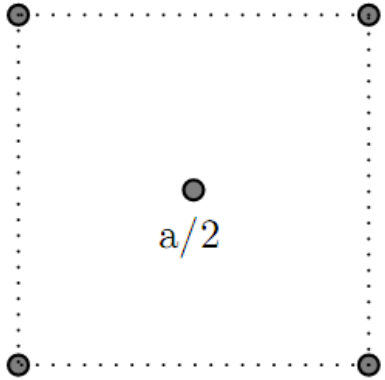
Cs = Simple Cubic with Basis

Cs at [0, 0, 0]
Cs at [½, ½, ½]

Unit cell of Body Centered Cubic Lattice (BCC) (Notated cubic-I)

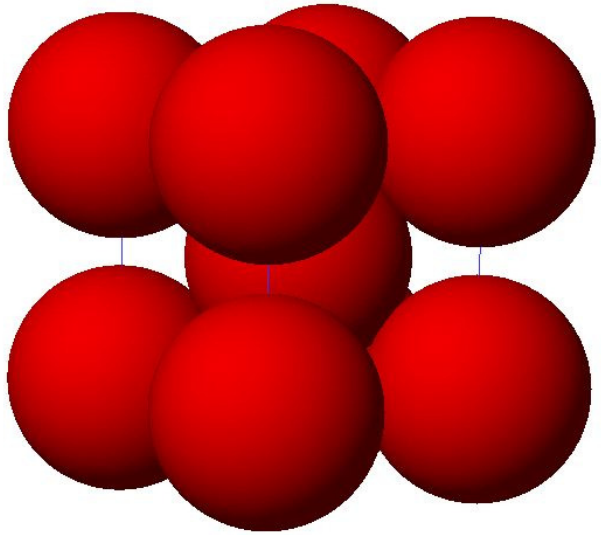


Conventional Unit Cell

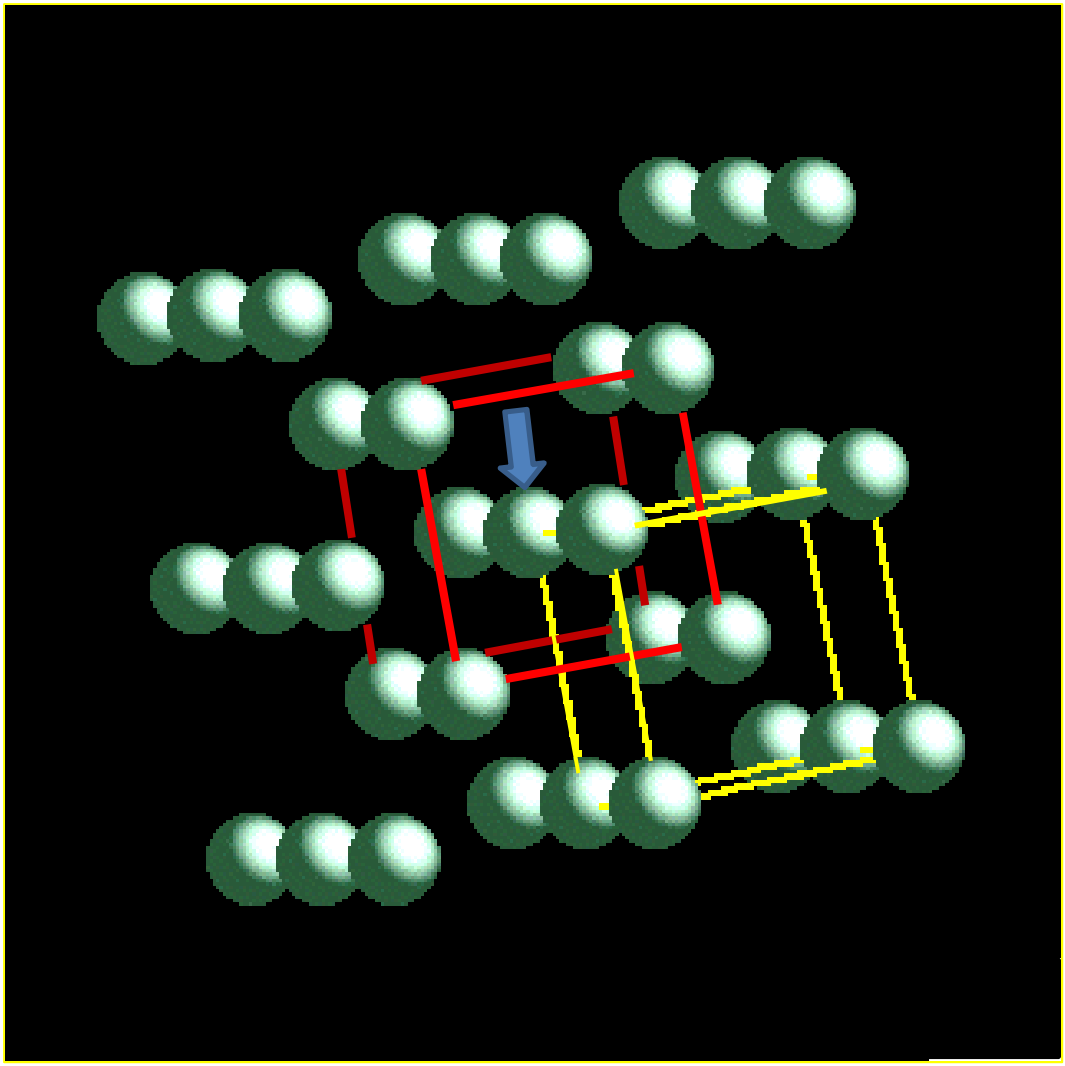


Plan View

(unlabeled points at height 0 and a)

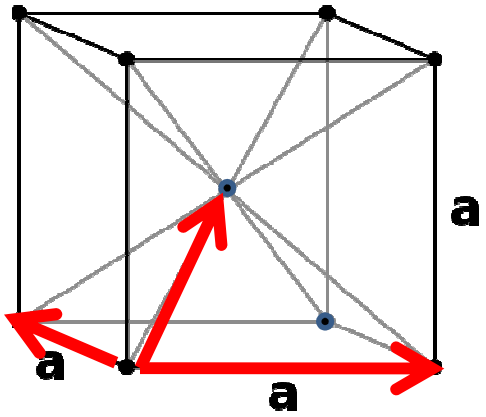


(More efficient sphere packing)

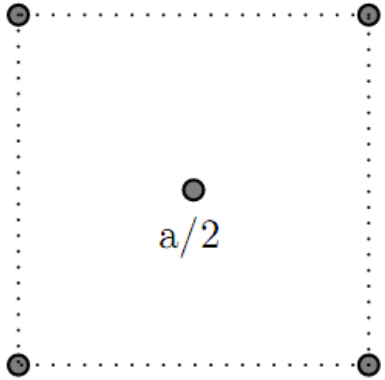


BCC Lattice

Unit cell of Body Centered Cubic Lattice (BCC) (Notated cubic-I)



Conventional Unit Cell



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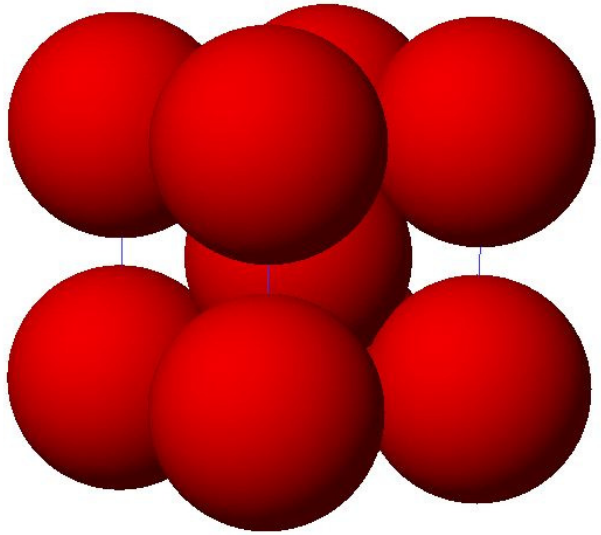

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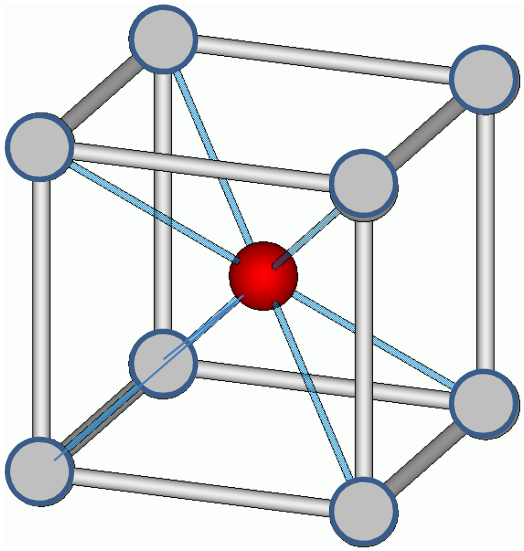

CsCl =Simple Cubic with Basis

Cs at [0, 0, 0]
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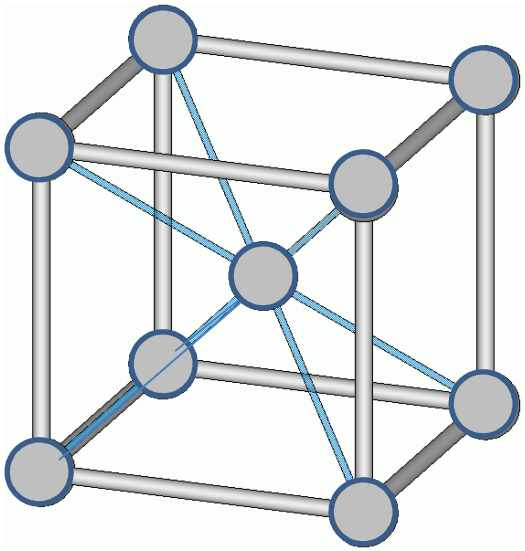

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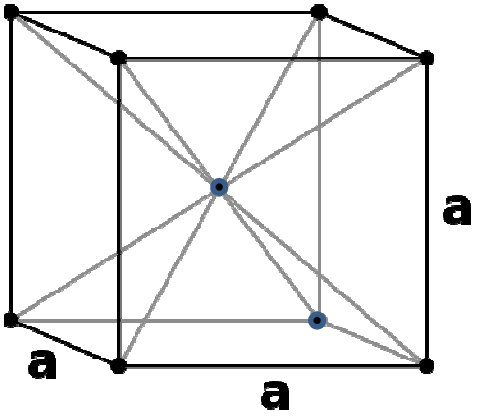
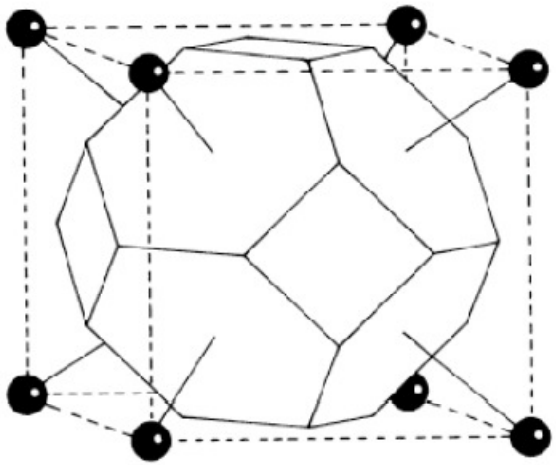
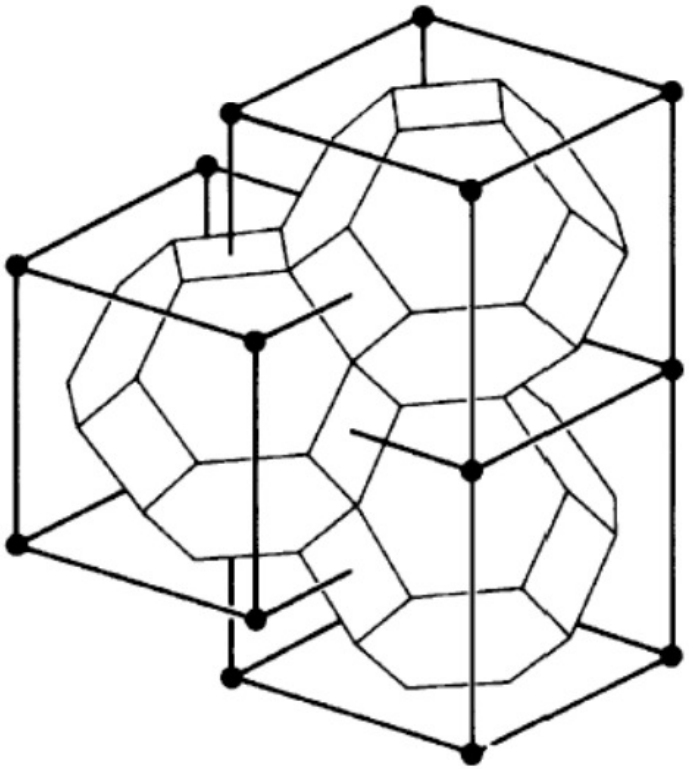
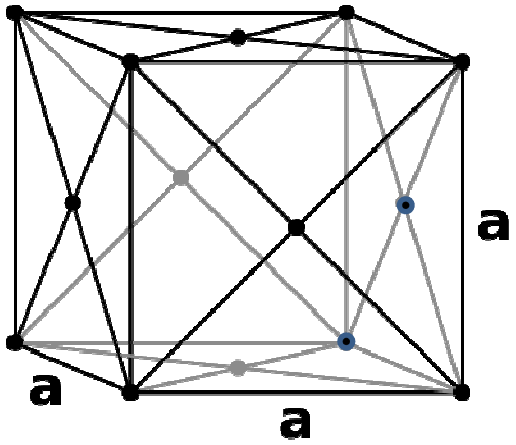




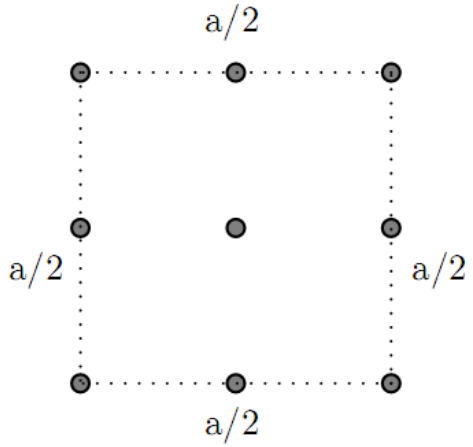
The Wigner-Seitz (Primitive) Unit Cell for the BCC lattice



Unit cell of Face Centered Cubic Lattice (FCC) (Notated cubic-F)

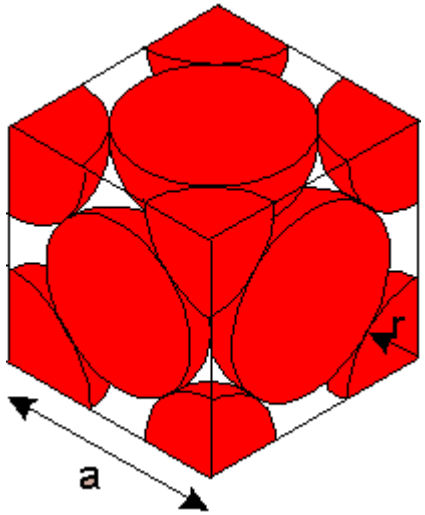


Conventional Unit Cell



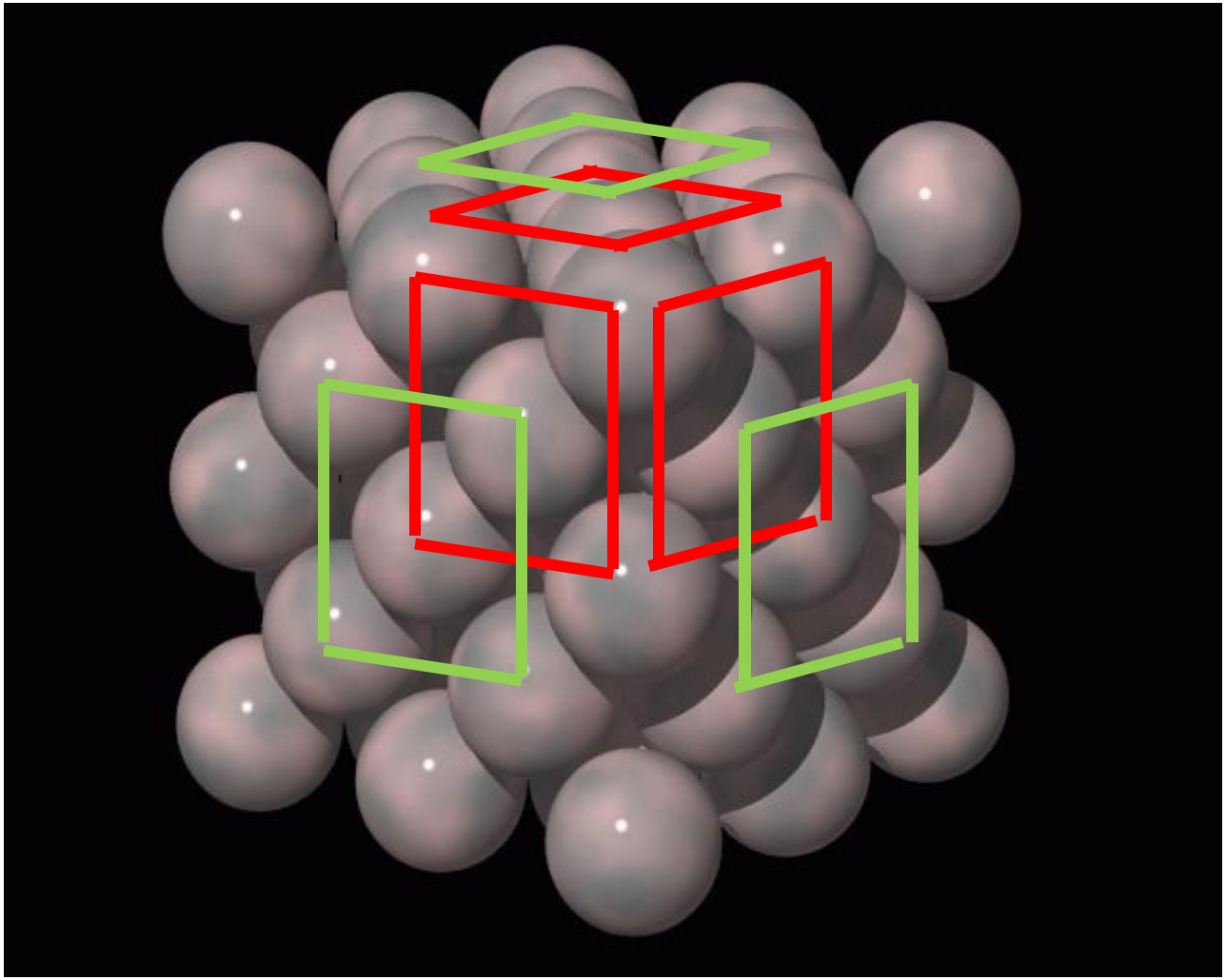
Plan View

(unlabeled points at height 0 and a)

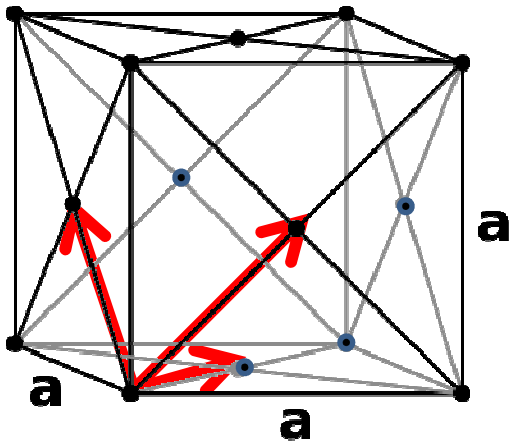


Most efficient sphere packing

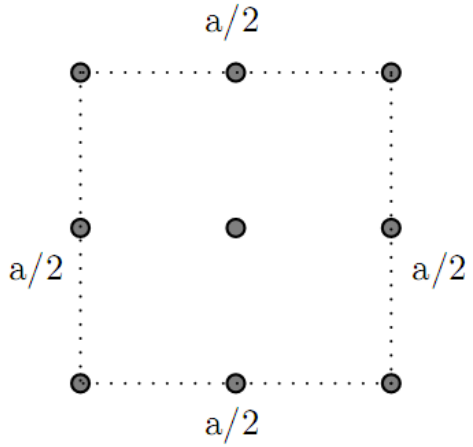
same density as “hcp” packing which we don’t’ learn this year



Unit cell of Face Centered Cubic Lattice (FCC) (Notated cubic-F)



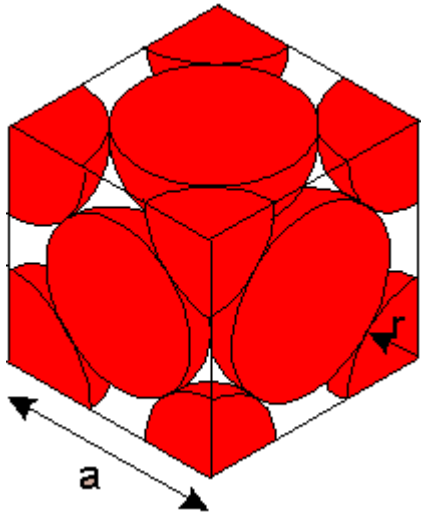
Conventional Unit Cell



Plan View

(unlabeled points at height 0 and a)

FCC lattice



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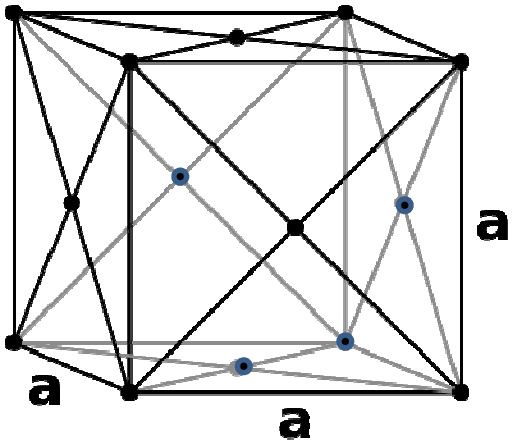
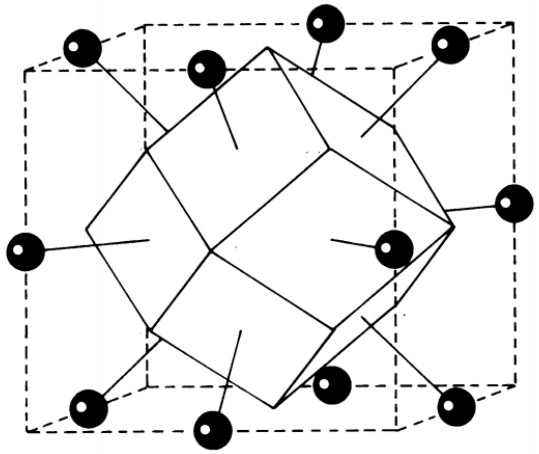


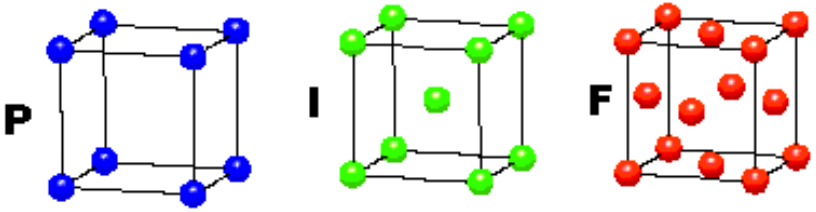


The Wigner-Seitz (Primitive) Unit Cell for the FCC lattice

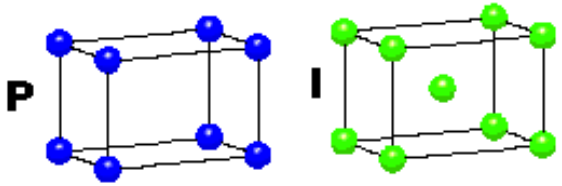
Packing Wigner Seitz cells to fill space

The 14 Bravais Lattice Types

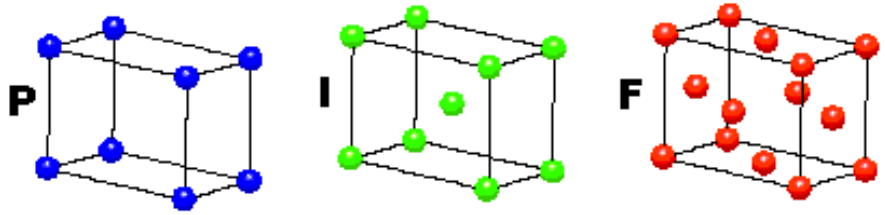
CUBIC
$a = b = c$
$\alpha = \beta = \gamma = 90°$



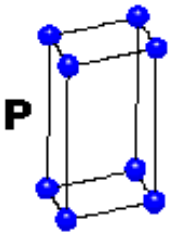
TETRAGONAL
$a = b \neq c$
$\alpha = \beta = \gamma = 90°$



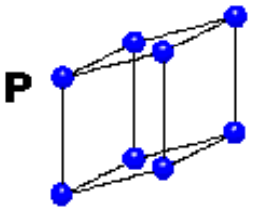
ORTHORHOMBIC
$a \neq b \neq c$
$\alpha = \beta = \gamma = 90°$



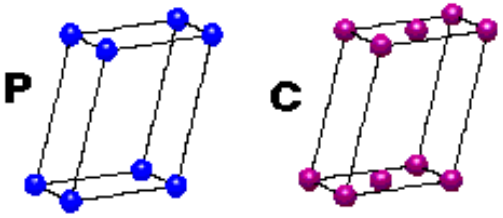
HEXAGONAL
$a = b \neq c$
$\alpha = \beta = 90°$
$\gamma = 120°$



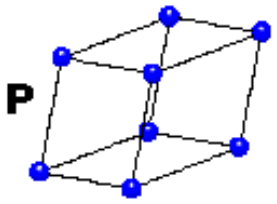
TRIGONAL
$a = b = c$
$\alpha = \beta = \gamma \neq 90°$



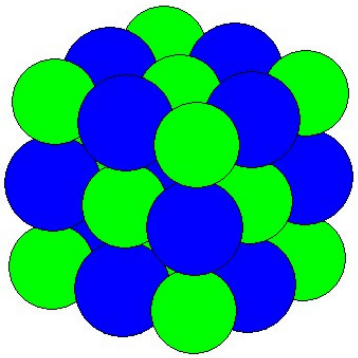
MONOCLINIC
$a \neq b \neq c$
$\alpha = \gamma = 90°$
$\beta \neq 120°$

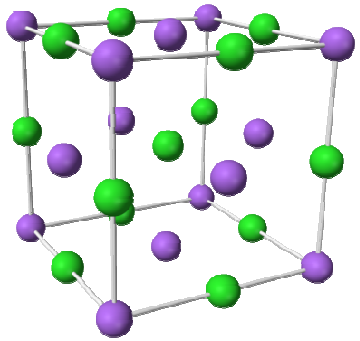


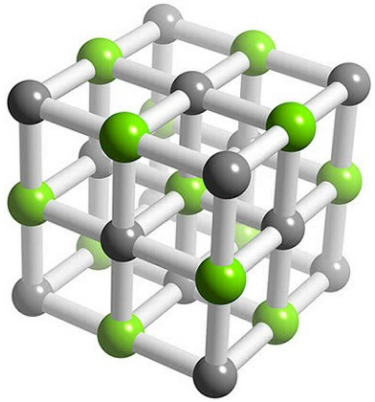
TRICLINIC
$a \neq b \neq c$
$\alpha \neq \beta \neq \gamma \neq 90°$



4 Types of Unit Cell
P = Primitive
I = Body-Centred
F = Face-Centred
C = Side-Centred
+
7 Crystal Classes
→ 14 Bravais Lattices







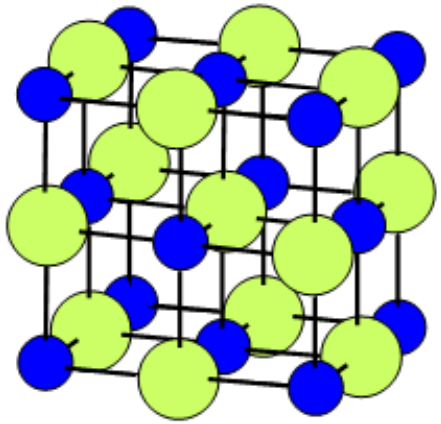
sodium chloride (NaCl)

lattice: cubic F

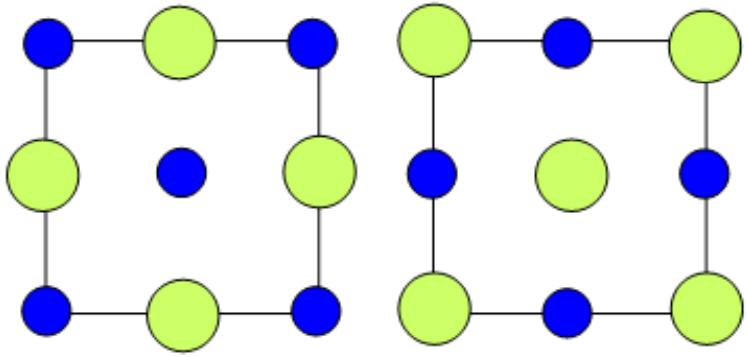
basis :

Na 000

Cl ½½½



Plan view



$z = 0$ layer

$z = ½$ layer

Na forms FCC lattice.

Cl is displaced (1/2,1/2,1/2) from each Na

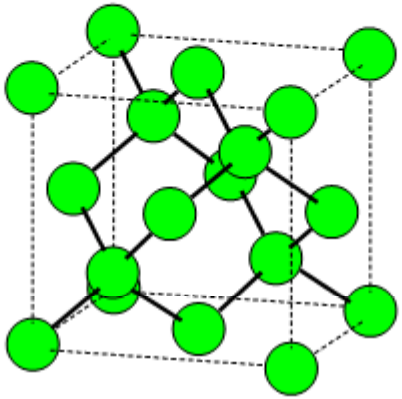
diamond (C) — also Si, Ge

lattice: cubic F

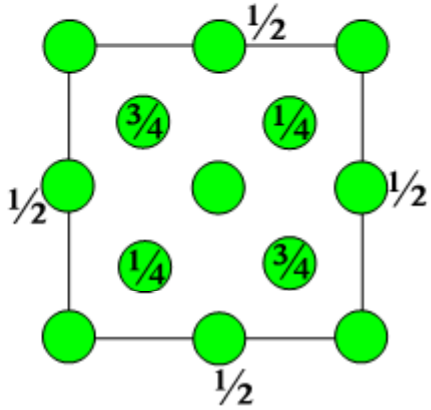
basis :

C 000

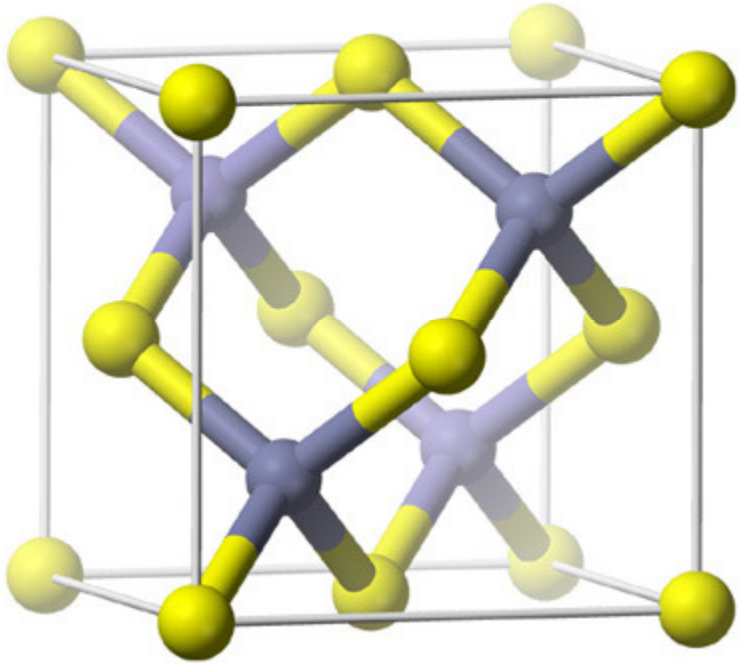
C ¼¼¼



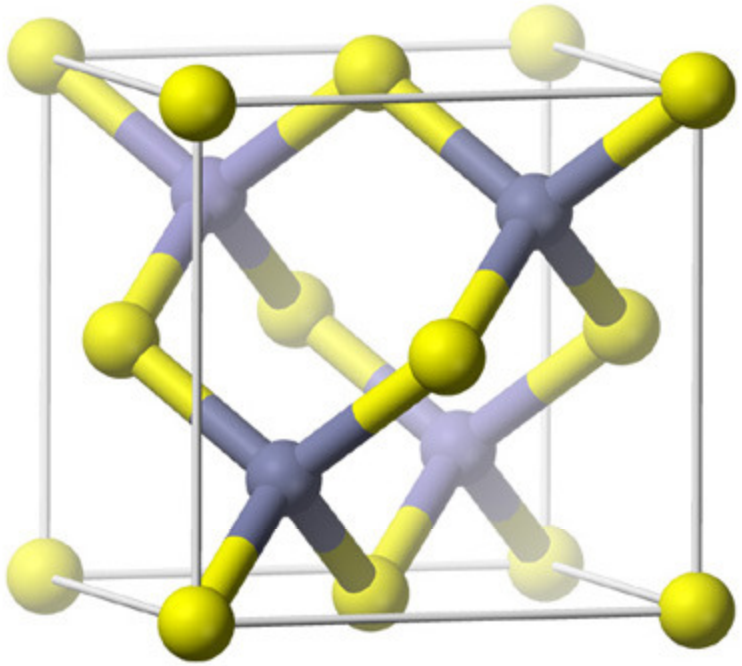
Plan view



GaAs Structure…



GaAs Structure…



FCC:

Basis: Yellow at (0,0,0)

Blue at (1/4,1/4,1/4)