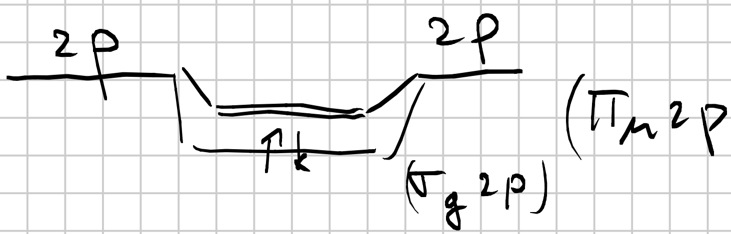
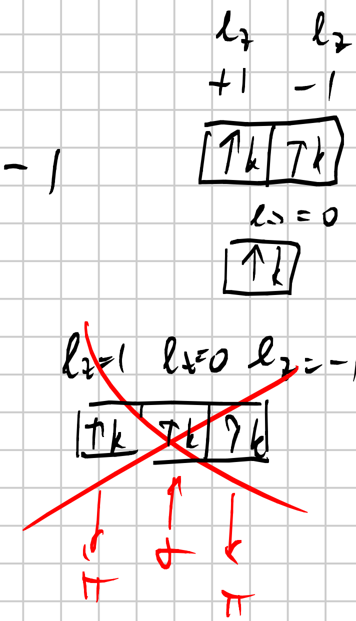
LECTURE # 10

Note Title 10/6/2008



$\pi \quad l_z = +1, -1$

$\sigma \quad l_z = 0$



F_2^+

ASK !

PRACTICE :

$S = \frac{1}{2}$	$+\frac{1}{2}$	$g\mu_B H\left(+\frac{1}{2}\right)$	E_1
	$-\frac{1}{2}$	$g\mu_B H\left(-\frac{1}{2}\right)$	E_0

MT:

$S=1$

$S_z = 1$	$g\mu_B H(+1)$	E_2
$S_z = 0$	0	E_1
$S_z = -1$	$g\mu_B H(-1)$	E_0

$$M(H,T) = \frac{-\frac{\partial E_0}{\partial H} e^{-\beta E_0} - \frac{\partial E_2}{\partial H} e^{-\beta E_2}}{e^{-\beta E_0} + \cancel{1} + e^{-\beta E_2}}$$

$$e^{x} - e^{-x} \sim 2\sinh x \sim 2x$$

$$e^{x} + e^{-x} \sim 2\cosh x \sim 1$$

PROB #3

$$\boxed{\int e^{-|x|} \frac{d^2}{dx^2} e^{-|x|}\, dx = -1}$$

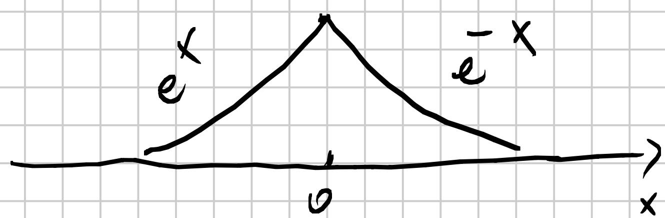
$$\frac{1}{\sqrt{\alpha}} e^{-\frac{|x|}{\alpha}}$$

$$y = \frac{x}{\alpha} \qquad dy = \frac{dx}{\alpha}$$

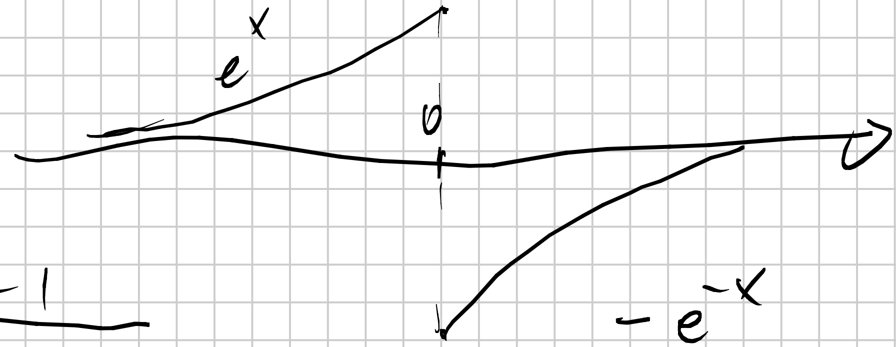
$$\frac{1}{\alpha} \int e^{-\frac{|x|}{\alpha}} \frac{d^2}{dx^2} e^{-\frac{|x|}{\alpha}}\, dx \rightarrow \frac{1}{\cancel{\alpha}} \int e^{-|y|} \frac{d^2}{\alpha^2 dy^2} e^{-|y|}\, \cancel{\alpha}\, dy$$

$$\frac{1}{\alpha^2}(-1)$$

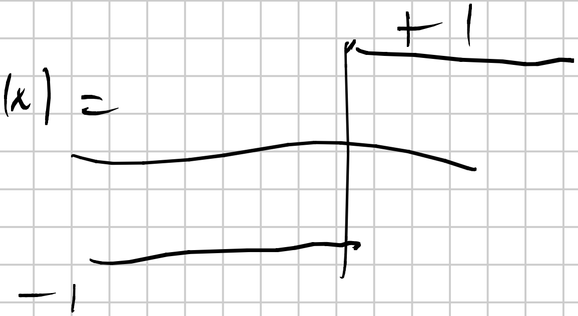
$e^{-|x|}$



$$\frac{d}{dx} e^{-|x|} = -\,\mathrm{sign}(x)\, e^{-|x|}$$



$\mathrm{sign}(x) =$



$$\int_{-\infty}^{\infty} e^{-|x|} \frac{d^2}{dx^2} e^{-|x|}\, dx = e^{-|x|} \frac{d}{dx} e^{-|x|} \Big|_{-\infty}^{+\infty} - \int_{-\infty}^{\infty} \left(\frac{d}{dx} e^{-|x|}\right)\left(\frac{d}{dx} e^{-|x|}\right) dx$$

$$= 0 - \int_{-\infty}^{\infty} e^{-2|x|}\, dx = -1$$

$\langle V \rangle$

$$\int f(x_1)\, \delta(x_1)\, dx_1 = f(0)$$

$$\cancel{f(y_1)}$$

$$\langle V_{12} \rangle = \int_{-\infty}^{\infty} dx_1 \int_{-\infty}^{\infty} dx_2 \; \varphi(x_1)\, \varphi(x_2)\, \delta(x_1 - x_2)\, \varphi(x_1)\, \varphi(x_2) =$$

$$x_1 - x_2 = 0$$

$$\Rightarrow x_2 = x_1$$

$$= \int_{-\infty}^{\infty} dx_1 \, \varphi^2(x_1) \int_{-\infty}^{\infty} dx_2 \; \varphi^2(x_2)\, \delta(x_1 - x_2) = \int_{-\infty}^{\infty} dx_1 \, \varphi^2(x_1)\, \varphi^2(x_1)$$

$$\int dx \; f(x)\, \delta(x - a) = f(a)$$

$H \qquad \psi(x_1, x_2) = \varphi_\alpha(x_1)\, \varphi_\alpha(x_2)$

$$\langle \psi | H | \psi \rangle$$

$$\int dx_1\, dx_2 \quad \psi^*(x_1, x_2)\, H\, \psi(x_1, x_2)$$

$$\langle V_{12} \rangle = \int_{-\infty}^{\infty} dx_1 \quad \varphi_\alpha^4(x_1)$$

SOLID STATE PHYSICS

CHAPT 4
ASHCROFT - MERMIN

CRYSTALLINE MATERIALS

POLYCRYSTALLINE MATERIALS

1915 BRAGG SCATTERING BY PHOTONS

DISTANCE BETWEEN ATOMS $\sim$ $d \sim 1\,\mathring{A}$

PHOTONS WITH $\lambda \sim d$

$$\hbar\omega_{photon}\,[eV] = \frac{12400}{\lambda\,[\mathring{A}]} \sim 10^4\ eV$$

10 keV

$\Rightarrow$ X RAYS

MATHEMATICAL DESCRIPTION OF A LATTICE

① BRAVAIS LATTICE

(A) SAME "VIEW"

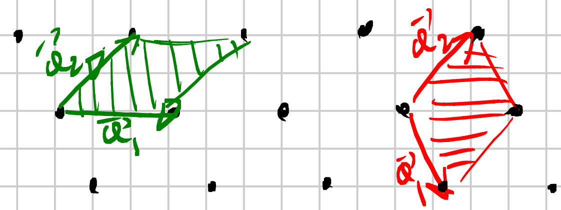
(B) $\vec{R} = n_1\vec{a}_1 + n_2\vec{a}_2 + n_3\vec{a}_3$

WHERE $\vec{a}_1, \vec{a}_2, \vec{a}_3$ NOT COLLINEAR 3D VECTORS

$n_1, n_2, n_3 \in \mathbb{Z}$

$\vec{a}_1, \vec{a}_2, \vec{a}_3$ PRIMITIVE VECTORS

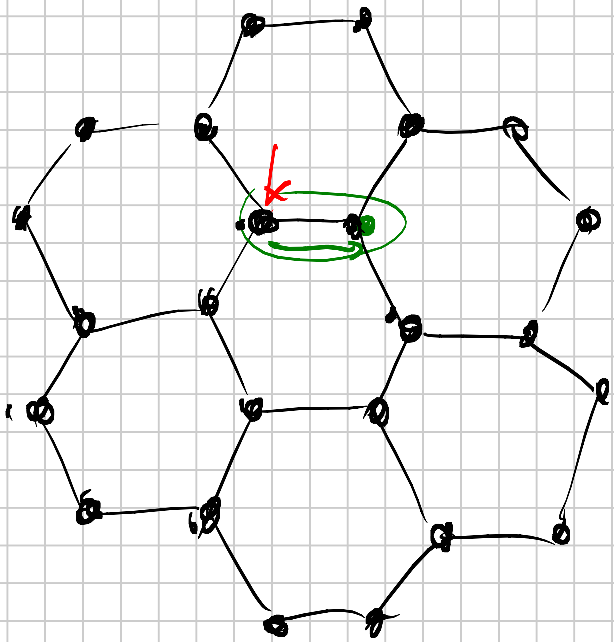
IN 2D $\vec{a}_1$, $\vec{a}_2$ PLANAR VECTORS



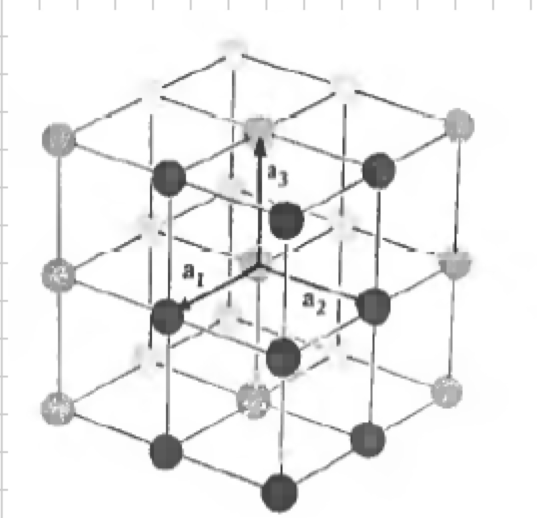
CHOICE OF PRIMITIVE VECTORS NOT UNIQUE

GRAPHENE

HONEYCOMB LATTICE

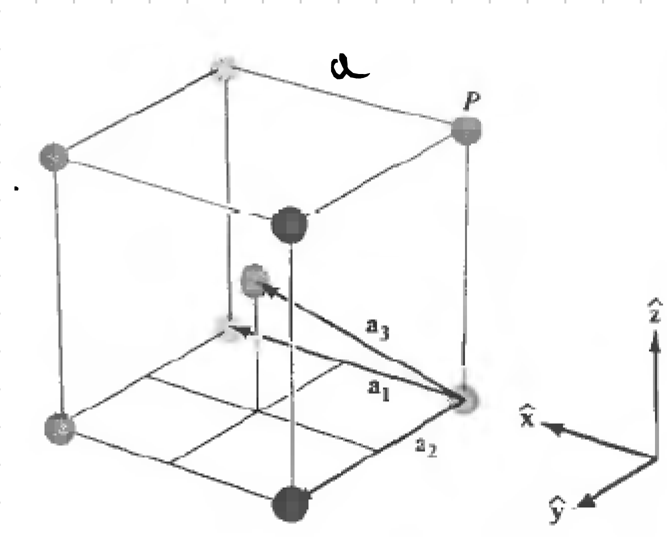


3D LATTICES



CUBIC

BODY - CENTERED CUBIC BCC



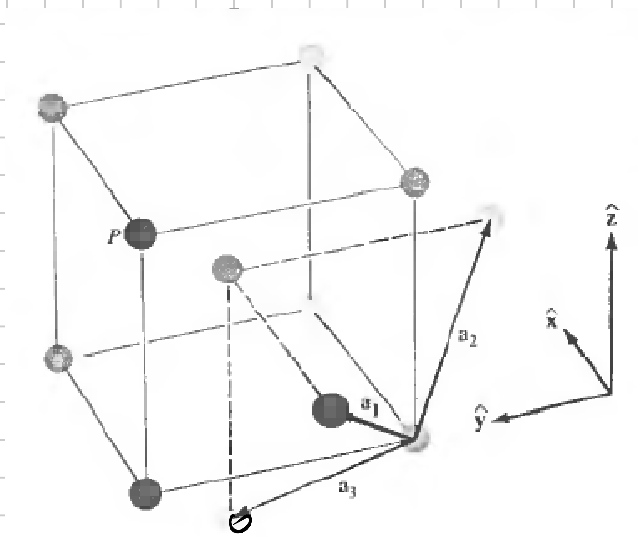
$\vec{a}_1 = a(1\,0\,0)$

$\vec{a}_2 = a(0\,1\,0)$

$\vec{a}_3 = \frac{a}{2}(1\,1\,1)$

Fe
Li
Na
K
W

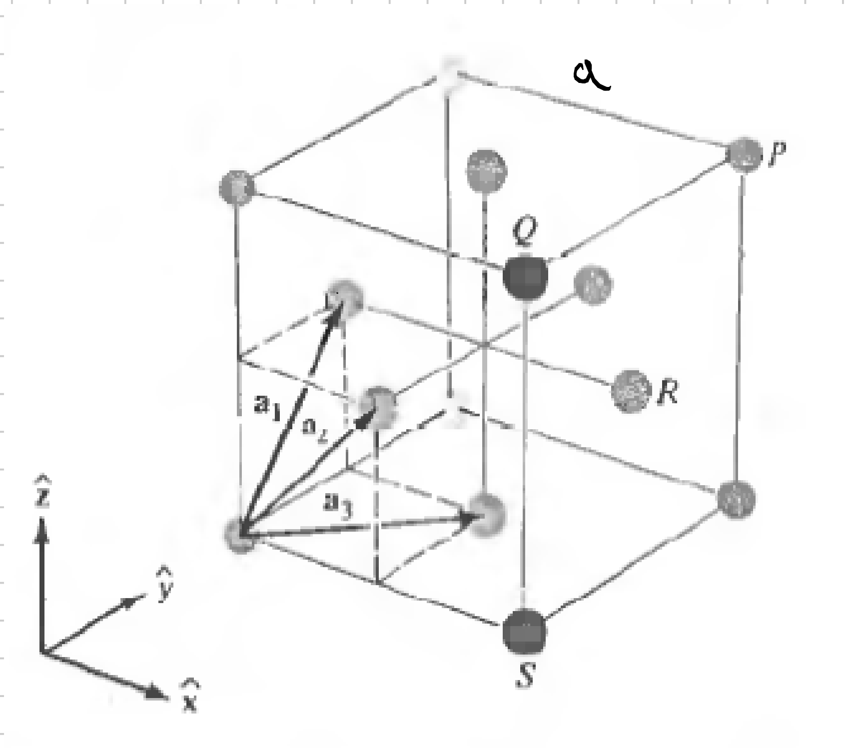
$\vec{a}_1 = (a_x, a_y, a_z)$



$\bar{1} = -1$

$$\boxed{\begin{aligned}\vec{a}_1 &= \frac{a}{2}(\bar{1},1,1)\\ \vec{a}_2 &= \frac{a}{2}(1,\bar{1},1)\\ \vec{a}_3 &= \frac{a}{2}(1\,1\,\bar{1})\end{aligned}}$$

FACE-CENTERED CUBIC FCC



$$\vec{a}_1 = \frac{a}{2}(0\,1\,1)$$

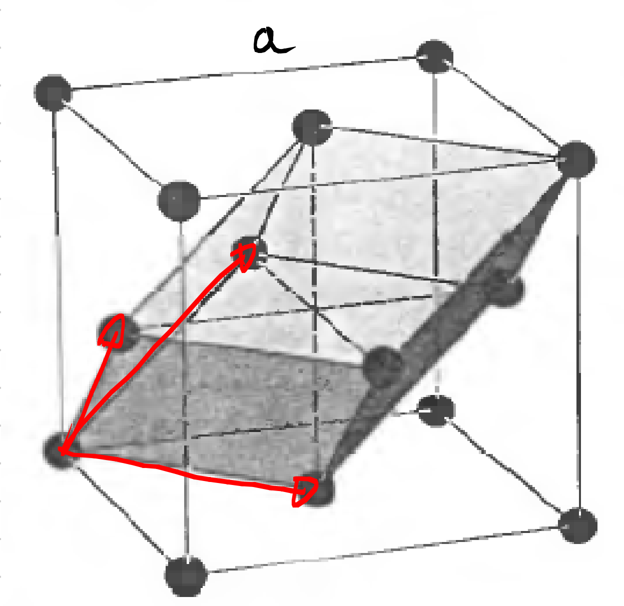
$$\vec{a}_2 = \frac{a}{2}(1\,0\,1)$$

$$\vec{a}_3 = \frac{a}{2}(1\,1\,0)$$

Ag
Au
Cu

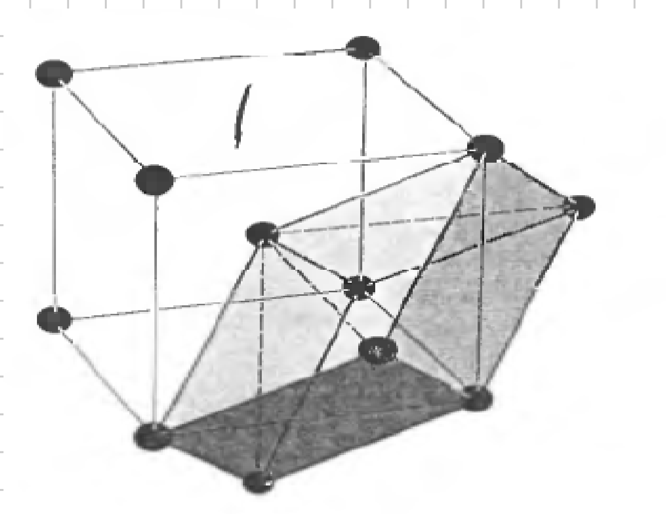
PRIMITIVE UNIT CELL

= SOLID (AREA IN 2 DIMENSIONS) GENERATED BY PRIMITIVE VECTORS



FCC

$$\frac{a^3}{4} = V$$ OF PRIMITIVE CELL



PRIMITIVE UNIT CELL

FOR BCC

$$V = \frac{a^3}{2}$$