Examples of :

Molecular Solid	Network Solid	Metallic	Ionic
Benzene	graphite	Copper	NaCl
Urea	SiC	Iron	AgCl
Ammonia	Diamond	Rubidium	Na_2SO_4
Water	AlN		CaF_2
$I_2(s)$	SiO_2 (Quartz)		ZnS
Ar			

fullerene

AlN

Difference between amorphous and crystalline solid

	Crystalline	Amorphous
(1)	Arrangement of atom/ion remain same throughout the solid	(1) Don't remain same throughout the solid.
(2)	ΔH_{fusion} is definite	(2) ΔH_{fusion} is not definite
(3)	Melt at a sharp temperature	(3) Melts over a range of temperature
(4)	Cleavage plane new surfaces are plain and smooth	(4) New surfaces are irregular
(5)	Anisotropic nature	(5) Isotropic nature

Depending upon the type of bonding crystalline solids can be categorised into

1. Ionic solid :— Ionic bonds are present
   e.g NaCl, KCl, ZnS
2. Metallic solid :— Metallic bonds are present
   e.g Cu, Fe, Ag
3. Covalent or network solid) :— Covalent bonds are presents
   e.g. Diamond, graphite, SiO_2 (Quartz)

4.) Molecular solids :- Molecules are held together by Vander Waal's forces

- non-polar — Examples: $I_2(s)$
- polar — $SO_2(s)$
- H-bonded — H_2O (ice), HF

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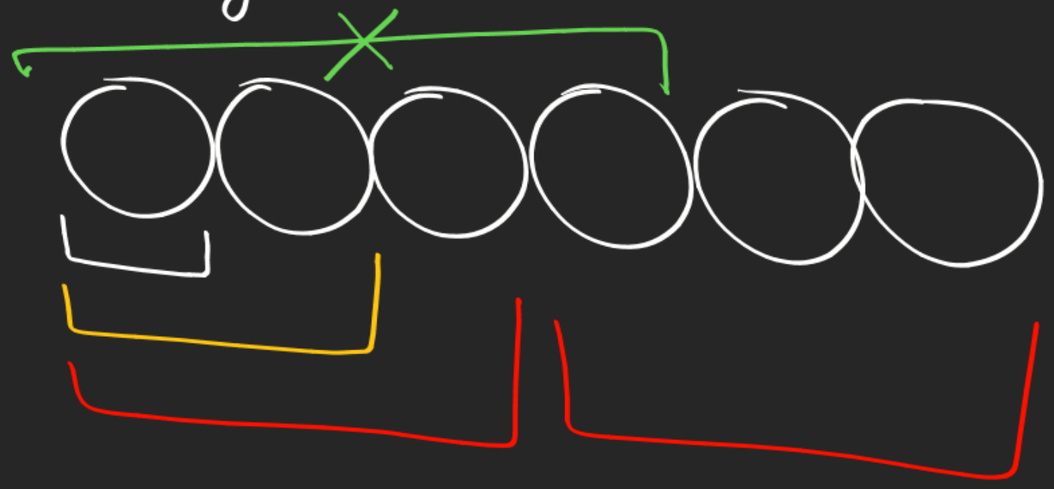
Some Basic Definitions

1. **Basis or Motif:** — A basis may be an atom, Molecule or ion which is repeated in Space to generate entire crystal (solid)



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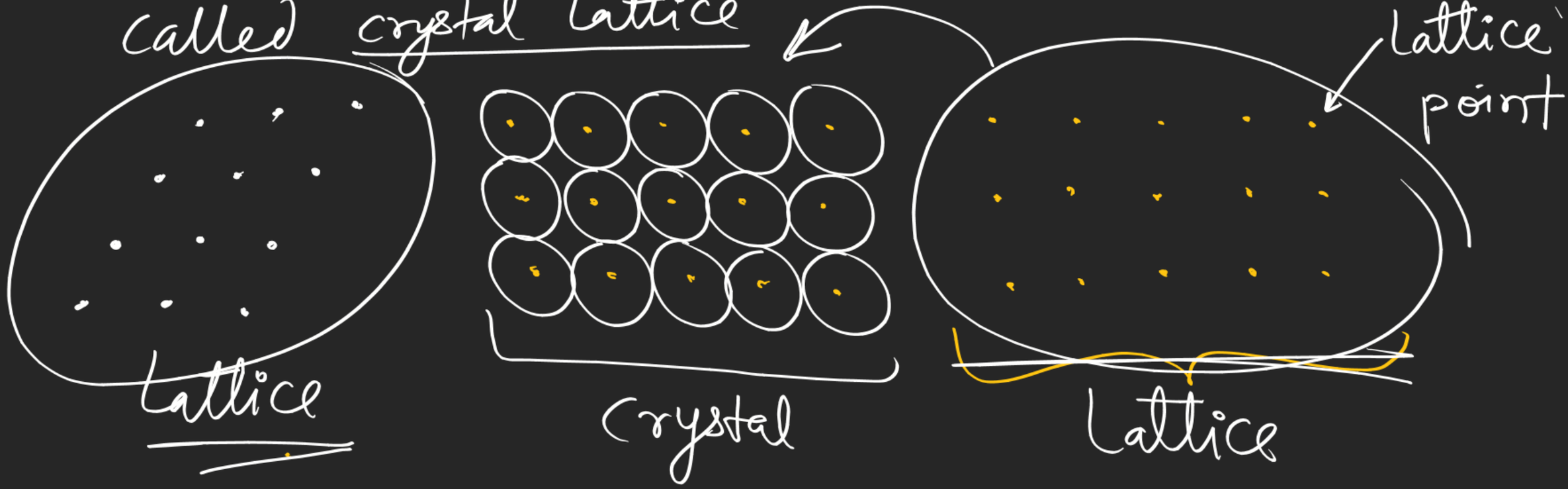
Crystal lattice, lattice or space lattice :→

If we put a point at the same location in each repeated basis, the collection of points is called crystal lattice



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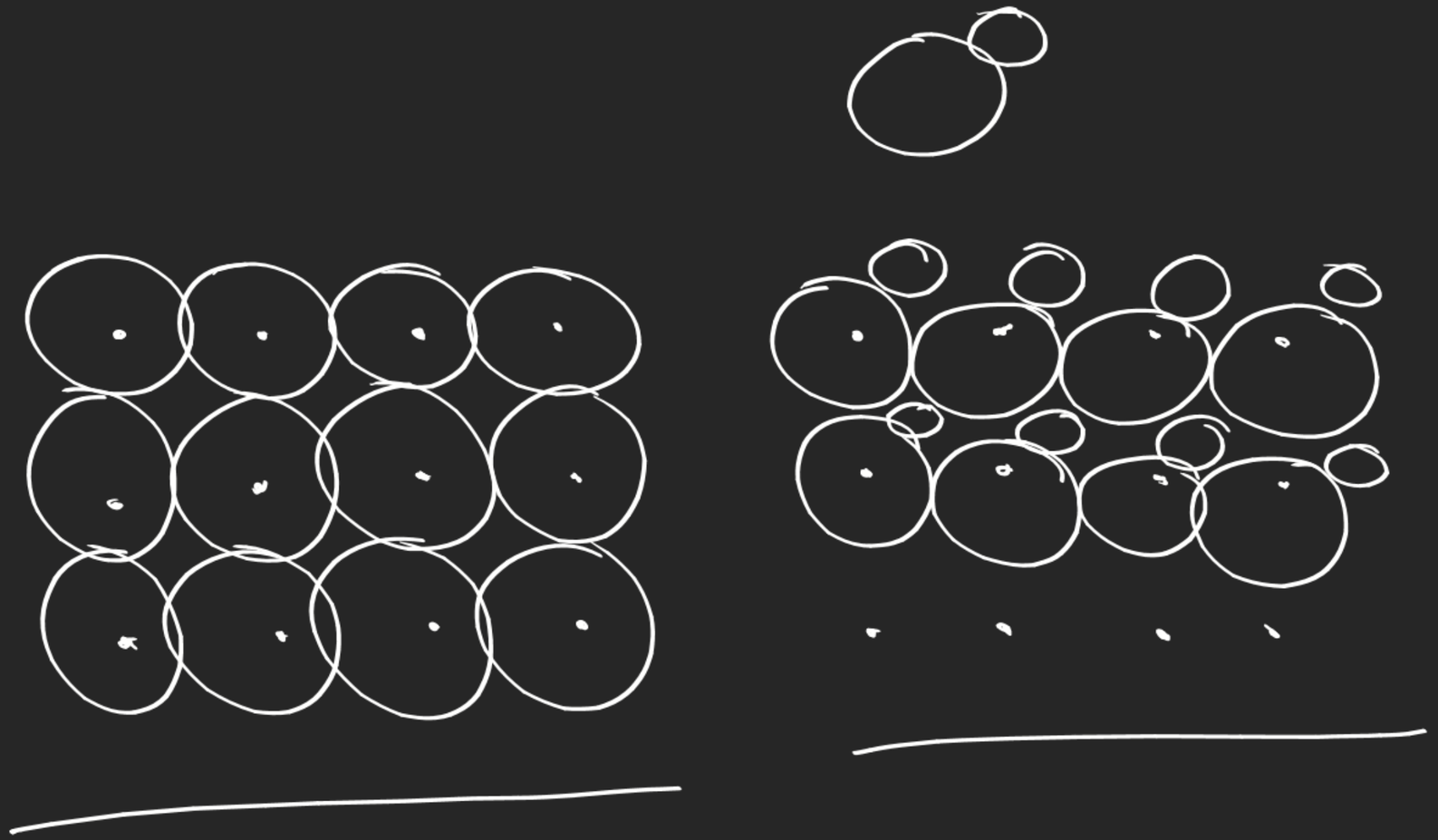

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parallelogram

edge length

a, b, C

Interfacial angles

α, β, γ

parallelopiped

having 6 faces, in which opposite faces are parallel to each other

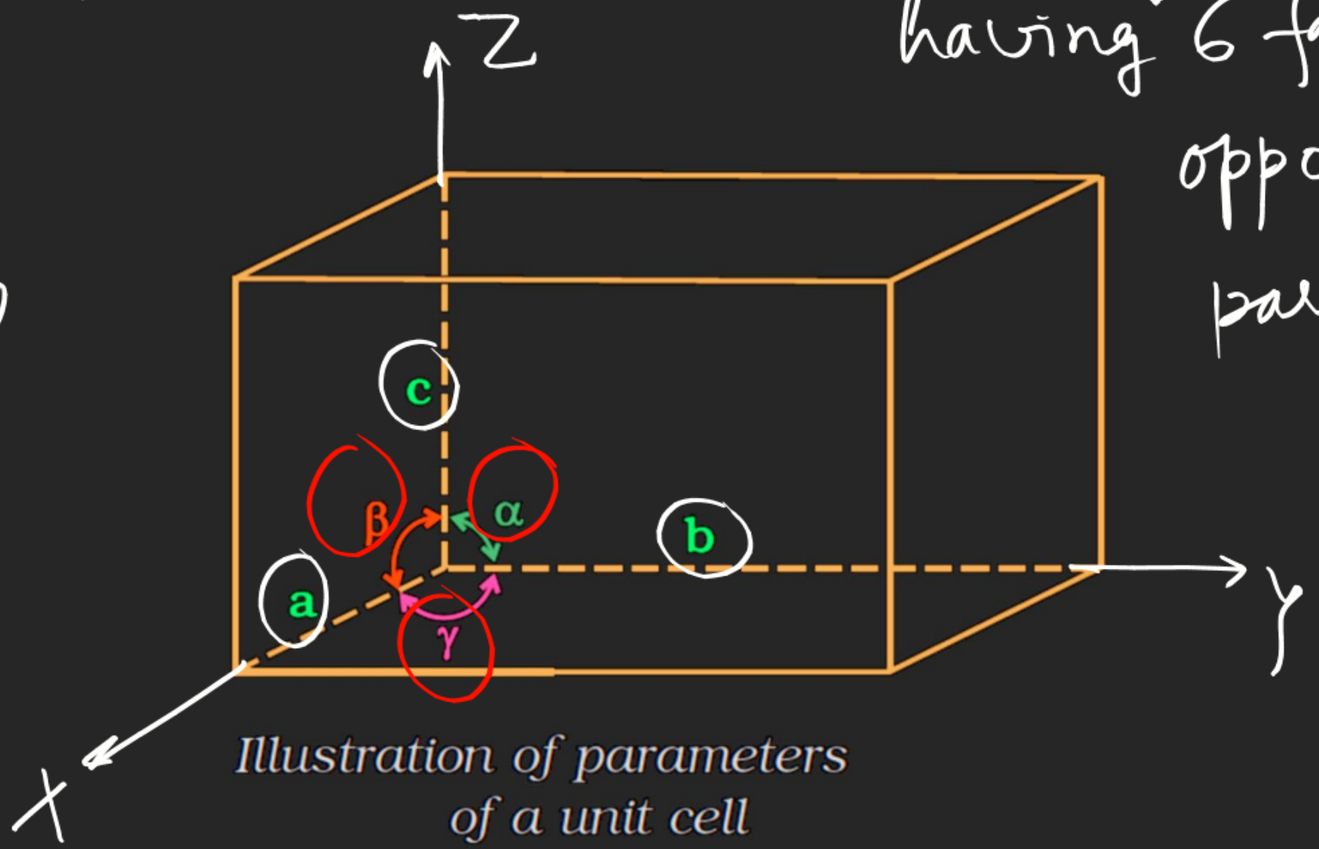

Illustration of parameters of a unit cell

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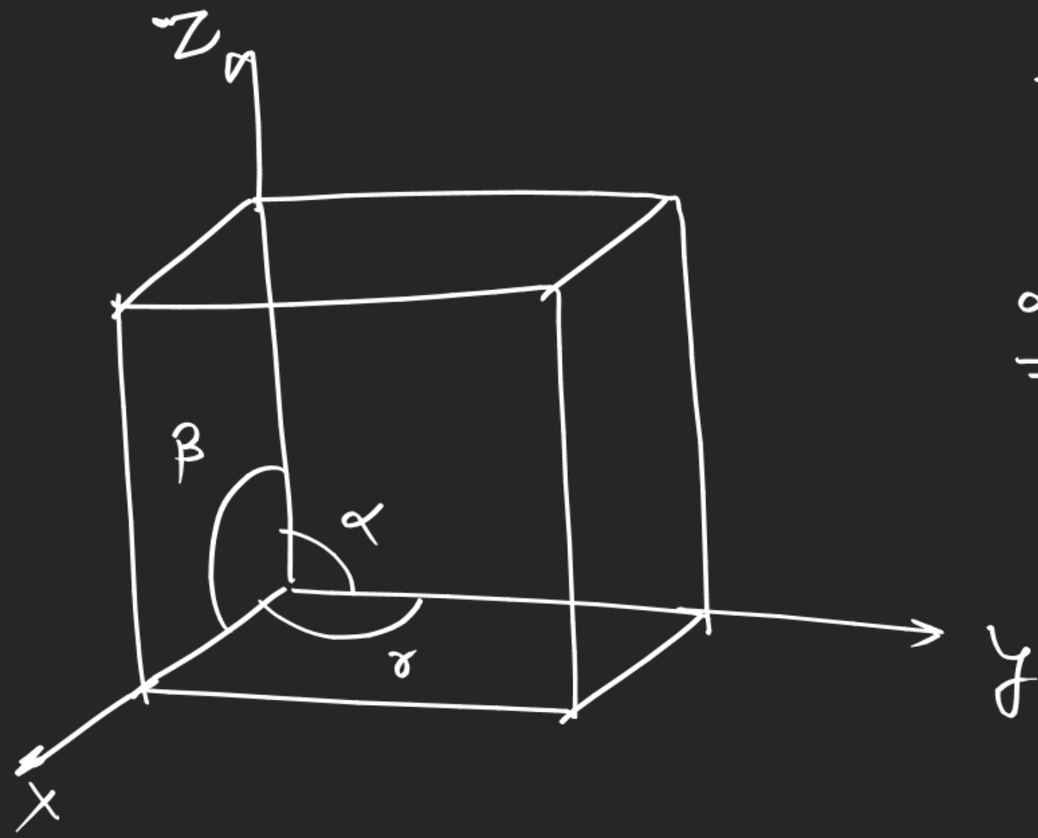

Cube

$a = b = c$

$\alpha = \beta = \gamma = 90^\circ$

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$a=b=c$
$\alpha=\beta=\gamma=90^\circ$

Cubic

Cube

$a=b\neq c$
$\alpha=\beta=\gamma=90^\circ$

Tetragonal

Cuboid

$a\neq b\neq c$
$\alpha=\beta=\gamma=90^\circ$

Orthorhombic

Prism

Hexagonal

Trigonal

Rhombohedral

Monoclinic

Triclinic

Seven crystal systems

Unit cell :—

Lattice
+
Basis
= crystal

If all the lattice points are connected by lines the smallest parallelopiped which can be repeated to generate the entire lattice is called unit cell

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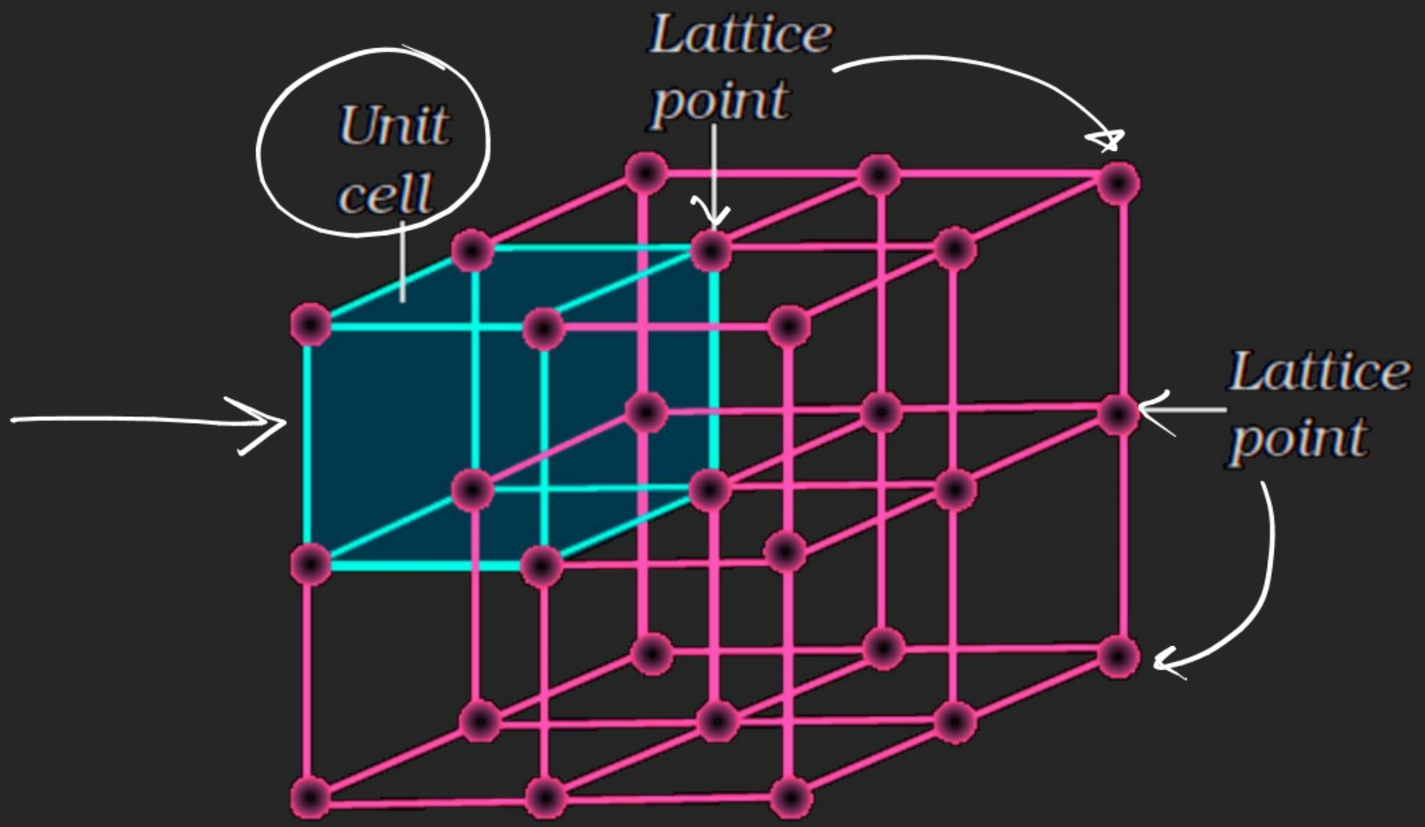
Lattice



Seven Primitive Unit cells and their Possible Variations as Centered Unit Cells

Crystal system	Possible Variations	Axial distance or edge lengths	Axial angles	Examples
Cubic	Primitive Body centered Face centred	a = b = c	α = β = γ = 90º	NaCl, Zinc blende, Cu
Tetragonal	Primitive Body centered.	a = b ≠ c	α = β = γ = 90º	White tin, SnO_2, TiO_2, $CaSO_4$
Orthorhombic	Primitive Body centered. Face centered, End centered	a ≠ b ≠ c	α = β = γ = 90º	Rhombic sulphur, KNO_3, $BaSO_4$
Hexagonal	Primitive	a = b ≠ c	α = β = 90º γ = 120º	Graphite, ZnO, CdS
Rhombohedral or Trigonal	Primitive	a = b = c	α = β = γ ≠ 90º	Calcite ($CaCO_3$), HgS (Cinnabar)
Monoclinic	Primitive End centred	a ≠ b ≠ c	α = γ = 90º β ≠ 90º	Monoclinic sulphur, $Na_2SO_4.10H_2O$
Triclinic	Primitive	a ≠ b ≠ c	α ≠ β ≠ γ ≠ 90º	K_2CrO_7, $CuSO_4.5H_2O$, H_3O

3 2 4 1 1 2 1

α = β = 90° γ = 120°

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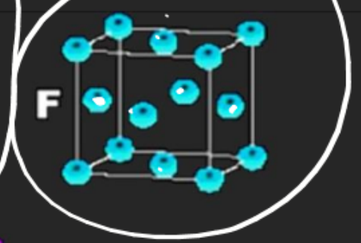
Primitive

Body centred

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



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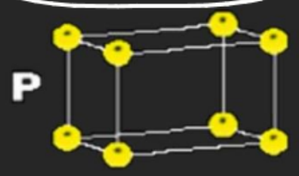
TETRAGONAL
$a = b \neq c$
$\alpha = \beta = \gamma = 90°$



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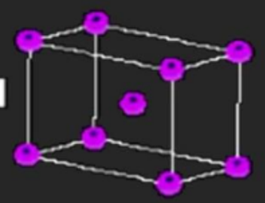
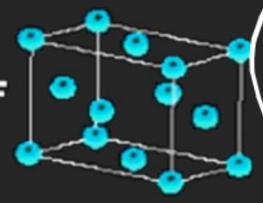
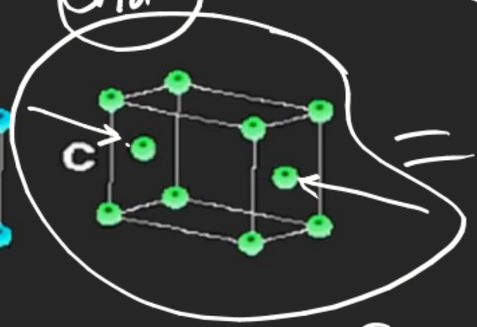
ORTHORHOMBIC
$a \neq b \neq c$
$\alpha = \beta = \gamma = 90°$





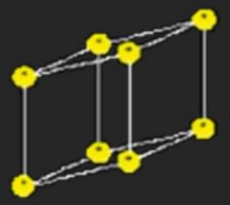
end



= 4

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

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



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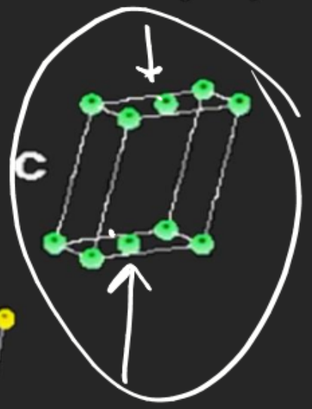
MONOCLINIC
$a \neq b \neq c$
$\alpha = \gamma = 90°$
$\beta \neq 120°$



= 3

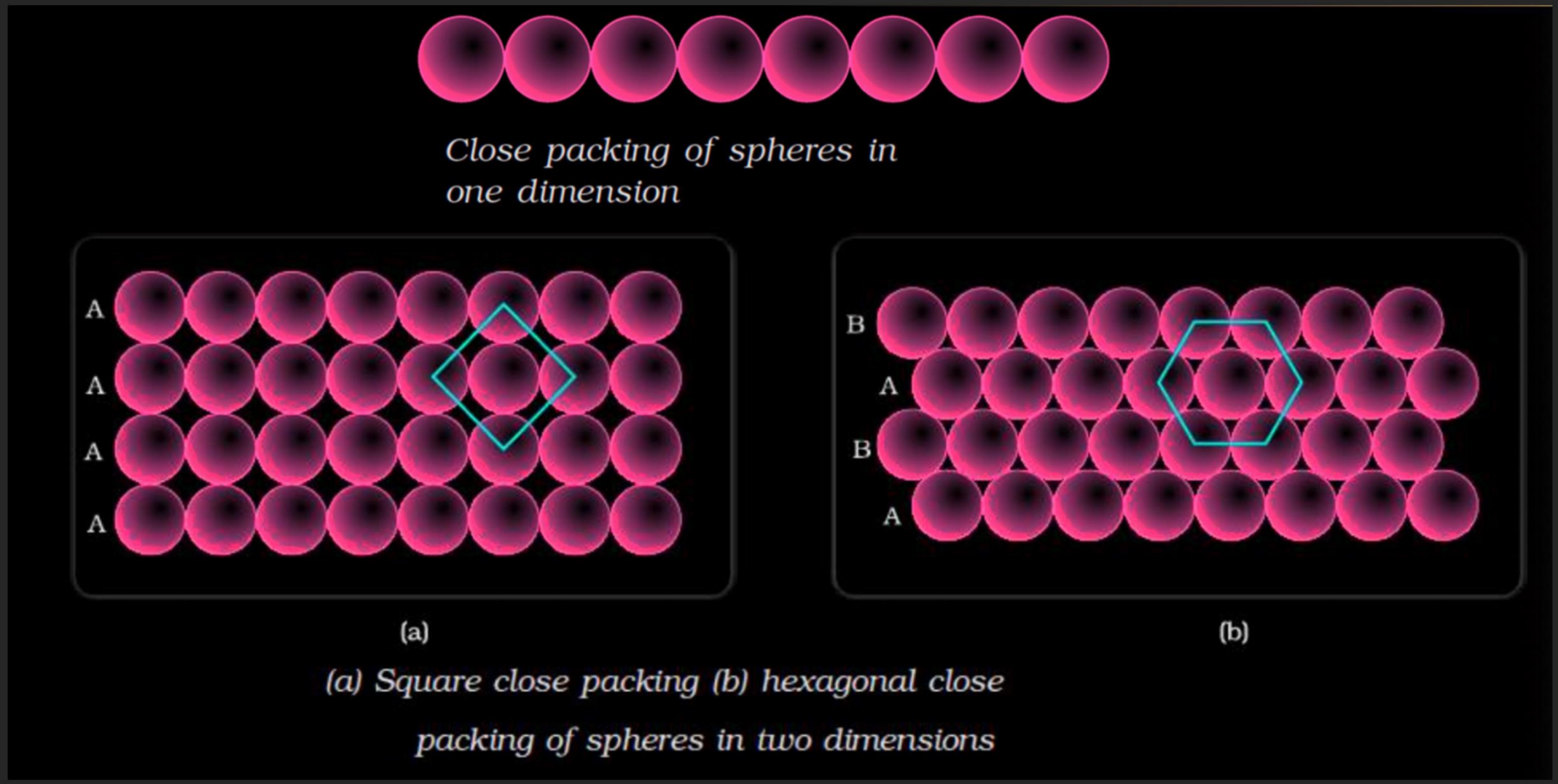
TRICLINIC
$a \neq b \neq c$
$\alpha \neq \beta \neq \gamma \neq 90°$

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

there are 14 types of Unit cell

Bravais Lattices

14



(a) Square close packing (b) hexagonal close packing of spheres in two dimensions

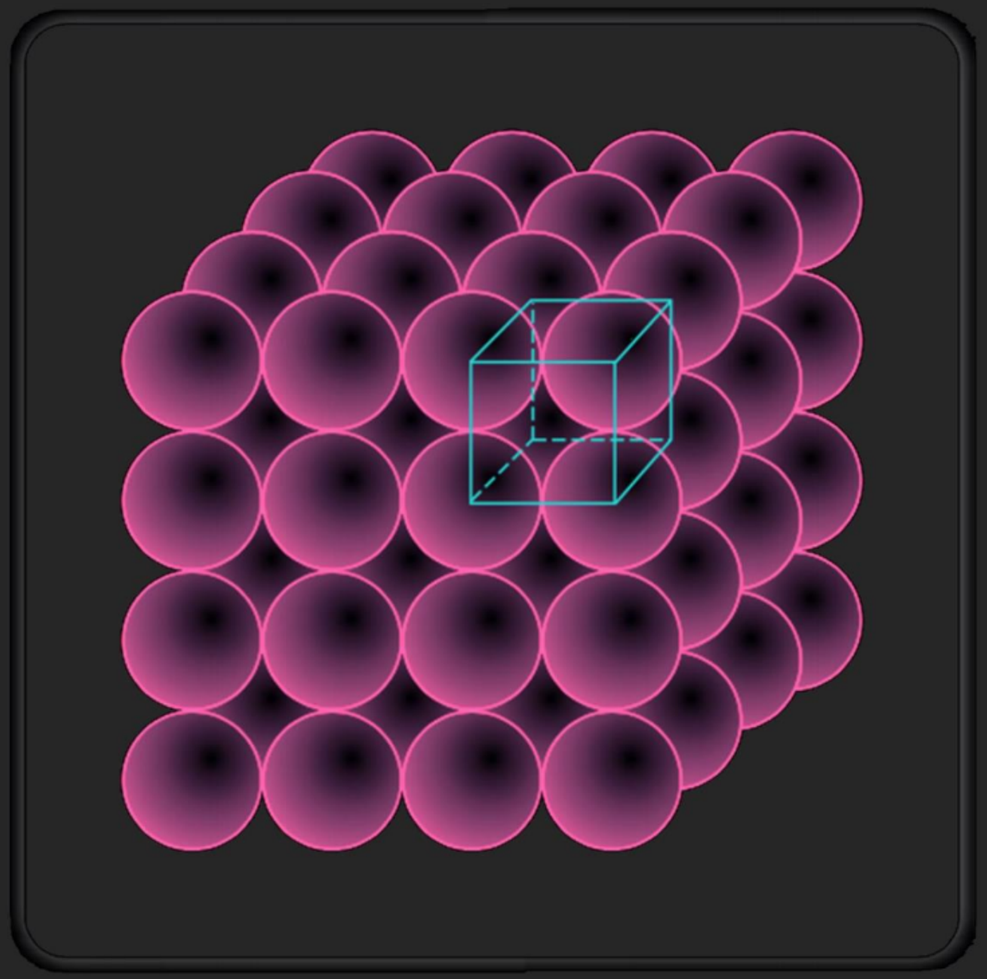
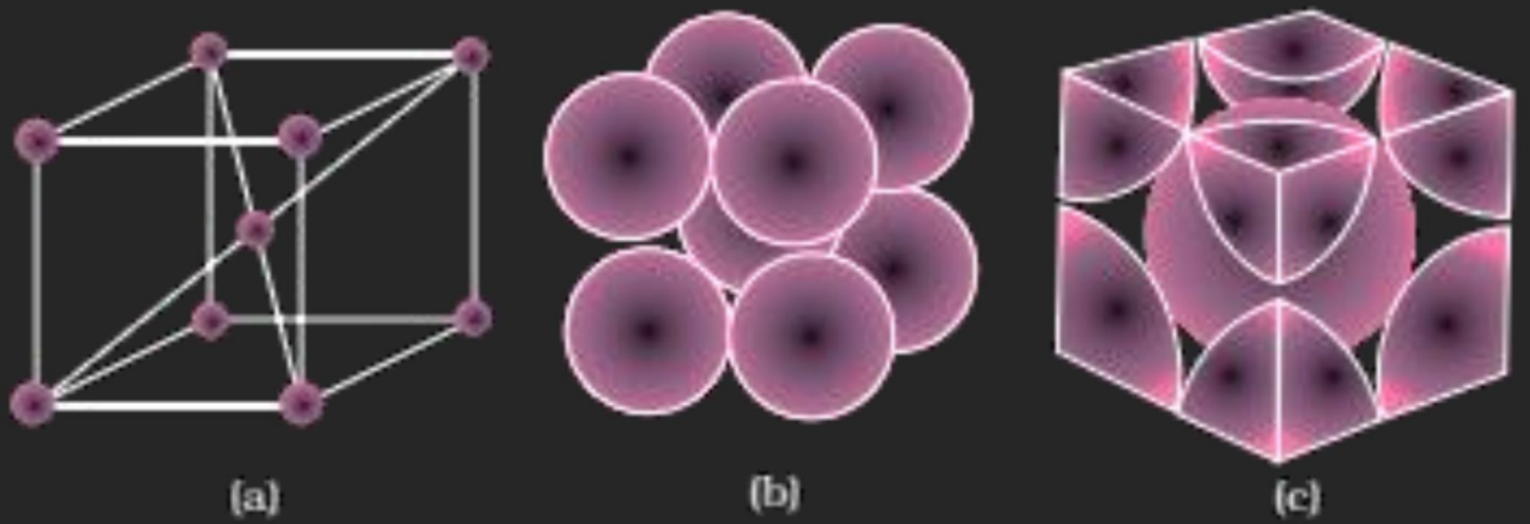


Fig. 1.19: Simple cubic lattice formed by A A A .... arrangement



A primitive cubic unit cell (a) open structure (b) space-filling structure (c) actual portions of atoms belonging to one unit cell.

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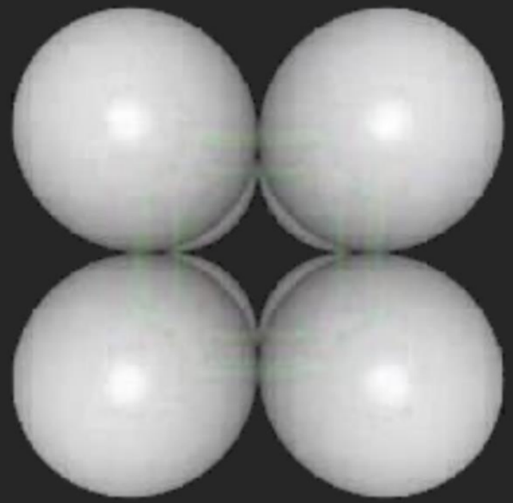

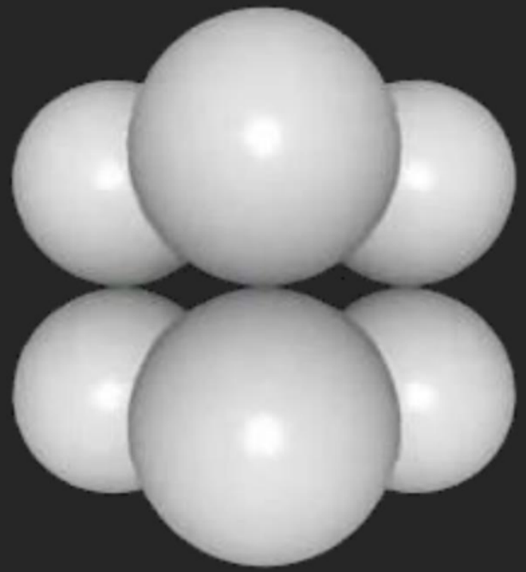

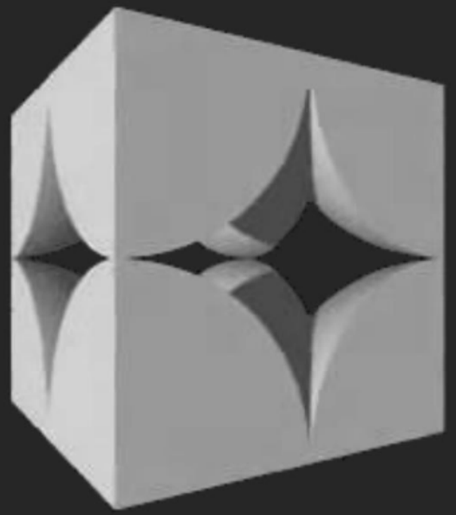

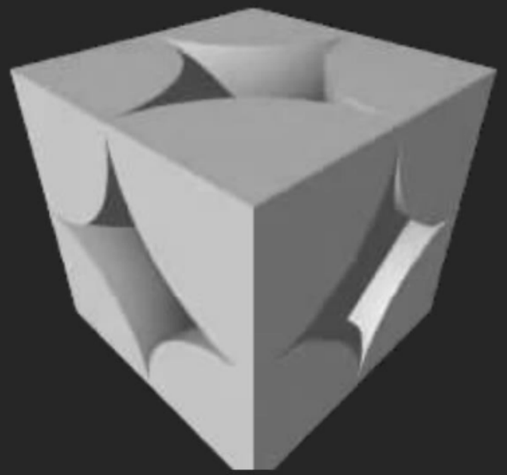

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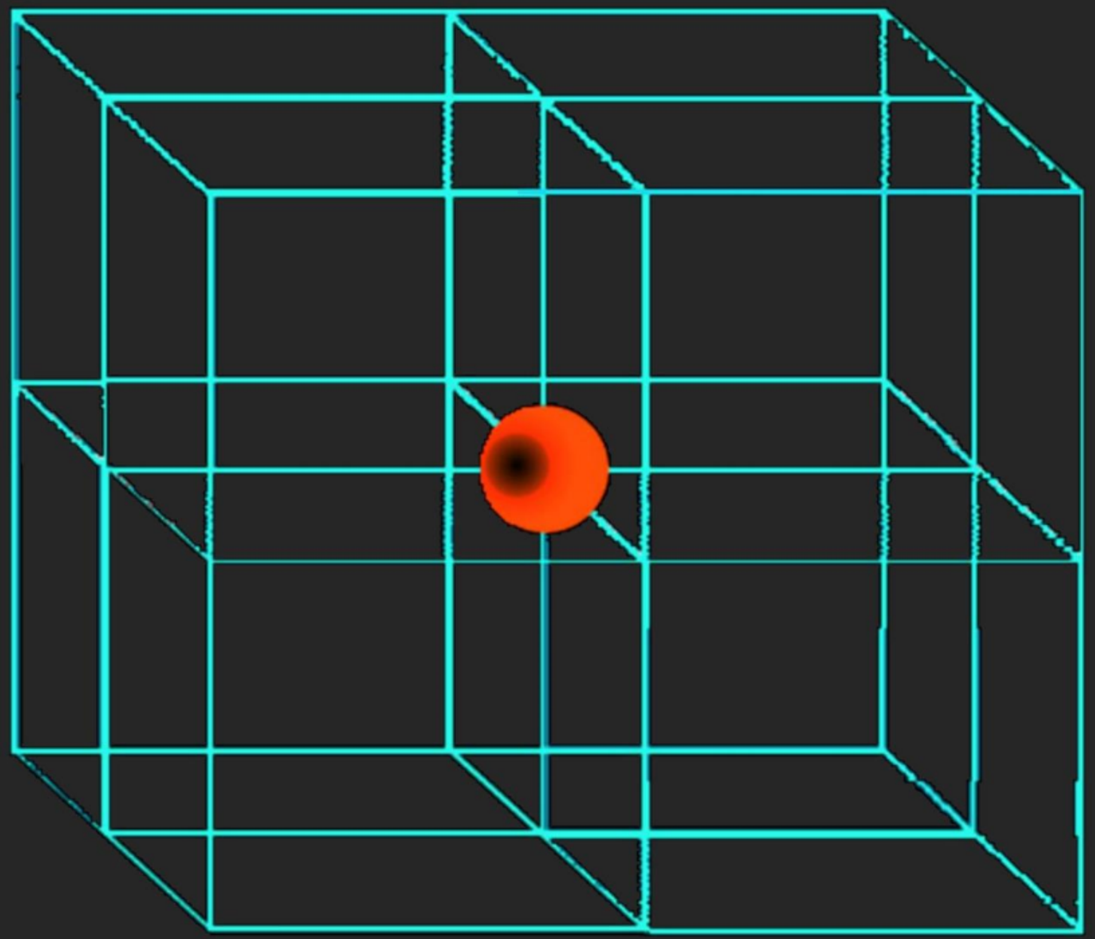

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