CLASSICAL MECHANICS

Asst. Prof. Sunil kumar

Dept. of Physics

S.S Arts College and T.P Science Institute, Sankeshwar

Belagavi

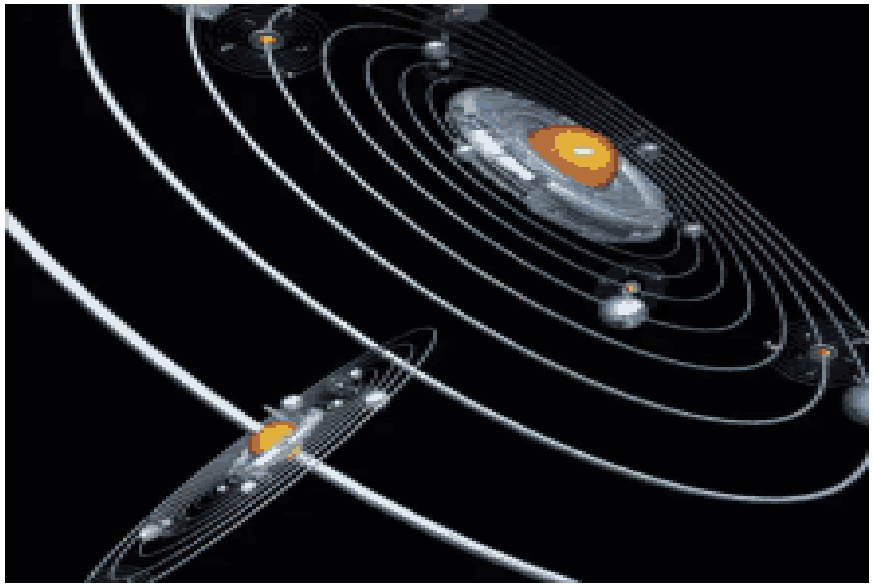
MECHANICS

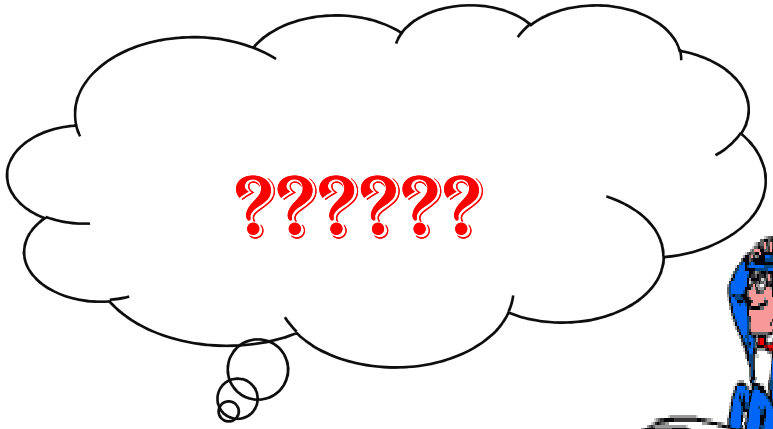
LASSICAL MECHANICS

MACROSCOPIC OBJECTS

• QUANTUM MECHANICS

MICROSCOPIC OBJECTS





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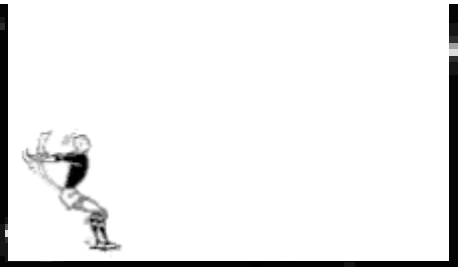
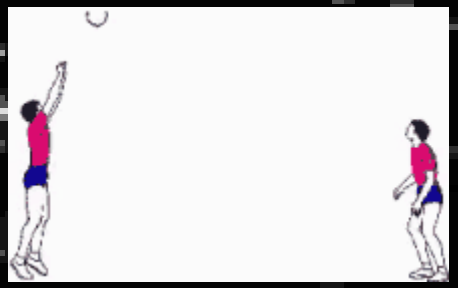
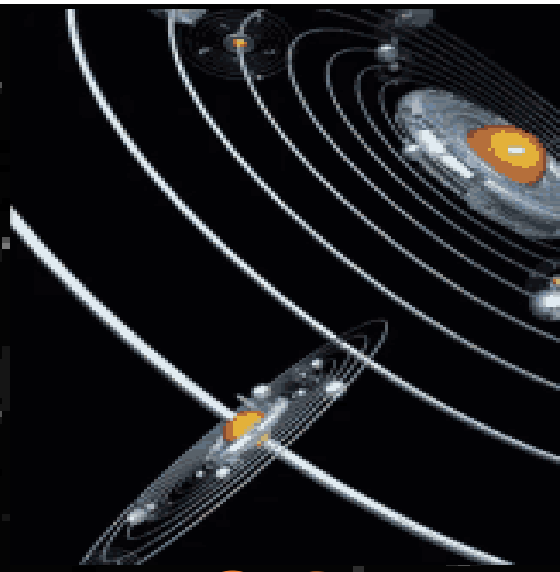


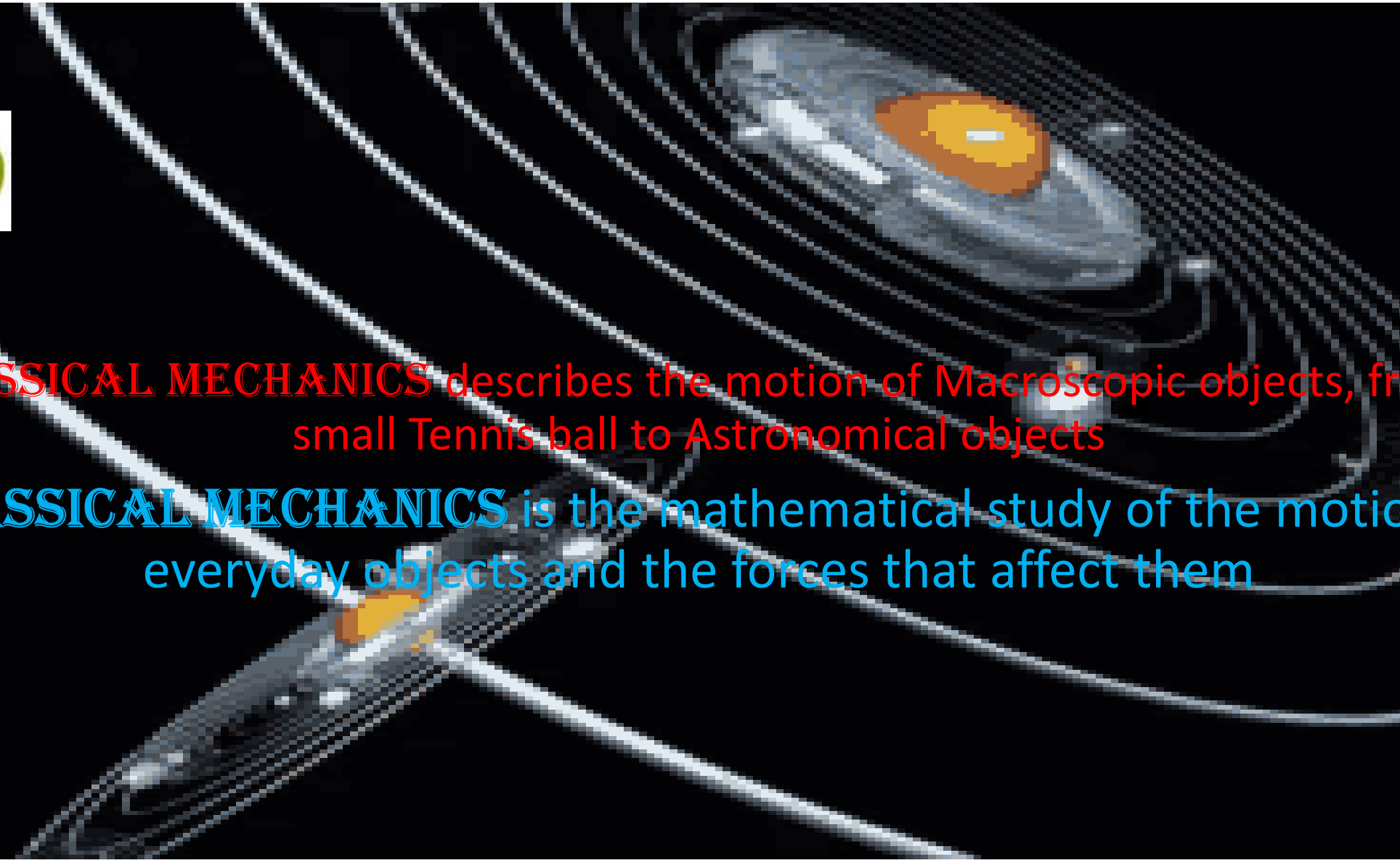




CLASSICAL MECHANICS

Galileo Galilei
1564 - 1642

Isaac Newton
1643 - 1727

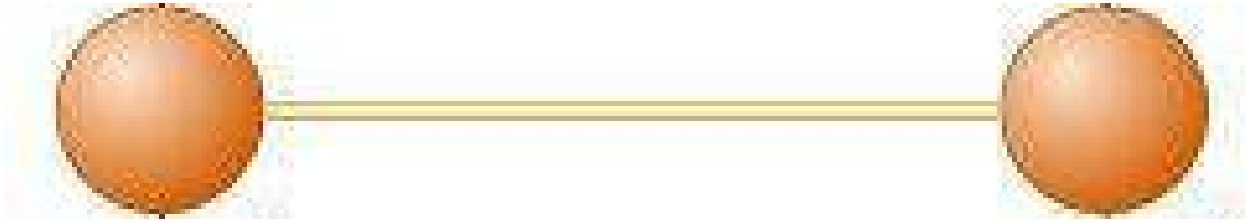

SSICAL MECHANICS describes the motion of Macroscopic objects, fr
small Tennis ball to Astronomical objects
SSICAL MECHANICS is the mathematical study of the motio
everyday objects and the forces that affect them

CLASSICAL MECHANICS

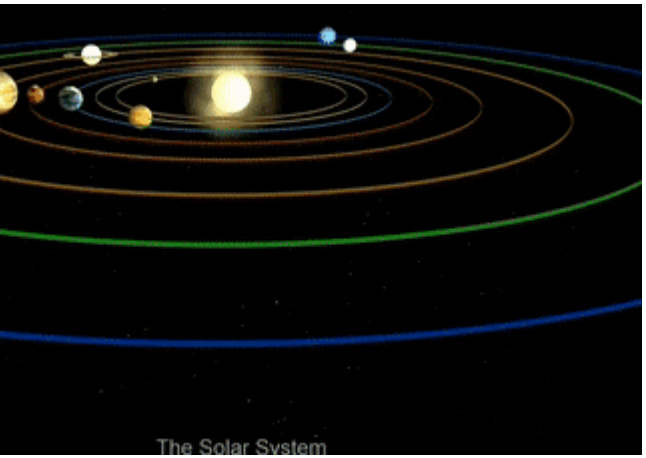
- Classical Mechanics describes the motion of *Macroscopic* objects

- V<<C

CONSTRAINTS



The limitation on the motion of a system are called constraints and the motion is said to be constrained motion


The Solar System

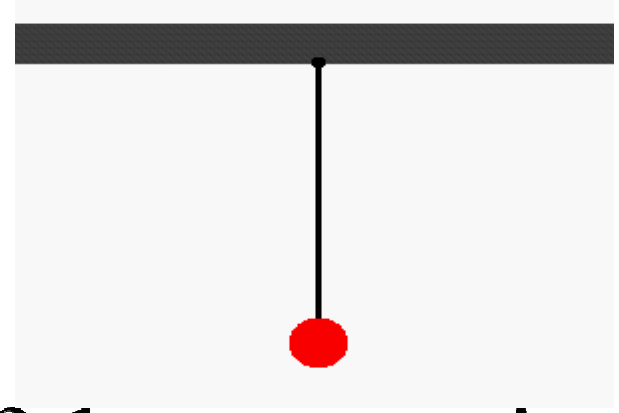

by arinnka

CONSTRAINTS

Types

- Holonomic constrains
- Nonholonomic constraints
- Sleronomic constraints
- Rheonomic constraints

HOLONOMIC CONSTRAINS



$$|r| = l$$

$$Or$$

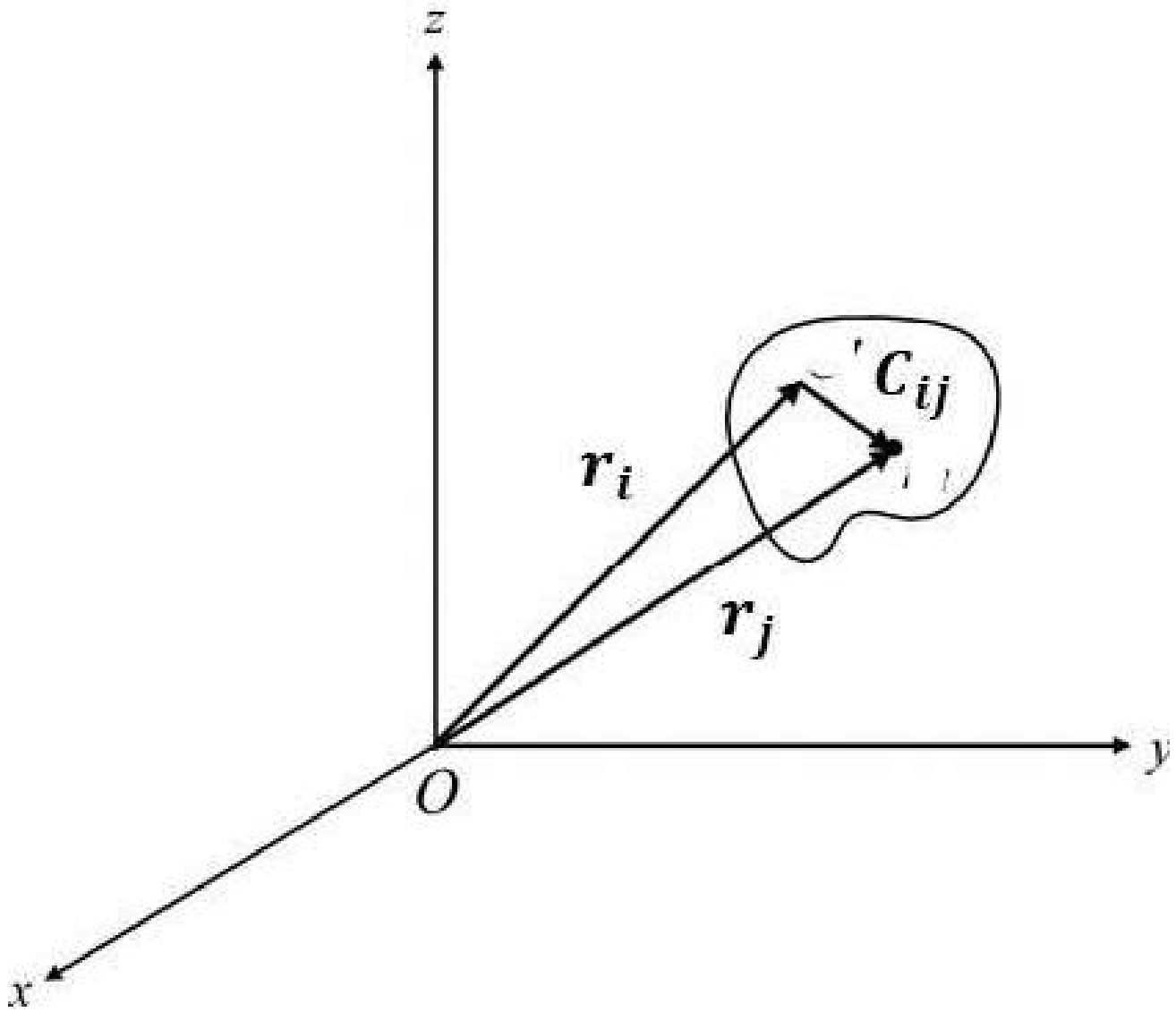
$$r^2 = l^2$$

$$r^2 - l^2 = 0$$

- If the constraints are expressible in the form of equations of the form

$$f(r_1, r_2 \ldots\ldots, t) = 0$$

then they are called holonomic constraints

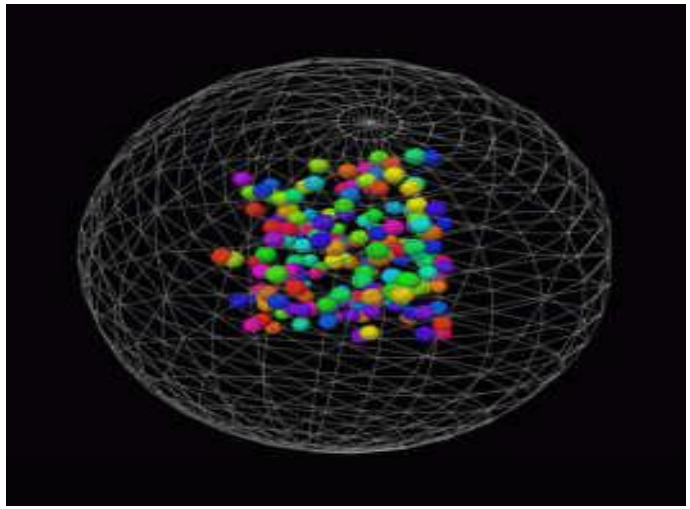


$$|r_i - r_j| = C_{ij}$$

$$(r_i - r_j)^2 = C_{ij}^2$$

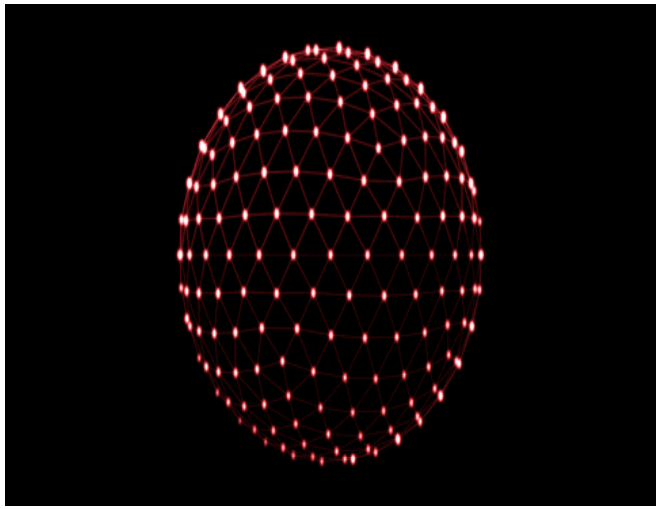
$$(r_i - r_j)^2 - C_{ij}$$

NONHOLONOMIC CONSTRAINS



$r \leq a$

$r-a \leq 0$



$r \geq$

$r-a$

Suppose the constraints are present in the system of N particles. If the constraints are not expressed in the form of equations of the form

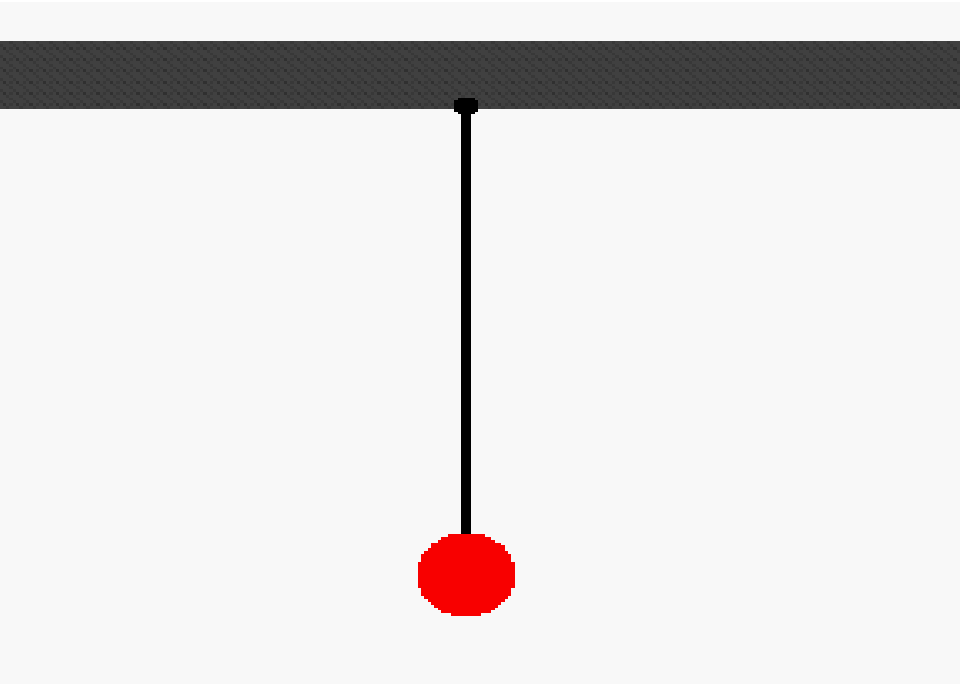
- $f(r_1, r_2 \ldots\ldots, t)=0$ ----- (1)

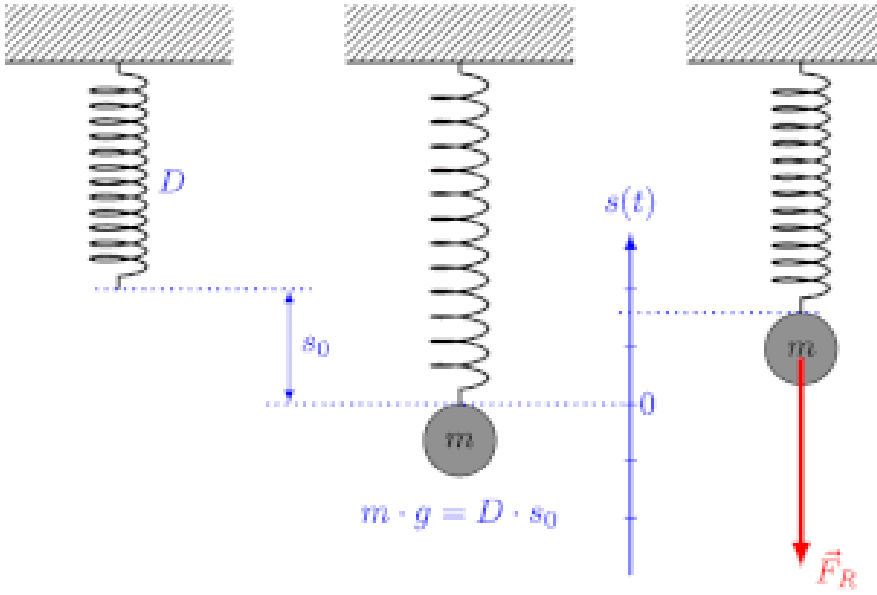
- i.e

- $f(r_1, r_2 \ldots\ldots, t)\neq 0$ ----- (2)

Then they are called nonholonomic constraints

SLERONOMIC CONSTRAINTS & RHEONOMIC CONSTRAINTS





Doesn’t depend on time explicitly

Depend on time explici

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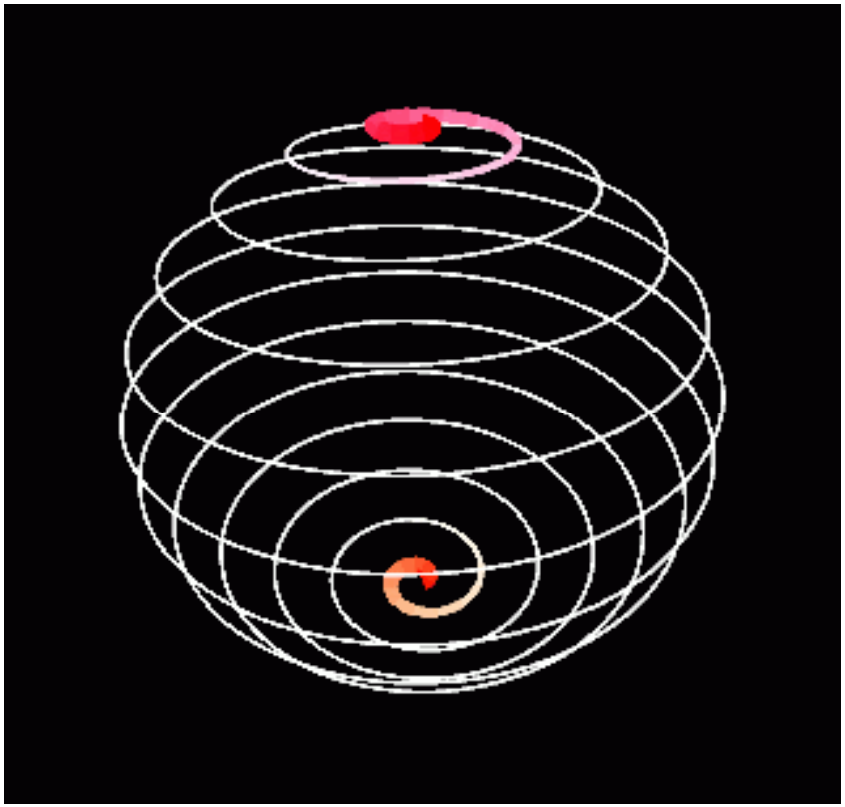
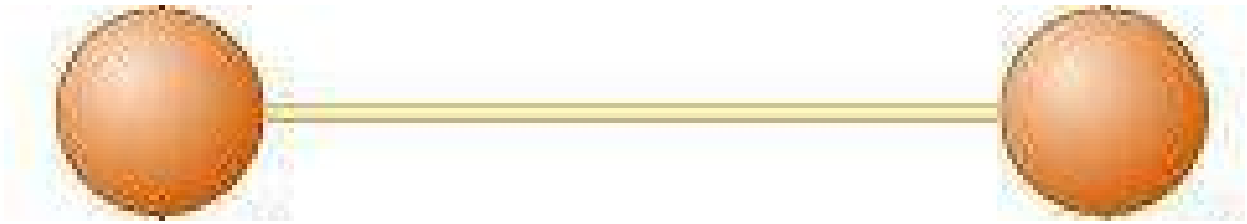
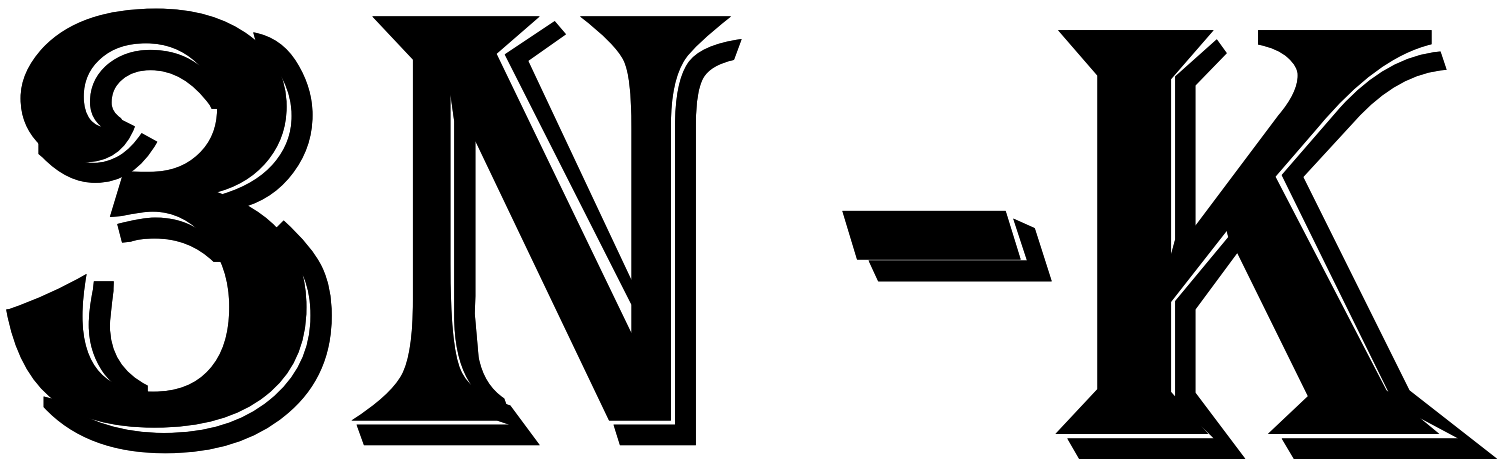




3N

2N


3N -K

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DEGREE OF FREEDOM

The number of independent variable in which the motion of a system is described is called the number of DEGREE OF FREEDOM

To explain the state of a particle or system, we require reference coordinates, through which we can configure the state of a particle or system.

Ex; Cartesian coordinates x, y and z

Polar coordinates; r and θ

Spherical coordinates; r, θ and ϕ

GENERALISED COORDINATES

"The least or minimum number of variable or coordinates used to describe the configuration of a system are called generalised coordinates"

- It eliminates the dependent variables
- They are independent coordinates (Neither polar nor Cartesian coordinates)

Holonomic system: generalised coordinates = degree of freedom

$_1, r_2, r_3, \ldots\ldots\ldots\ldots\ldots r_n$

$_1, q_2, q_3, \ldots\ldots\ldots\ldots\ldots q_{3n}$

nd the relation given by

$\vec{}_1 = \overrightarrow{r_1}\ (q_1, q_2, q_3, \ldots\ldots\ldots\ldots\ldots q_{3n}, \text{t})$

$\vec{}_2 = \overrightarrow{r_2}\ (q_1, q_2, q_3, \ldots\ldots\ldots\ldots\ldots q_{3n}, \text{t})$

$\vec{}_n = \overrightarrow{r_n}\ (q_1, q_2, q_3, \ldots\ldots\ldots\ldots\ldots q_{3n}, \text{t})$

eneralised coordinates are the transformation equations from an old set of r_i ariables to a new set of q_i, where i = 1,2,3,…….

he inverse transform is given by

$_i = q_i\ (r_1, r_2, r_3, \ldots\ldots\ldots\ldots\ldots r_n, \text{t})$

GENERALISED DISPLACEMENT

e the position vector of the particles, where i = 1,2,3,.....n

erms of generalised coordinates, we have

$$\vec{r_i} = \vec{r_i}\,(q_1, q_2, q_3, \ldots\ldots\ldots\ldots\ldots q_{3n}, t)$$

change of position $\delta\vec{r_i}$ gives the displacement

ind $\delta\vec{r_i}$ using Euler's theorem

(Euler's theorem, If X = f(x,y,z) then $\delta x = \frac{\partial X}{\partial x}\delta x + \frac{\partial X}{\partial y}\delta y + \frac{\partial X}{\partial z}\delta z$)

v,

$$\delta\vec{r_i} = \frac{\partial r_i}{\partial q_1}\delta q_1 + \frac{\partial r_i}{\partial q_2}\delta q_2 + \frac{\partial r_i}{\partial q_3}\delta q_3 + \ldots\ldots\ldots$$

$$\boxed{\delta\vec{r_i} = \sum_{j=1}^{N} \frac{\partial r_i}{\partial q_j}\,\delta q_j}$$

e, $\delta\vec{r_i}$ is called virtual displacement

is called generalised displacement

Generalysed velocity

- Constraints
- Degrees of freedom
- Generalysed coordinate
- Generalysed displacement

Time derivative of a generalysed coordinate q_i

i.e $\frac{dq_i}{dt} = \dot{q}_i$

$$\delta\vec{r_i} = \frac{\partial r_i}{\partial q_1}\delta q_1 + \frac{\partial r_i}{\partial q_2}\delta q_2 + \ldots\ldots\ldots$$

$$\text{Velocity} = \frac{\delta r_i}{\partial t} = \dot{r}_i = v_i = \frac{1}{dt}\left(\frac{\partial r_i}{\partial q_1}\delta q_1 + \frac{\partial r_i}{\partial q_2}\delta q_2 + \ldots\ldots\ldots\right)$$

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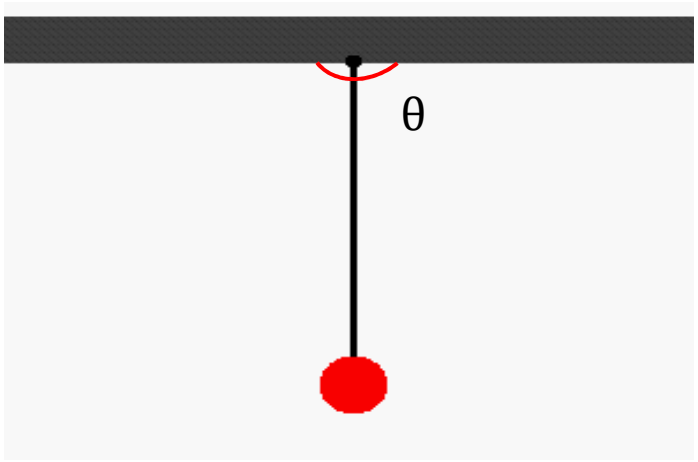
xample:



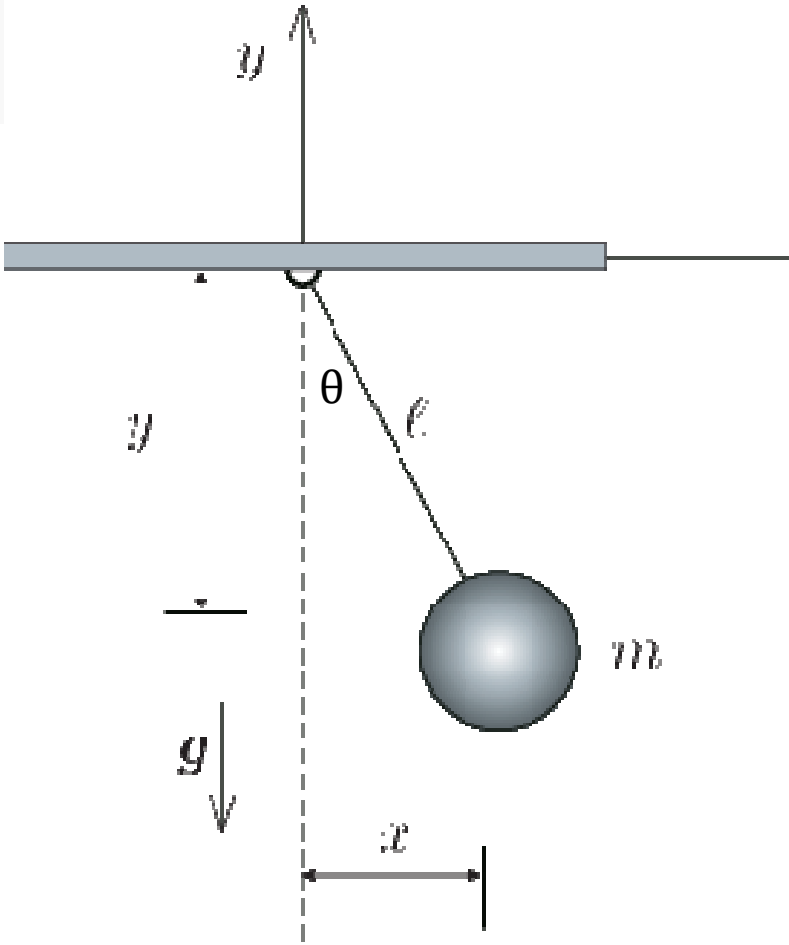
= $\vec{r_i}$ (q_1, q_2,q_3,.....q_{3n}, t)

= q_i (r_1, r_2, r_3,.....r_n, t)

= lsinθ and $y = l\cos\theta$

= $\theta = sin^{-1}\ \frac{x}{l}$

= $\theta = cos^{-1}\ \frac{y}{l}$



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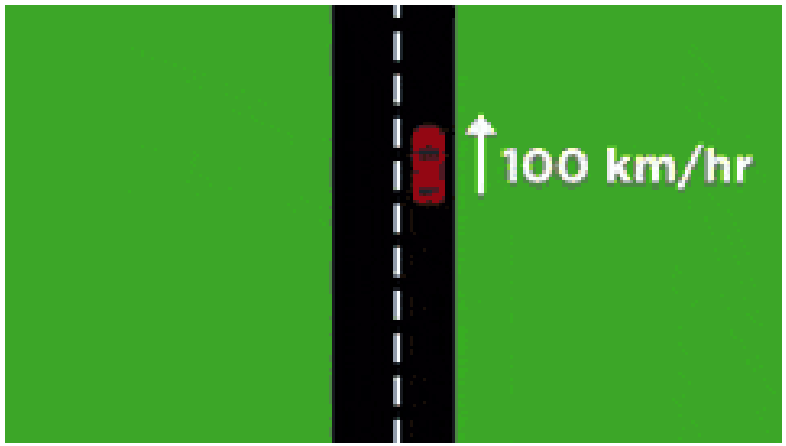


PRINCIPLE OF VIRTUAL DISPLACEMENT AND VIRTUAL WORK

r_i be the virtual displacement of the i^{th} particle of the given system. F_i
e resultant force on the i^{th} particle.

given system is in equilibrium, then F_i = 0. Therefore, virtual work for
particle must be zero.

δr_i= 0

considering all the particles the virtual work done

r_i= 0 -----(1)

onstraints are present, the resultant force F_i acting on the i^{th} particle is
o of two forces the applied force F_i^a and the forces of constraint f_i.

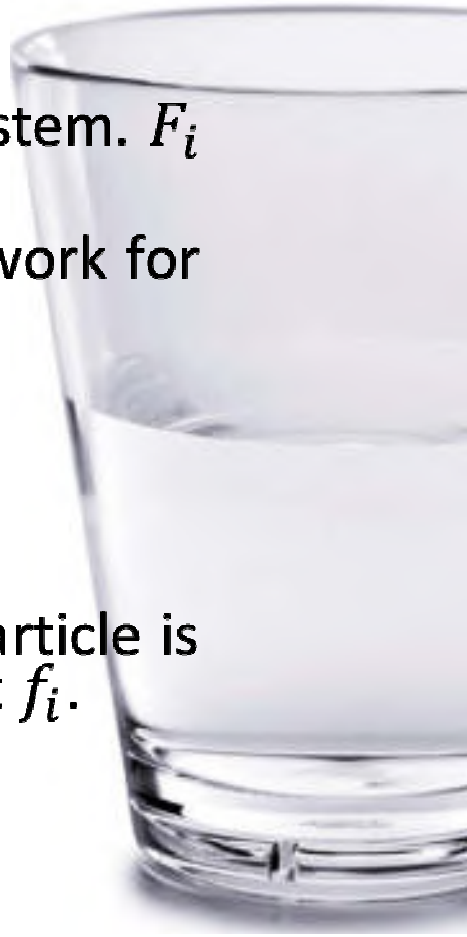
$_i^a$ + f_i Then equation (1) becomes,

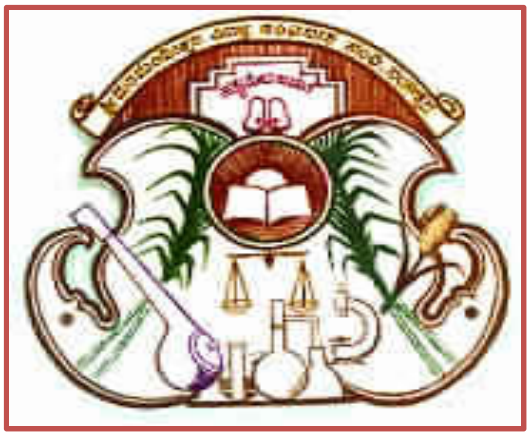
$_i$= 0 , $\sum_i (F_i^a + f_i)\, \delta r_i$= 0,

$_i$+ $f_i\ \delta r_i$= 0 -----(2)

virtual work done by the forces of constraints is zero, i.e $f_i\ \delta r_i$ = 0.

uation (2) becomes, $\sum_i F_i^a \delta r_i$ = 0 for equilibrium of a system





Paper – I

Bio-inorganic Chemistry

BSc VI semester

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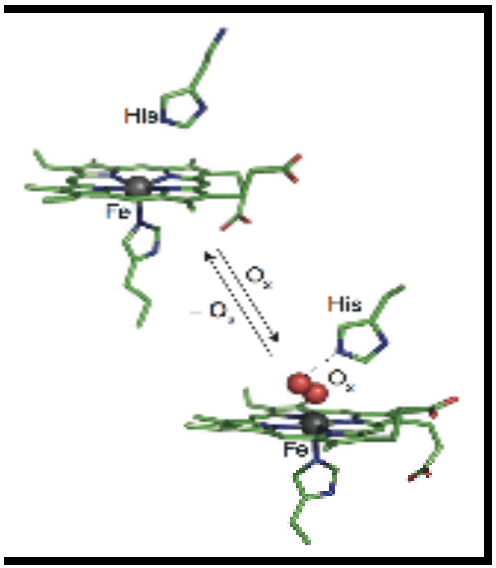
India

CONTENT

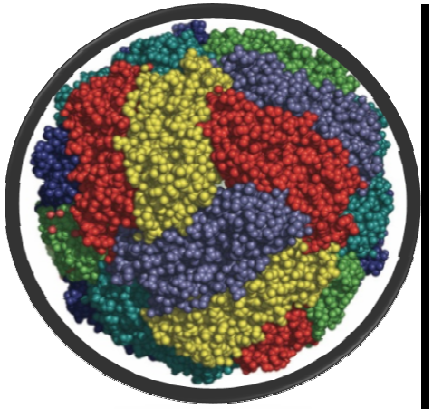
- Bioinorganic Chemistry:
- Essential and trace elements in biological process
- Metalloporphyrins with respect to haemoglobin and chlorophyll (structure and function)
- Biological role of Na, K, Fe and Zn.

BIOINORGANIC CHEMISTRY

L C S R S D S

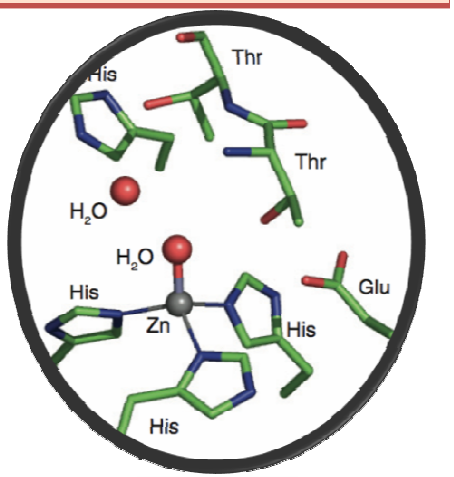


Oxygen Bound Myoglobin

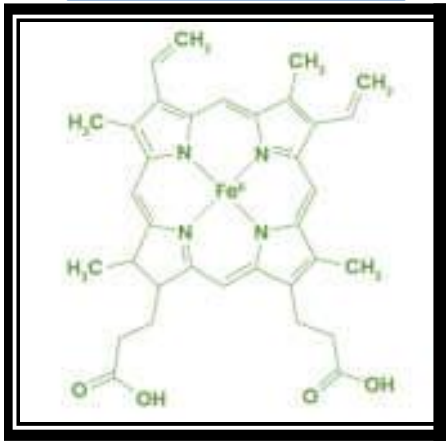


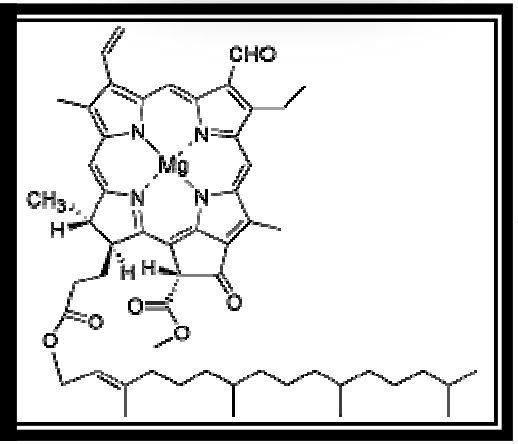
Ferritin

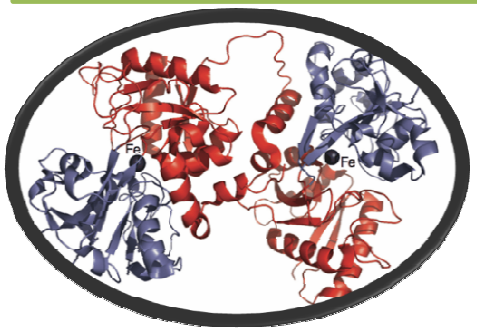
Zinc finger interacting with DNA molecules



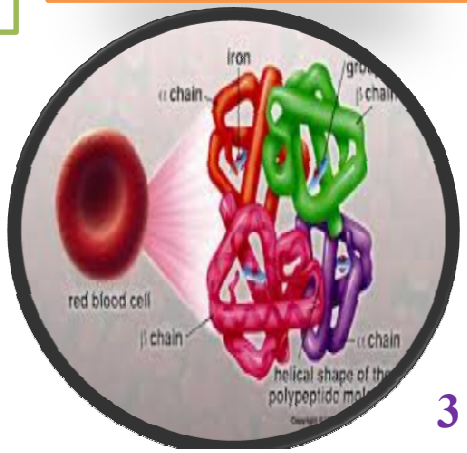
Carbonic anyhdrase







Transferrin



ESSENTIAL ELEMENTS OF LIFE

- Bulk elements
- C, H, N, O,
- Macronutrients (relatively large amounts)
- Na, K, Mg, Ca, S, P, Cl, Fe
- Micronutrients (Trace elements)
- Mn, Co, Ni, Cu, Zn, V, Cr, Mo, Se, F, I, Se, Si,

BIOLOGICAL IMPORTANCE OF SODIUM

- Source:
- Occurrence in humans
- Importance of sodium in biological system
- Deficiency
- Excess

SODIUM

- Outside cell = 10 mM, extracellular fluid
- Inside cell = scarce
- Normal serum sodium level = 135 – 145 mmol/L
- Weak binding to ligands
- Sodium ions are primarily found inside the human cells such as nerve cells.

Source: Table salt, high content in bread, cheese, carrots, cauliflower, eggs, milk, nuts, spinach.

BIOLOGICAL IMPORTANCE OF SODIUM

- Role – acid-base balance
- Regulate the flow of water across the membrane.
- They are needed for transport of sugars (glucose, galactose) and amino acids into the cells.
- Regulation of osmotic pressure of body.
- Regulation of membrane potentials i.e., electrical impulse of nerve system
- Maintains the electrolyte balance in the body.
- Enzyme activity (Many enzyme reactions are controlled by Na and K ions.)
- Signaling process
- Conformation of proteins and nucleic acids

ORS – oral rehydration solution
Freezing mixture
Preservative in pickling

DEFICIENCY OF SODIUM

- Hyponatremia – headache, nausea, coma, seizures (sudden uncontrolled electrical disturbance in the brain) etc.
- Due to high environmental temperature extreme sweating may cause loss of Na^+. Results in muscular cramps – abdomen, headaches
- Addison's disease ($Na_2S_2O_3$ (30% aq solution – i.v))
- Stoker's cramp
- allergic disease
- Neurology arthritides – swabbing and gargling in disease, upper respiratory track (Drug: NaCl/KCl (0.9 %) – isotonic solution

EXCESS OF SODIUM

- Hypernatremia
- Dehydration/loss of body fluids
- Vomiting, diarrhea, sweating, high fever
- High intake of table salt causes high BP, on continuation it causes stroke, heart failure, osteoporosis, stomach cancer, kidney disease.

POTASSIUM

- Inside the cell
- Cytoplasm, intracellular fluid – high = 0.3M.
- Outside the cell – low 5 x 10^{-3} M.
- Maintains the osmolarity of the cell.
- As co-factor – ex. Pyruvate kinase
- Na/K – ATPase enzyme
- Sodium & potassium transport channels.
- 2003 – Roderick Mackinnon shared chemistry Nobel prize – structure & mech of ion channels (passive)
- VALINOMYCIN is an antibiotic also an IONOPHORE has an high selectivity for K^+ ions coordinated by six carbonyl groups – enables to pass through bacterial cell membrane & thereby dissipate the electrical potential difference causing the bacterium's death.

Source: nuts, beans, banana, dairy foods, starchy vegetables, dried fruits, apricots, spinach, broculli, meat, poultry, fish, milk, yogurt, papaya etc.

BIOLOGICAL ROLE OF POTASSIUM

- Maintains the electrolyte balance in the body.
- Osmotic pressure.
- Heart function, skeleton and muscle contraction
- Conformation of proteins and RNA replication
- Electrolyte balance in the body
- Secretion of gastric acid
- Nerve impulse transmission. (Concentration gradient control the development & functioning of the nurve cells).
- Acts as co-factor for certain enzymes.
- Like Na, K has a stimulating effect on muscle irritability

DEFICIENCY

HUMANS

- Hypokalemia – < 3.5 mM
- vomiting, diarrhoea, weakness & fatigue,
- Muscle cramps & spasms,
- Digestive problems, constipation,
- Heart palpitations (regulate heart beat)
- Muscle aches & stiffness,
- Tingling & numbness (harmless),
- Breathing difficulties, mood changes & mental fatigue.
- Diets with low K+ leads to hypertension

PLANTS

- Chlorosis
- Growth regulation
- Protein synthesis
- Regulation of opening/
- closing of stomata

- (Tiny pores in plant that allow for gas exchange.)

EXCESS OF POTASSIUM

- Hyperkalemia
- Heart rhythm – affects – dangerous

WHEN CELLS RELEASE TOO MUCH OF K^+ IONS

- Breakdown of RBCs – Hemolysis
- Breakdown of muscle tissues – Rhabdomyolysis
- Burns, trauma, or other tissue injuries
- Uncontrolled diabetes

ZINC

- Zn – over 300 metallozymes
- Over 2000 transcription for regulation of lipid, protein and nucleic acid metabolism and gene tranascription.
- metalloenzymes catalyse peptide hydrolysis and maintain HCO_3^-/CO_2 equilibrium (CO_2 transportation).
- Zinc finger proteins enables the protein to recognize and bind to precise sequences of DNA base pairs and plays a crucial role in transferring information from gene.

Sources:
Oysters, meat, nuts, shell fish, poultry, eggs, milk products, cereals, bread, fish, green vegetables, potatoes, fresh fruits.

PHYSIOLOGICAL FUNCTIONS OF ZINC

Biochemical functions

- Co-factor for enzymes.
- Activity of zinc finger proteins

Cellular functions

- Growth and cell development
- Cell membrane integrity
- Tissue growth and repair
- Wound healing

Immunological functions

- Function of neutrophils, T cells, B cells, & NK cells

Endocrinological functions

- Reporduction: spermatagenesis
- Thyroid function
- Pancreatic function – insulin storage & release
- Prolactin secretion

Neurological function

- Cognition, memory, taste acuity, vision

Hematological function

- Coagulation factors,

Skeleton function

- Bone mineralization

ZINC DEFICIENCY

- Chronic renal disease
- Cystic fibrosis
- Liver disease and alcoholism
- Mild depressed immunity, impaired taste, and smell, onset of night blindness, decreased spermatogenesis
- Moderate – growth retardation and delayed puberty in adolescents
- Hypogonadism in males, rough skin, poor appetite, mental lethargy, delayed wound healing, night blindness.
- Severe immune suppression, frequent infections, pustular dermatitis, diarrhoea.

ZINC EXCESS

- Nausea, vomiting, loss of appetite, stomach cramps (pain), diarrhea, headaches, flu like symptoms, changes in taste.
- Too much of zinc intake (> 40 mg/day)

  - Low cu levels, lower immunity (frequent infections) and low levels of HDL cholesterol (good cholesterol)

  - Blood disorders

  - Treatment – drink milk

IRON

- **Oxygen transport and storage**
- Hemoglobin
- Myoglobin
- Hemerythrin,
- hemocyanin
- **Electron transfer**
- Cytochromes C,
- Cytochrome a, a3, & b
- **Enzymes**
- Peroxidase, catalase, etc
- Nitrogenase – 2 Mo and 30 Fe atoms

- **Oxidases, Oxygenases**
- Cytochrome c oxidase

- **Non-heme proteins**

Iron transport - Transferrin
Iron storage – Ferritin
Hemosiderin

Iron –sulfur proteins

i. **1 Fe ferredoxins**
ii. **2 Fe ferredoxins**
iii. **4 Fe ferredoxins**

CHEMISTRY OF IRON

- Fe- 26,
- Variable oxidation state – Ferrous, ferric, ((IV), (V)..)
- 2/3 of body contains iron – Hb
- RBCs contain a protein called – Hb
- Erythrocytes and iron are updated every 120 days
- Essential for cellular activity of all tissues
- **Hepcidin** – circulating peptide hormone secreted by the liver that plays a central role in the regulation of **iron homeostasis**
- Internalization and degradation of iron

BIOLOGICAL ROLE OF IRON

Metabolic process

Iron essential for

- cell division,
- cell growth,
- synthesis of DNA molecules
- protein metabolism
- to strengthen the immune system
- Fe involved in the formation of connective tissues of several neurotransmitter in the brain
- Cytochromes – transfer of oxygen, involved in energy production
- Thyroid hormones (iron contain) – regulate metabolic processes

Some foods rich in iron include:

Meat and Poultry (Heme Fe)

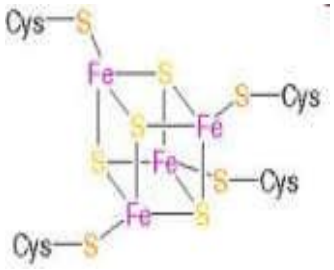
- Lean beef
- Veal, Pork
- Lamb
- Chicken
- Turkey
- Liver (except fish liver)

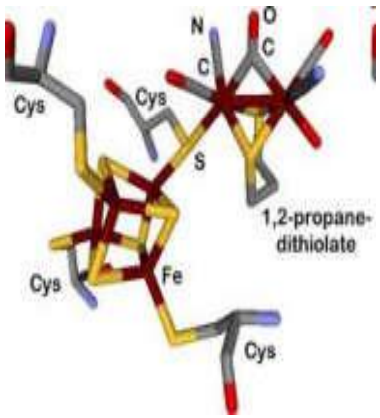
Seafood

- Fish
- Mussels
- Shellfish

- **Non-heme Fe**
- Cereals
- Pulses
- Vegetables
- Greens, all kinds
- fruits
- legumes
- Broccoli
- Sweet Peas
- Cabbage etc

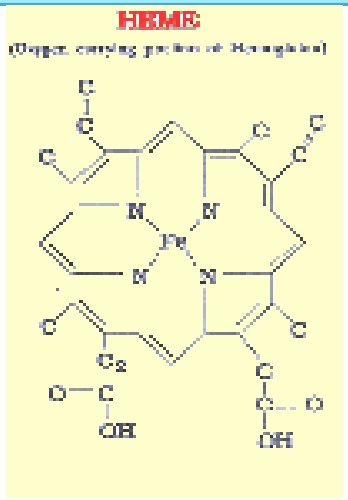
Inorganic Active site / Prosthetic group

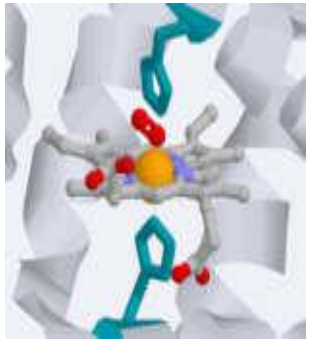


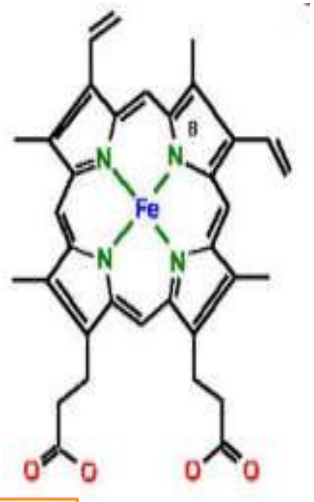


Ferredoxin (e transfer)

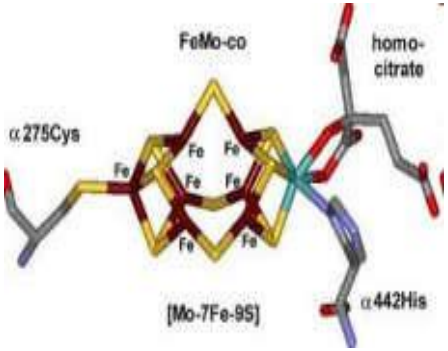
In molecular biology the **active site (prosthetic group)** is part of an enzyme where substrates bind and undergo a chemical reaction. It can perform its function **only when it is associated with the protein unit**





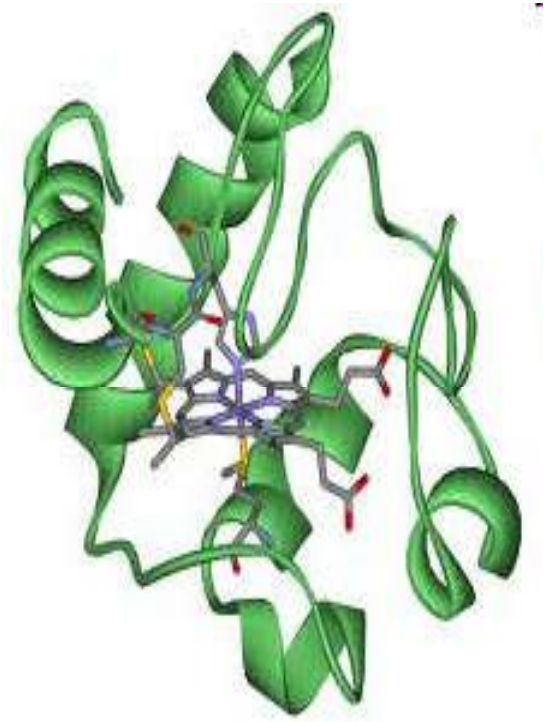


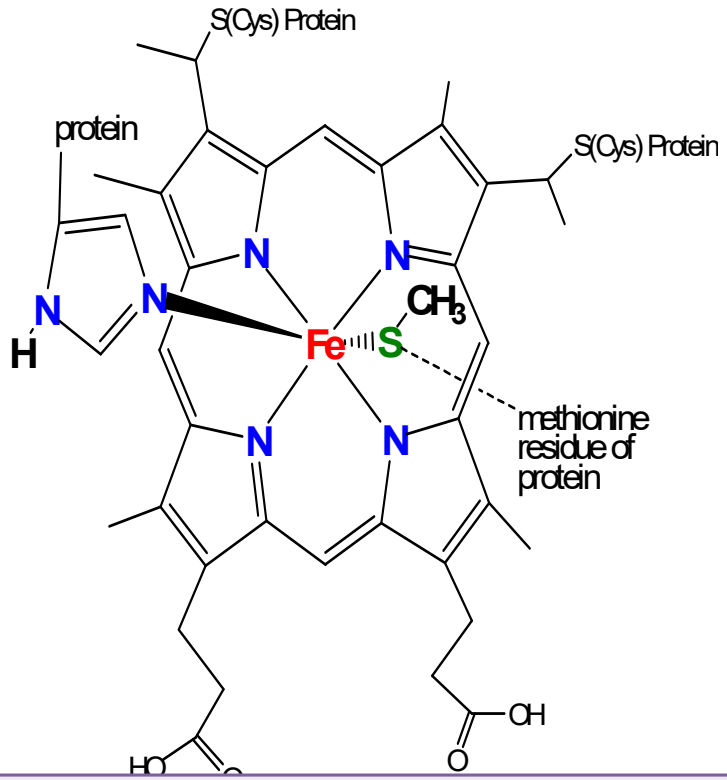
Heme in Myoglobin (O_2 storage)



Nitrogen Fixation

Electron transfer agents; e.g. Cytochrome C





Electron transfer agents

Fe^{2+}/Fe^{3+}

Cytochromes: redox intermediates

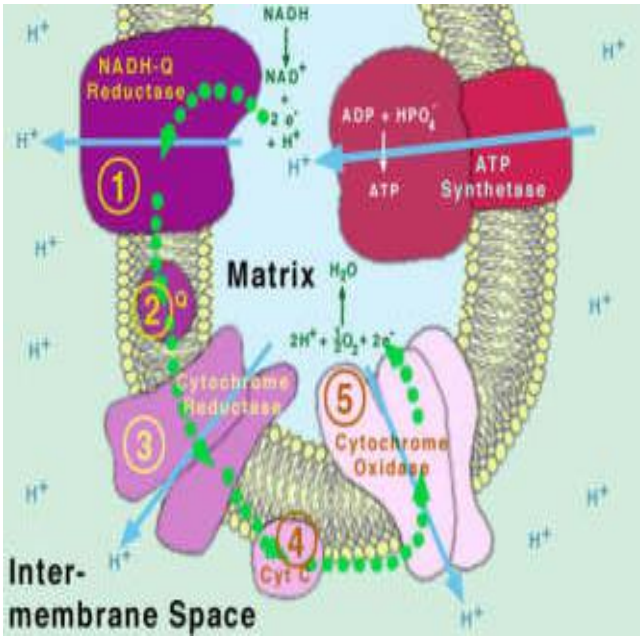
membrane-bound proteins that contain heme groups and carry out electron transport in Oxidative phosphorylation

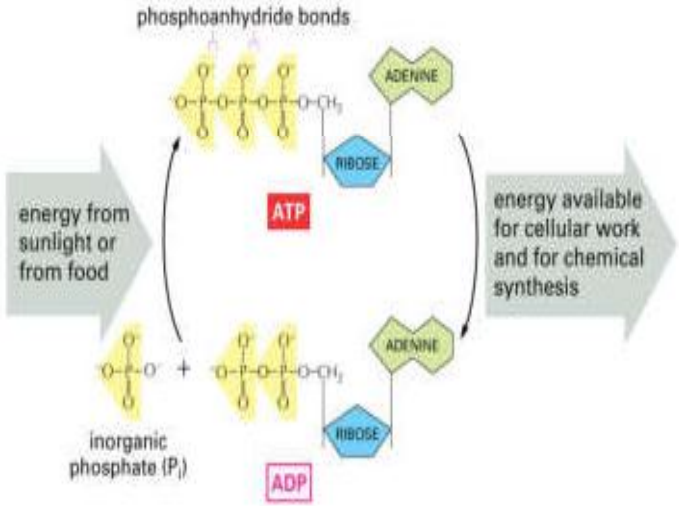
Glycolysis + Oxidative phosphorylation: How food is converted into energy

$$Glucose + 36\,ADP + 36\,Pi + 36\,H^{+} + 6\,O_2 \longrightarrow 6\,CO_2 + 36\,ATP + 42\,H_2O$$

Glucose gives 18 times more energy when oxidized

$$ATP + H_2O \longrightarrow ADP + Pi + H^{+} + energy \qquad \Delta G^{0} = -7.3\ kCal/mole$$





Different forms of Cytochromes (except Cytochrome P-450) are involved in the electron transfer process leading to ATP synthesis and conversion of O_2 to H_2O

ATP : Universal currency for energy

in living systems

Red Blood Cells –Fact sheet

1 microlitre of blood (1/50th of an average drop) of an adult human has

RBC	**4,000,000 - 6,000,000**
WBC	**4,000–11,000**
Platelets	**150,000–400,000**

Each human red blood cell (RBC) contains approximately **270 million** of hemoglobin molecules, each carrying **four heme** groups;

Hemoglobin comprises about a third of the total RBC volume. The red blood cells of an average adult human male store collectively about **2.5 grams of iron**.

The cells develop in the bone marrow (stem cells) and circulate for about 100–120 days in the body before their components are recycled. Each circulation takes about **20 seconds**. Approximately **1/4th of the cells in the human body** are red blood cells

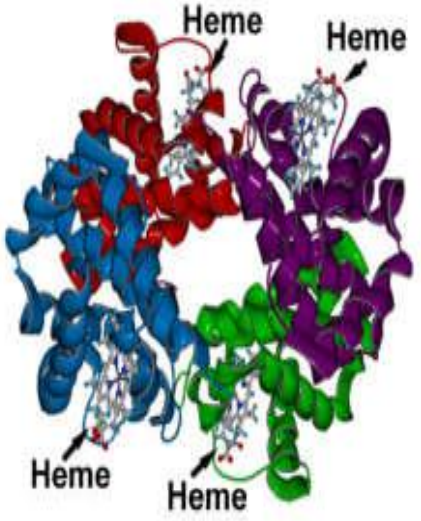
Mammalian red blood cells are unique among the vertebrates as **they don't have a cell nucleus** in their mature form (so no chromosomes or DNA present). These cells have nuclei in the early stages of development, but extrude them as they mature in order to provide more space for hemoglobin. These cells also does not have cellular organelles such as their mitochondria.

RBC strange **shape** -- a biconcave disc that is round and flat

RBC has **no nucleus**. The nucleus is extruded from the cell as it matures.

An RBC can **change shape** to an amazing extent, without breaking, as it squeezes single file through the capillaries.

An RBC contains **hemoglobin**.



270,000,000 hemoglobin units are present per RBC. Each hemoglobin has 4 heme units; 2 α and 2 β units. Active site of a heme unit has an **Iron** ion

BIO-AVAILABILITY – BIO-ABSORPTION

Iron inhibitors

- Polyphenols (tea, coffee, wine, vegetables, some cereals)
- Phytic acid
- Calcium
- Peptides from partially digested proteins
- Soybean

- Milk proteins (Casein)
- Egg proteins (Egg white)
- albumin

Enhancers

- Ascorbic acid
  - i. Fe(III) to Fe(II)
  - ii. Chelator
- Muscle tissues
- Ascorbate
- Citrate

} (as chelators increases Fe uptake)

Deficiency of Fe

- Anemia – reduce learning ability, sickle cell anemia, Heart palpitations, Shortness of breadth, Decreased concentration, disturbed sleep, severe menstrual pain and bleeding, Inflammation of the eye, Mouth ulcers, Hair loss
- Rheumatoid arthritis
- Thalassemia
- Blood plasma – low Fe
  - itchy skin – elderly
  - Nails – soft, brittle & white

- **Pregnancy**
- Newborn child –can become easily infected
- Miscarriage
- Premature birth
- low weight in newborns
- increased risk of anemia of child
- Drastic impact may lead to death of a child at birth
- Slow growth of children & weaker development of mental abilities

EXCESS OF FE

- Can cause damage to intestinal tract
- Vomiting, diarrhea,
- liver damage, abdominal & joint pain, weight loss, fatigue, thurst & hunger,
- cancer,
- heart disorders,
- arthritis,
- osteoporosis,
- Diabetes,
- a variety of psychiatric disorders,
- Cirrhosis of liver,
- Excessive skin pigmentation
- Body weakness
- Hemochromatosis

SUPPLEMENTATION

- ❖Oral iron supplementation
- ❖Ferrous sulphate
- ❖Ferrous gluconate

FORTIFICATION

- ▪Ferrous sulphate
- ▪Ferrous fumarate
- ▪Ferric pyrophosphate
- ▪Electroltic iron powder
- ▪Wheat flour – Fe fortified food

BIO-FORTIFICATION

- ➢Plant breeding
- ➢Genetic engineering
  - -Wheat
  - -Rice grains
  - -Beans,
  - -Millets

HAEMOGLOBIN

- Hb – discovered by Friedrich Ludwig Hunefeld – 1840
- Structure of Hb - Max Perutz and John Kendrew – 1959
- Mb – 1958 X-ray crystallography
- Globin protein
- Distal histidine - stabilize OxyHb, protects from CO poisoning for both Hb & Mb, controls the properties of Hb & Mb, Pull effect, do not coordinate with Fe in both oxyHb & deoxyHb.
- Proximal histidine - Push effect
- $\alpha_2\beta_2$ tetramer
- α = 141 AA residue
- β = 146 AA residue
- N-Imidazole of Histidine

Hb = tetramer of Mb
2 α chains = 141 AA's residues – each
2 β chains = 146 AA's residues –

Structure of heme unit in Hb and Mb

$$H_2PIX^{2-} + Fe^{2+} \longrightarrow Fe(PIX)^{2-} + 2H^+$$

Heme-b

STRUCTURE OF HEMOGLOBIN

- Hb = Conjugated protein having M. Wt. = 65400 Da
- Mb = M.W = 16000 Da.
- Tetramer containing 4 identical units arranged roughly in tetrahedron.
- Each contain one heme group. Heme – chelate of iron with porphyrin ligand.
- Each Hb molecule has 4 heme groups bound to the globin (a protein) on its surface.
- Heme group – prosthetic group.
- (At. Radius Fe(II) = 126 pm)
- Van der waal's radius = 244 pm.

OxyHb	DeoxyHb
Bright red colour	Purple colour (bluish red)
Fe = 75 pm	Fe = 92 pm
Oxygen co-ordinated	Water coordinated
Arterial blood	Venus blood
LS	HS
Diamagnetic	Paramagentic
Size of iron increases by 30%	Fe (II)

DIFFERENCE BETWEEN Hb AND Mb – CHEMISTRY

Properties	Hb	Mb
Molecular weight	64,000 Da	16,000 Da.
Metal ion and O. S	Fe (II), binds 4 O_2	Fe (II), binds only one O_2 molecule
Fe position	Not situated on the plane of the porphyrin ring = just above the plane 42 pm	In the plane of porphyrin ring
Coordination	6 and out of 4 N atom of pyrrole in a porphyrin system 5^{th} coordination = histidine 6^{th} coordination = vacant or weakly bonded water molecule	6 and out of 6, 4 N atom of pyrrole ring in a porphyrin ring system 5^{th} coordination = histidine 6^{th} coordination = oxygen molecule
Ligand field	Since 5 coordination is only available it offers HS complex	Enough field is available to make LS complex
Magnetic property	$T_{2g}^4e_{2g}^2$ paramagnetic, ESR active	t_{2g}^6, diamagnetic, ESR inactive
Action	Transport of molecular oxygen	Storage of molecular oxygen
%sat vs PO_2 mm Hg	Sigmoid curve – pH effect – Bohr effect, co-operative effect.	Hyperbolic – No pH effect , no co-operative effect.
	Low O_2 conc – less oxygenated	

STRUCTURE OF HEMOGLOBIN

Hb REACTIONS

- **Lungs (gills)**:

  $Hb + 4\ O_2 \longrightarrow Hb(O_2)_4$

- **Tissues**:

$Hb(O_2)_4 + 4\ Mb \longrightarrow 4\ (Mb(O_2) + Hb$

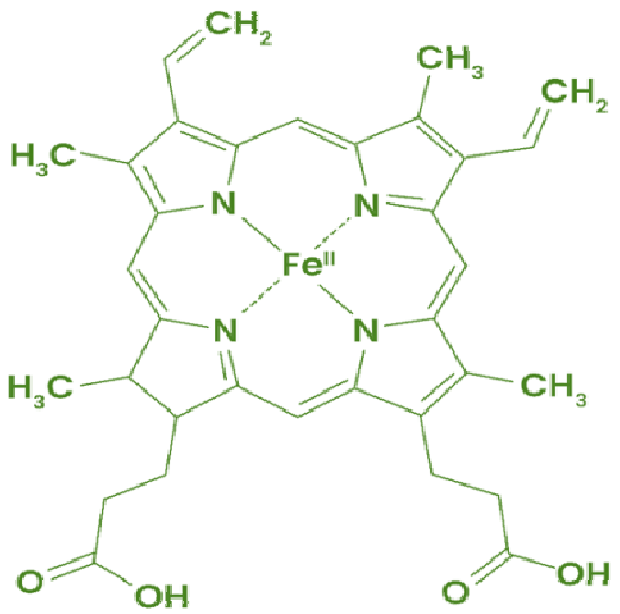
- **CO_2 as HCO_3^- (25%)**
- **1st stage**

  $CO_2 + H_2O \longrightarrow H_2CO_3$

- **2nd stage**

  $H_2CO_3 \longrightarrow HCO_3 + H^+$

STRUCTURE



FUNCTION OF HEMOGLOBIN

- Hb = tetramer of Mb
- Mb does not exhibit
  Bohr effect and
  Sigmoid curve
- Hb binds 4 O_2, red pigment in RBCs carries O_2 from lungs to the tissues in the Mb.
- Hb = cooperative effect binds 4 oxygen,
- Enhanced affinity results in a sigmoid shape instead of straight line for the curve.

- At lungs Hb saturated with O_2,
- As blood returns from the tissue, it takes away CO_2.
- CO_2 is more soluble than O_2 in the blood.
- CO – 500 times stronger than O_2 – for free heme
- (steric hindrance – Globin Protein, Dist & Prox. Hist and H-bonding)

STRUCTURE AND FUNCTION OF CHLOROPHYLL

- Structure of chlorophyll was established by H. Fischer 1940, R. Willstater 1915, and J. B. Conant.
- R. B. Woodward first synthesized chlorophyll from simple organic molecules – **1960**. Nobel prize – synthetic organic chemistry – 1965.
- **1817** – Chlorophyll was isolated by Joseph Bienaine Caventon and Pierre Joseph Pelletier

- Chlorophyll
  - Mg – porphyrin complex – green pigments in plants
  - Square planar complex - Mg^{2+}
- Mg is at the centre of the flat heterocyclic porphyrin ring system
- Metal atom is bonded to four nitrogen atoms
- Chlorophyll a is the pigment directly responsible for the transformation of light energy to chemical energy.

$$6CO_2 + 6H_2O + \text{Solar Energy} \longrightarrow C_6H_{12}O_6 + O_2$$

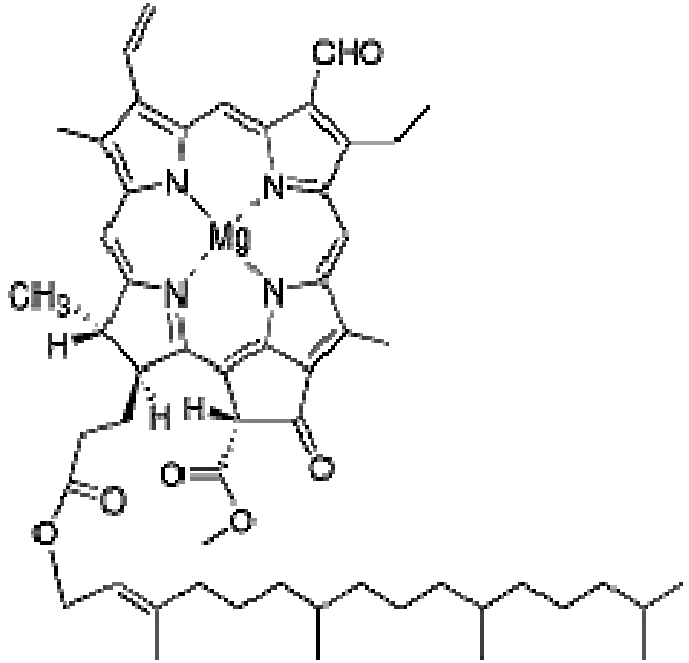
STRUCTURE AND FUNCTION OF CHLOROPHYLL continued..

1906 – Mg

ARTIFICIAL PHOTOSYNTHESIS

- water splitting reactions
- fuel cells

STRUCTURE



- Chlorophyll as a photoreceptor/photosensitizer
  – Chl. a – $R_1 = CH_3$
  – Chl. b – $R_2 = CHO$

Magnesium – porphyrin complex (macrocyclic ligand) – green pigment in plants

- Square planar complex containing Mg^{2+}
- Metal atom is bonded to four nitrogen atoms
- Reaction takes place at R.T. (which is quite difficult to perform at lab)
- Mg- slightly above the plane of the rigid chelate ring structure
- One or two water molecules – Chl can add axially
- Chl responsible for transformation of light energy to chemical energy (red region – near 700 nm)
- **Hydrophobic long hydrocarbon chain – Phytol** attached to ring helps anchor molecule in internal membranes of chloroplast
- **Photosynthesis** = chl + 4 other metal complexes [Mn complex + 2 iron complexes (Cyt & ferredoxins) + copper complex (plastocyanin)

INTERESTING ASPECTS OF CHLOROPHYLL

AMAZING FACT

- From where does the oxygen molecule come from, whether from water or carbon dioxide?
- **Traces studies** – Oxygen – comes from water and not from CO_2

ATP PRODUCTION

- ATP molecules – produced during cell respiration (3 step process of ATP production)
  - Glycolysis
  - Tricarboxylic acid cycle
  - Oxidative phosphorylation
- [2 ATP & 6 NADH] produced for every glucose molecule entering glycolysis

FUNCTION OF CHLOROPHYLL

CO_2 + moisture = glucose + O_2	Photosystem – I and Photosystem – II
• Chlorophyll absorbs light in the red region = 680 nm from sunlight • Glucose is further converted into polysachharides like starch. • When it is associated with certain proteins and embedded in a specialized membrane	• Mn complex and Two iron complexes • Cytochrome • Ferrodoxins • Copper complex – Plastocyanin • CO_2 undergo red – glucose • H_2O undergo oxid – oxygen

FUNCTION OF CHLOROPHYLL continued…

$6CO_2 + 6H_2O = h\gamma/Chl = C_6H_{12}O_6 + O_2$

(A) [Reaction takes place in two steps]

FIRST STEP: Light reaction

[EMR energy (visible) is trapped]

- $12\ H_2O$ = oxidized = $12\ H_2 + 6O_2$ (Water oxidation)

SECOND STEP: Dark reaction

[Energy acquired in light reaction used]

$6CO_2 + 12\ H_2 = 18\ ATP = C_6H_{12}O_6 + 6H_2O$

- reduce CO_2 to glucose ie., ug red^n.
- for one molecule of glucose = 18 molecules of ATP
- Energy needed for above reaction – supplied by ATP molecules

ROLE OF Mg IN CHLOROPHYLL
(PHOTOSYSTEM – I & PHOTOSYSTEM - II)

ELECTRON TRANSFER REACTIONS –

- Mn complex (OEC)- under go reversible redox reaction
- Fe – cytochromes
- Ferrodoxins
- Cu – Plastocyanin
- Photosystem – I – electron donor – Cu protein
- Photosystem – II – electron donor – Water molecule
- OEC – light driven oxidation of water to molecular oxygen is carried out by the OEC in PS (II)
- S0 – S4 – Four (semi) stable S – states

Thank you for your kind ATTENTION

INTEGRATED CIRCUIT, OP-AMP AND THEIR APPLICATION

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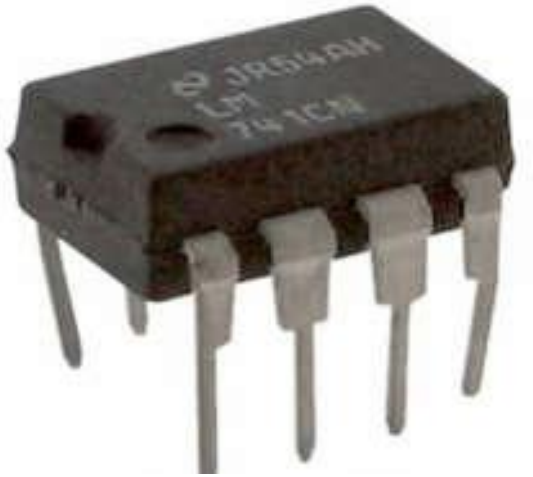
Belagavi

INTRODUCTION TO INTEGRATED CIRCUITES (IC)



CONTENTS :

- HISTORY OF IC
- INTEGRATED CIRCUIT (IC)
- TYPES OF IC
- APPLICATION


Vacuum Tubes

DISCRETE CIRCUIT COMPONENTS

Diode

Resistor

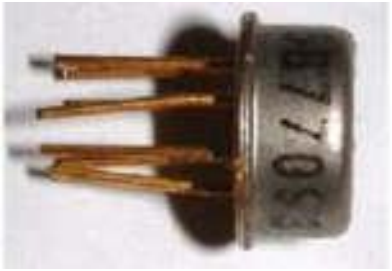
Transistor

Capacitor

Discrete Circuit Vs IC

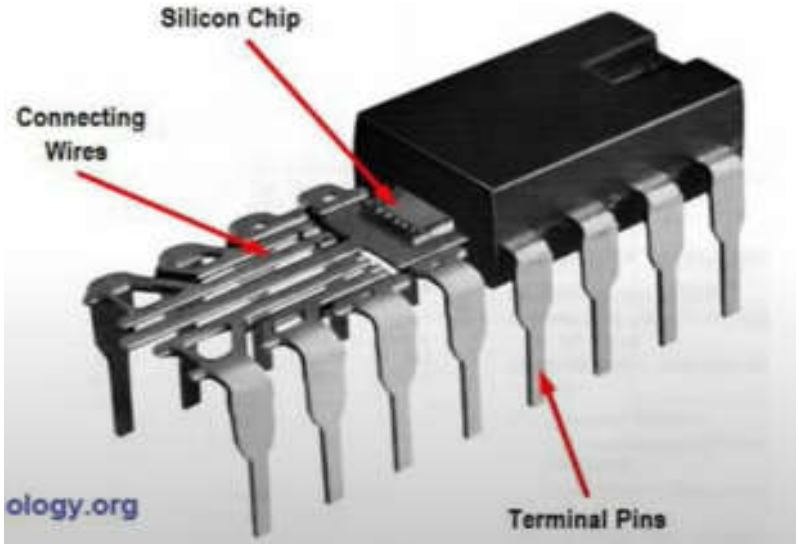
Vs

INTEGRATED CIRCUIT (IC)



- First commercially successful Monolithic Op-Amps (1965)

- If multiple electronic components are interconnected on a single chip of semiconductor material, then that chip is called as an **Integrated Circuit (IC)**. It consists of both **active and passive** components.



ON BASIS OF CHIP SIZE

SSI (small-scale integration) : Up to 100 electronic components per chip.

MSI (medium-scale integration) : 100 t0 3000 electronic components per chip.

LSI (large-scale integration) : 3000 to 1.00.000 electronic components per chip.

VLSI (very large-scale integration) : 1.00.000 to 1.000.000 electronic components per chip.

ULSI (ultra large-scale integration) : More than one million electronic components per chip.

ON BASIS OF FABRICATION

- Monolithic ICs
- Thin and Thick Film ICs.
- Hybrid or Multi-chip ICs.

ord 'monolithic' comes from the Greek words 'monos' and 'lithos' which m
and 'stone'.

onolithic IC's refer to a single stone or a single crystal.

power rating.

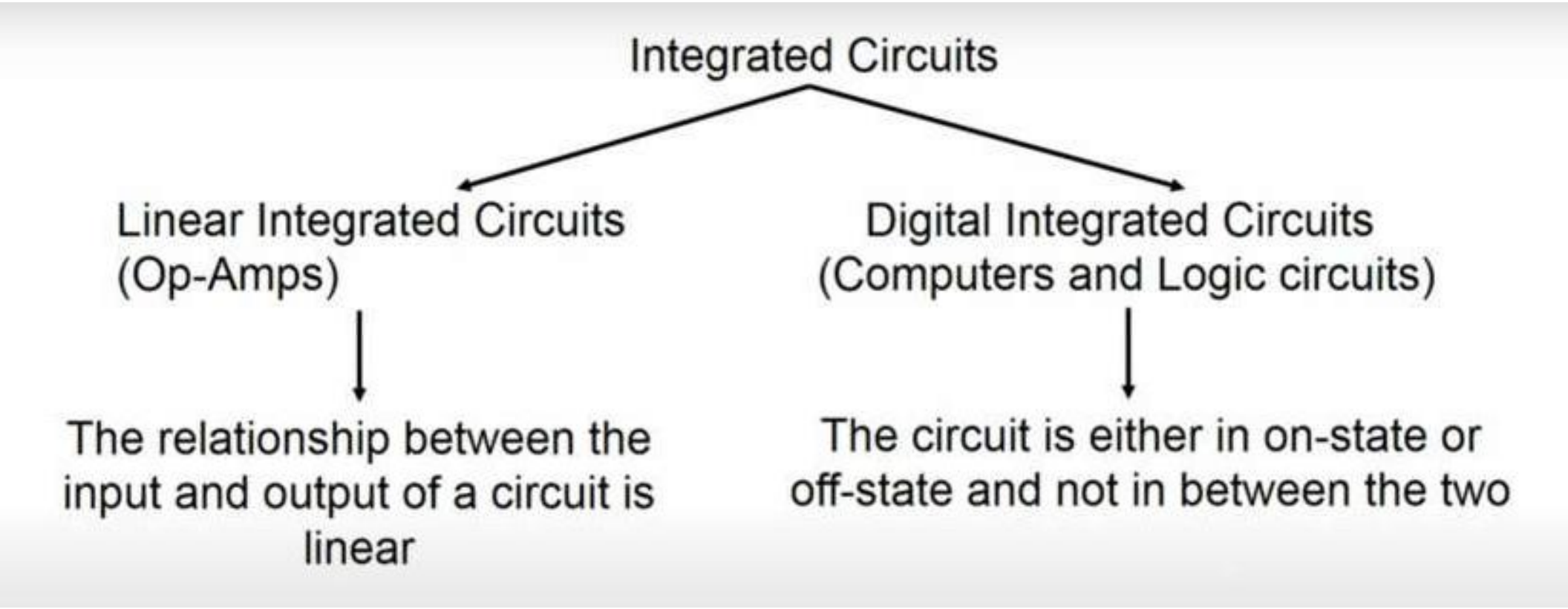
not be used for high power applications as it can't have power rating of mor
1 W.

isolation between the components within the integrated circuit is poor.

Thin and Thick Film Integrated Circuit

ntegrated circuit are larger than monolithic IC's and smaller than discrete

e used in high power applications.


Integrated Circuits
Linear Integrated Circuits
(Op-Amps)
Digital Integrated Circuits
(Computers and Logic circuits)
The relationship between the input and output of a circuit is linear
The circuit is either in on-state or off-state and not in between the two

ADVANTAGES OF IC

Small size

Low cost

Improved performance

High reliability

Low power consumption

Easy troubleshooting

Increased operating speed

Less weight, volume

Easy replacement

DISADVANTAGES OF IC

- IC is small in size its unable to dissipate large amount of power. increase in current may produce enough heat which may destroy the device.
- At present coils, inductors and transformers can not be produced in IC form.

APPLICATIONS OF IC

- Bipolar Junction transistors.
- Logic Gate array.
- MOSFET.
- Timer **ICs**.
- Micro Processors.
- Op-amps or Operational Amplifies.
- RAM chips /Memory chips.
- Voltage /Current regulators .

Thank you

OPERATIONAL AMPLIFIER

Operational Amplifier, also called as an Op-Amp, is an versatile integrated circuit device, whic can be used to perform various linear, non-linear, and mathematical operations. An op-amp is **direct coupled high gain amplifier**. You can operate op-amp both with AC and DC signals.

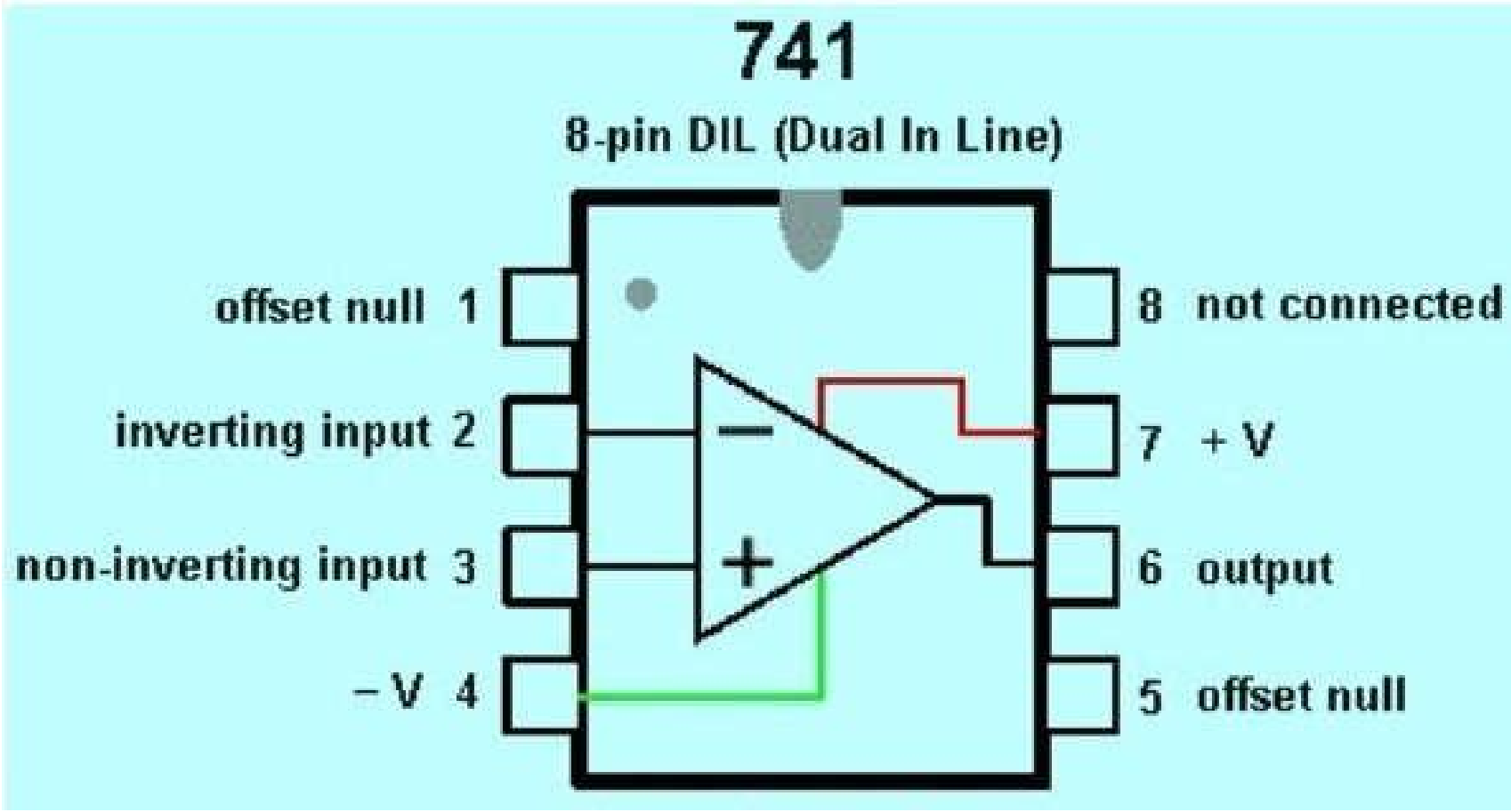
The term Op-Amp was originally used to perform Mathematical operations such as summation subtraction, integration and differentiation.

Early Op-Amp were constructed by using Vacuum tubes(in 1948 first VT based Op-Amp). Th invention of semiconductor based Transistor replaced Vacuum tubes and therefore they wer costly. In 1965 first Monolithic IC based Op-Amp was invented. The Op-Amps were then widel used with the reduction in cost.

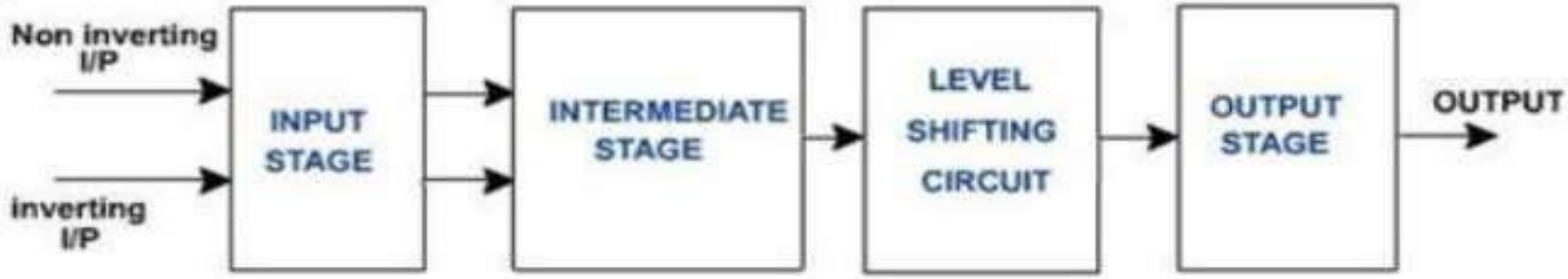
The inexpensive linear IC Op-Amps perform all the functions of the discrete Op-Amp.

CONSTRUCTION OF OPERATIONAL AMPLIFIER

An op-amp consists of differential amplifier(s), a level translator and an output stage. differential amplifier is present at the input stage of an op-amp and hence an op-amp consists o **two input terminals**. One of those terminals is called as the **inverting terminal** and the other on is called as the **non-inverting terminal**. The terminals are named based on the phase relationshi between their respective inputs and outputs.


741
8-pin DIL (Dual In Line)
offset null 1
inverting input 2
non-inverting input 3
– V 4
8 not connected
7 + V
6 output
5 offset null
–
+

BLOCK DIAGRAM REPRESENTATION OF TYPICAL OP-AMP



1. Input Stage:

- Dual i/p, Balanced o/p Diff Amplifier
- Provides → most voltage gain of Op-Amp
  → i/p resistance of Op-Amp

2.Intermediate Stage:

- Dual i/p, Unbalanced o/p Diff Amplifier
- Drives the o/p of 1st stage
- Direct coupling→ dc voltage well above gnd level

3. Level Translator (or) Shifting Stage:

- Dc voltage level to zero w.r.t gnd

4.Output Stage:

- Increases o/p voltage swing
- Raises current supply capability of Op-Amp
- Low Resistance

rational Amplifiers have atleast following five terminals:

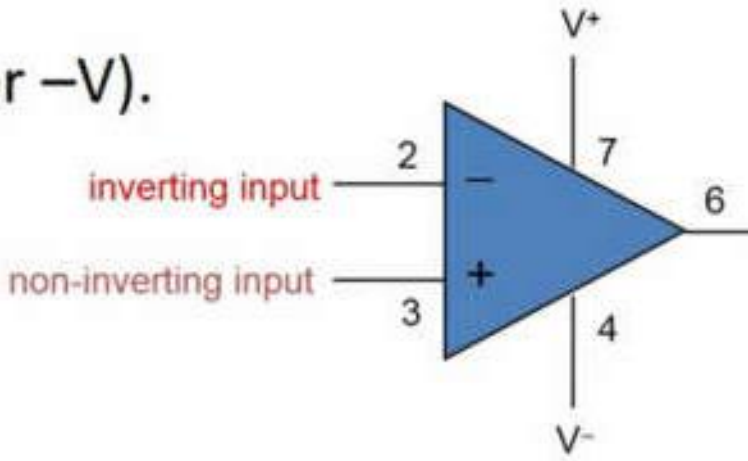
e positive supply voltage terminal (V_{cc} or +V).

ne negative supply voltage terminal ($-V_{cc}$ or $-V_{EE}$ or –V).

ne output terminal.

ne inverting input terminal.

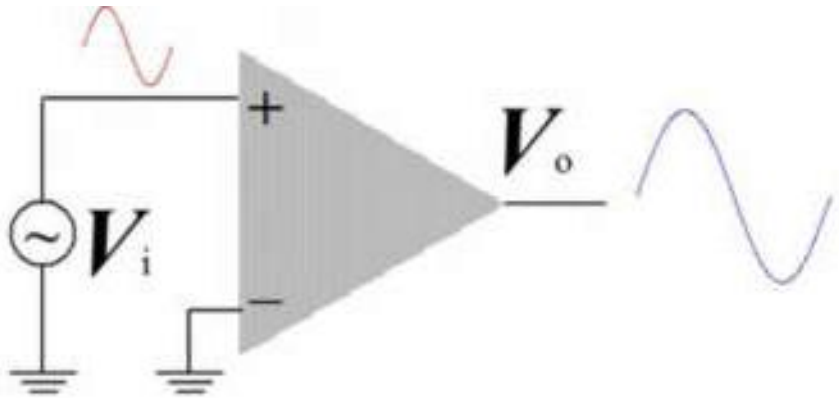
ne non-inverting input terminal.

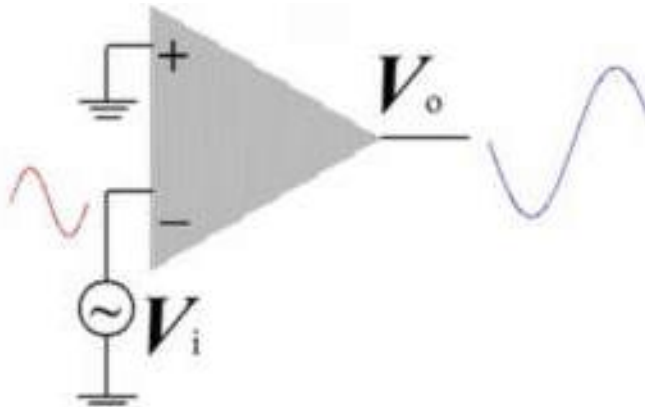


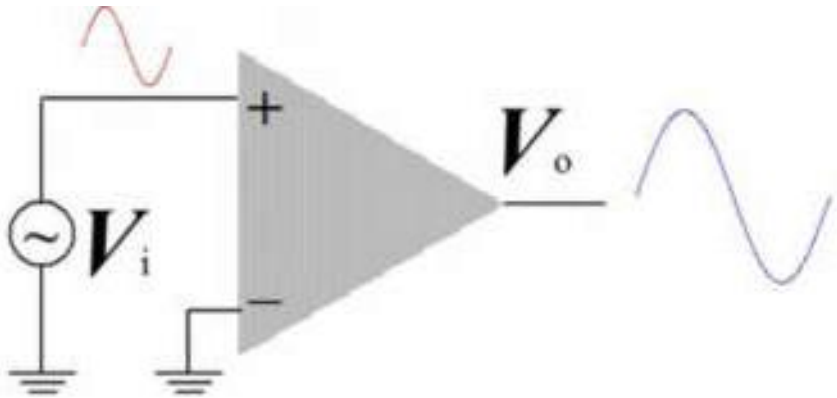
input at inverting terminal results in opposite polarity (antiphase) output.

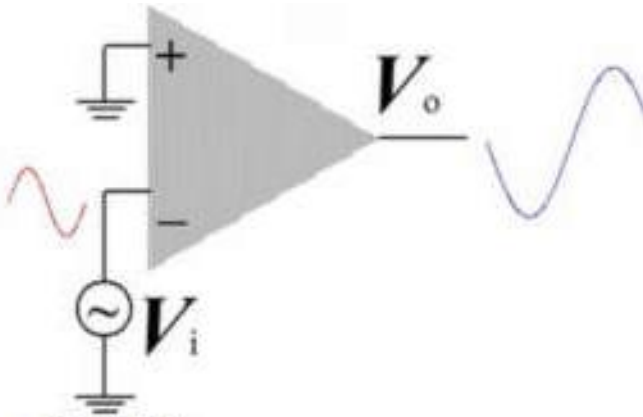
le the input at noninverting terminal results in the same polarity (ph
ut.

op-amp is fabricated on a tiny silicon chip and packaged in a suitable case.
ge wires are used to connect the chip to the external leads.


+
−
V_o
V_i


+
−
V_o
V_i





-AMP is a very high gain amplifier fabricated on Integrated Circuit (IC)
mbination of many transistors, FETs, Resistors in a pin head space
nds application in:
udio amplifier
ignal generator
ignal filters
iomedical Instrumentation
And numerous other applications

antages of OPAMP over transistor amplifier:

Less power consumption
Costs less
More compact
More reliable
Higher gain can be obtained
Easy design

INTEGRATED CIRCUIT, OP-AMP AND THEIR APPLICATION

Asst. prof. Sunil Kumar

Dept. of Physics

S.S Arts College and T.P Science Institute, Sankeshwar

Belagavi

Ideal Op-Amp characteristics and Equivalent circuit

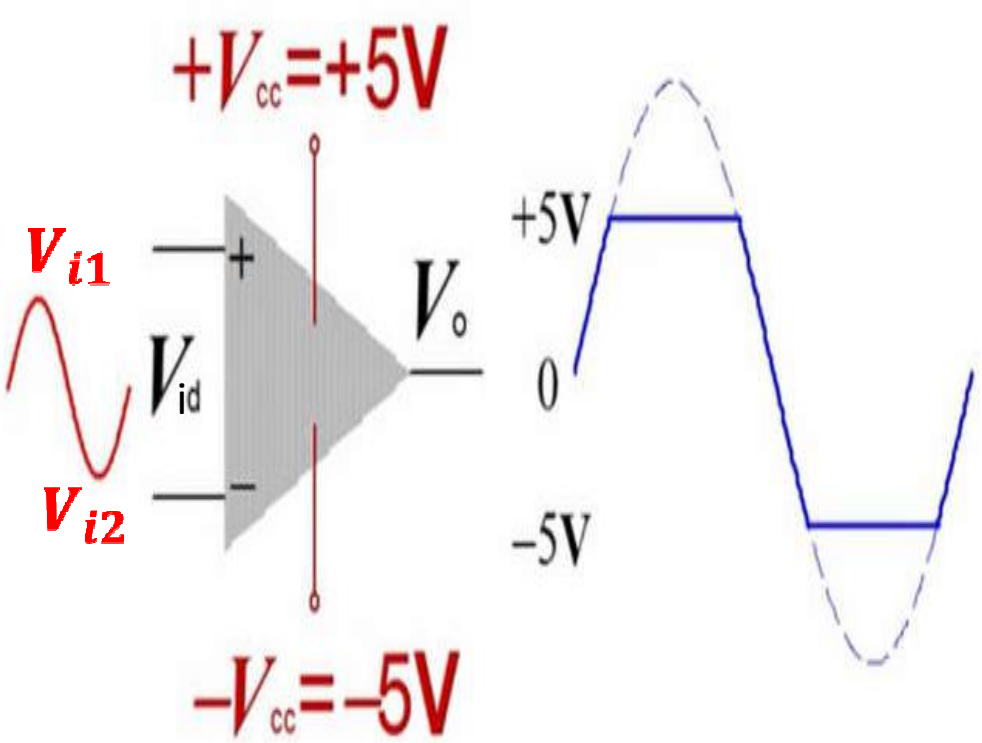
Ideal Op-Amp characteristics

Voltage Gain (A): Infinite

A difference between two inputs is amplified infinitely

$$A = \frac{V_0}{V_{id}} = \frac{V_0}{(V_{i1} - V_{i2})}$$

oltage at noninverting input (volts)
oltage at inverting input (volts)
utput voltage (volts)
ifference input voltage



ZERO OUTPUT VOLTAGE : When input voltage is absent.

INFINITE INPUT RESISTANCE : No current flows into inputs.

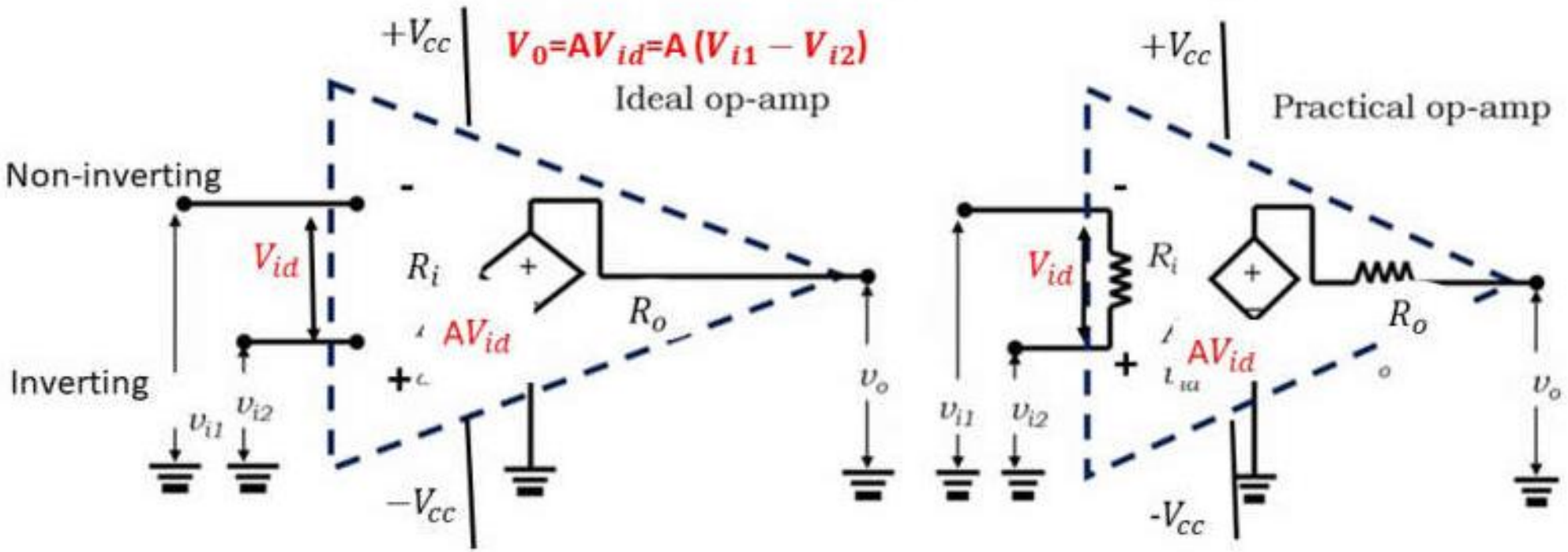
ZERO OUTPUT RESISTANCE :

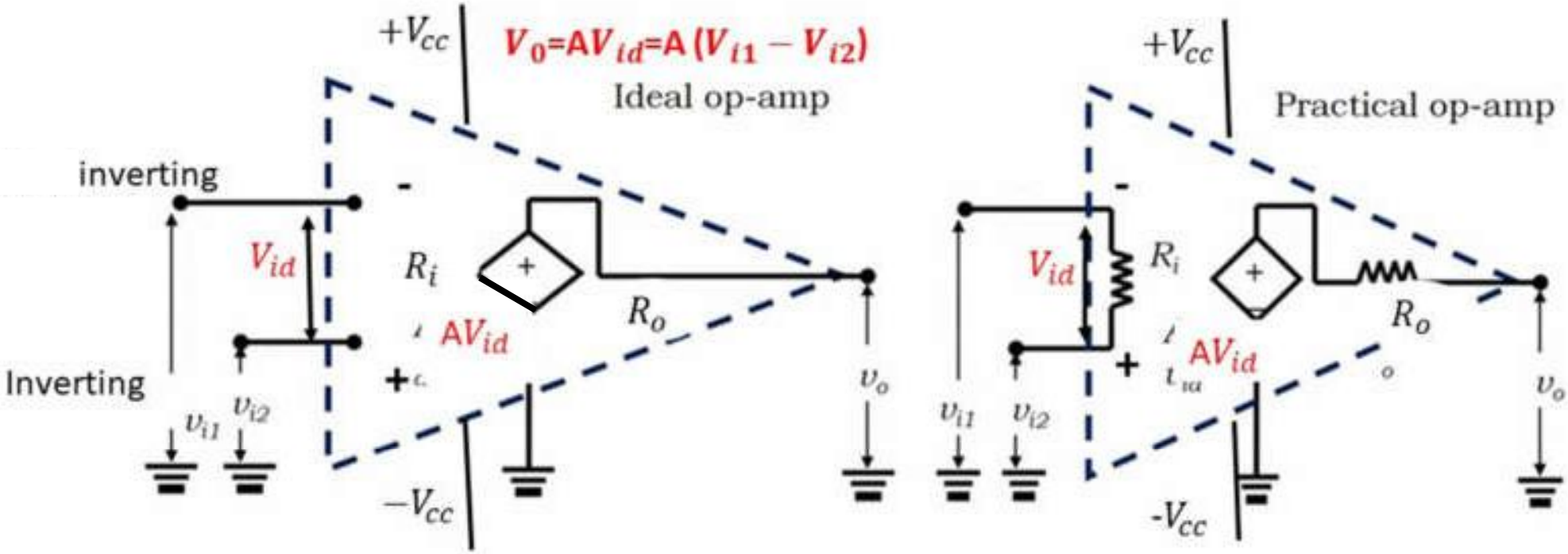
INFINITE BANDWIDTH :

INFINITE SLEW RATE : Infinitely fast

Ideal Operational Amplifier versus Actual Operational Amplifier

Parameter	Ideal Op-Amp	Real Op-Amp
Differential Voltage Gain	∞	10^5 - 10^9
Gain Bandwidth Product (Hz)	∞	1-20 MHz
Input Resistance (R)	∞	10^6 - 10^{12} Ω
Output Resistance (R)	0	100 - 1000 Ω





gure,
= voltage at noninverting input (volts)
= voltage at inverting input (volts)
Output voltage (volts)
= Difference input voltage
= Input resistance
= Output resistance

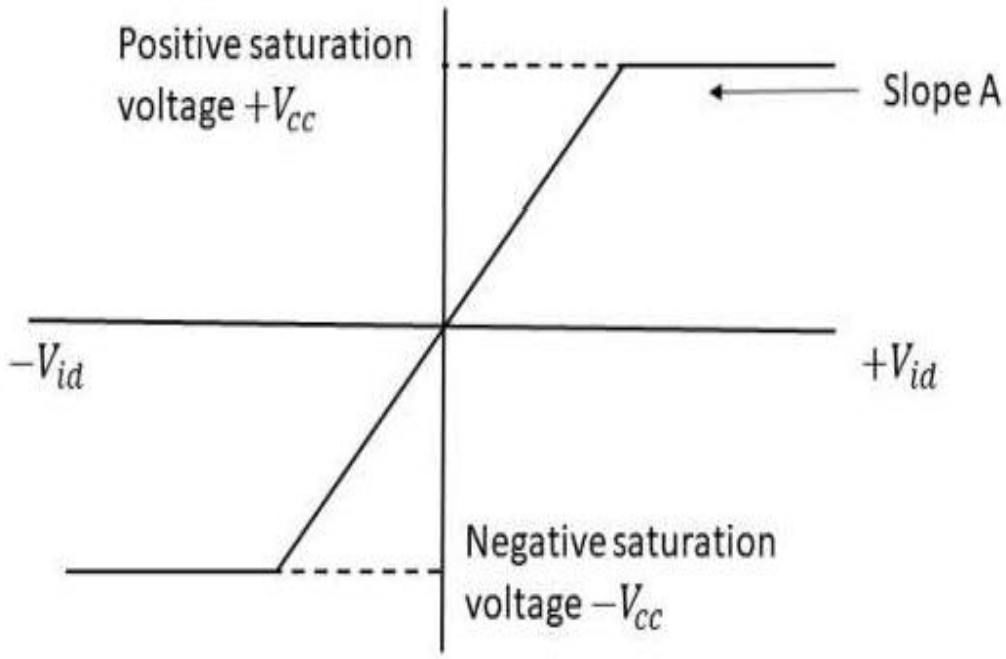
Parameter	Ideal Op-Amp	Real O
Differential Voltage Gain	∞	10^5
Gain Bandwidth Product (Hz)	∞	1-20
Input Resistance (R)	∞	10^6 -
Output Resistance (R)	0	100 -

Ideal voltage transfer curve

$$A = \frac{V_0}{V_{id}} = \frac{V_0}{(V_{i1} - V_{i2})}$$

$$V_0 = AV_{id} = A\,(V_{i1} - V_{i2})$$

The output voltage linearly varies with input difference voltage until it reaches the saturation voltage and next higher values it remains constant.



Thank you

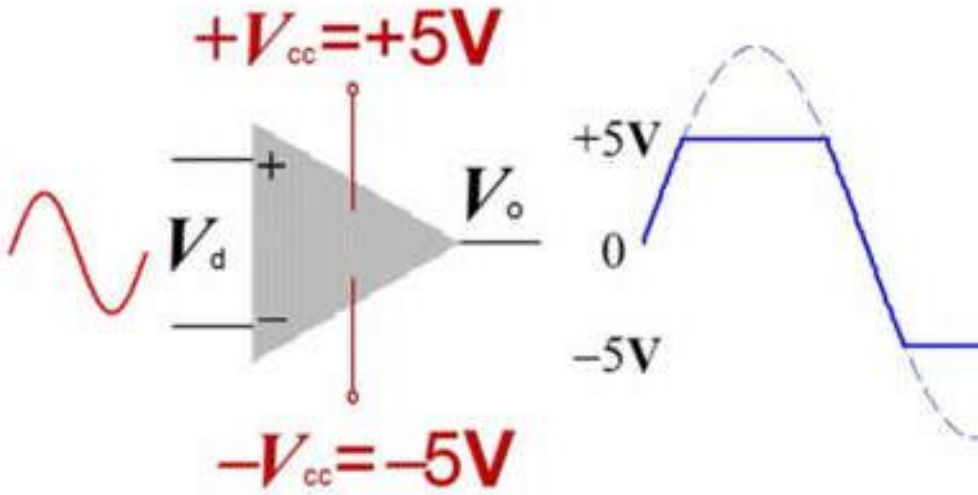
Ideal Operational Amplifiers

oltage gain
tage difference at the two inputs is magnified infinitely
uth, very high (~250000)
ns difference between inverting terminal and non-terminal is amplified by 250,000.

put impedance
urrent flows into inputs
uth, about $10^{12}\ \Omega$ for Field Effect Transistor input op-amps

ut impedance
-solid independent of load
up to current maximum (usually 5–25 mA)

fast (infinite bandwidth)
tically limited to few MHz range
rate limited to 0.5–20 V/μs



The output voltage never excess the DC voltage supp

Op-Amp

Op-Amp "Golden Rules"

op-amp is configured in *any* negative-feedback arrangement, it will obey the following two rules:

nputs to the op-amp draw no current (true whether negative feedback or not)

p-amp output will do whatever it can (within its limitations) to make the voltage difference between the two

INTEGRATED CIRCUIT, OP-AMP AND THEIR APPLICATION

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S.S Arts College and T.P Science Institute, Sankeshwar

Belagavi

PRACTICAL OP-AMP CHARACTERISTICS

Characteristics of Operational Amplifier (Op-Amp)

nput offset voltage (V_{io}) = V_{io} is the input voltage which must be pplied between the two input terminals to obtain zero output voltage

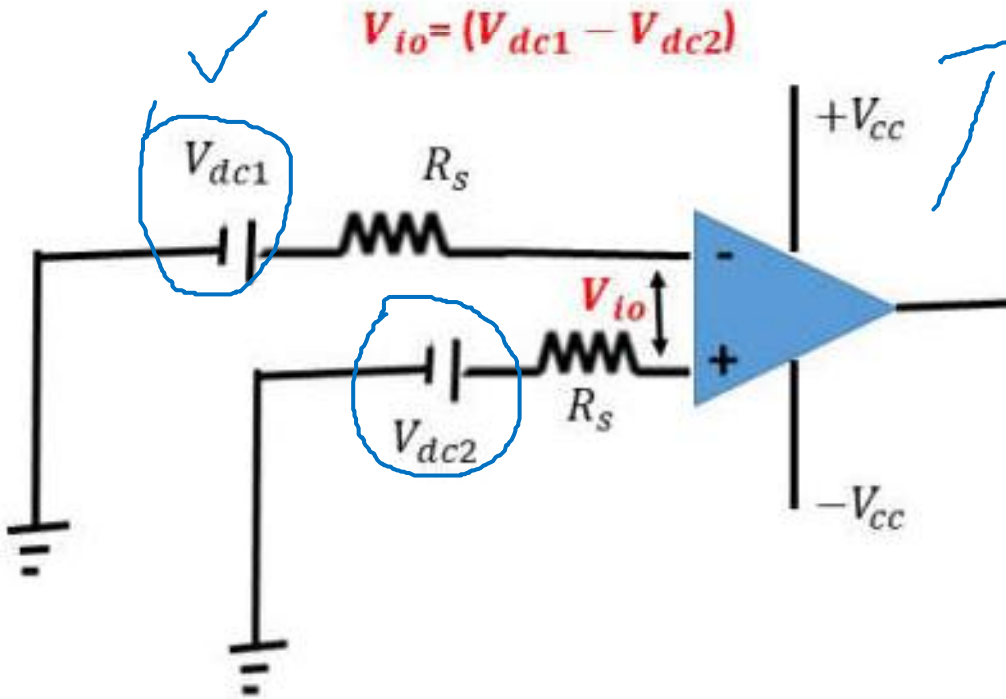
$V_{io} = (V_{dc1} - V_{dc2})$

V_{dc1} = Input dc voltage to terminal 1

V_{dc2} = Input dc voltage to terminal 2

$V_o \neq 0$

$V_{i1} = V_{i2} = 0$

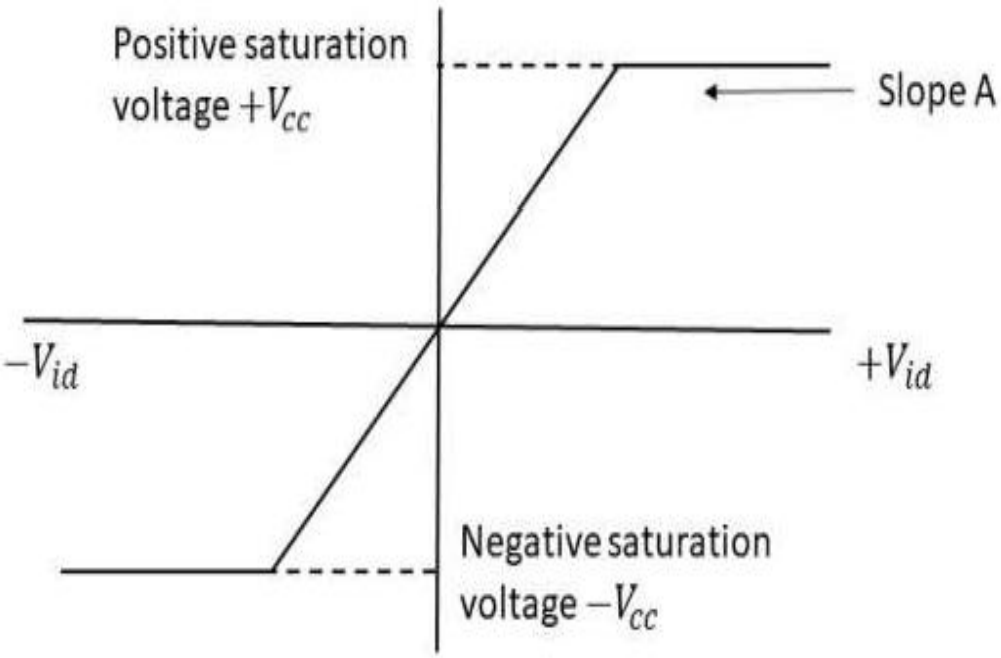


put offset current (I_{io}) = I_{io} is the gebraic deference between the urrent in the inverting and non-verting terminal. When I_{B1} and $_{B2}$ come closer, the Input offset urrent (I_{io}) becomes smaller. laximum value for IC741 is 200 mA.

$$I_{io} = |I_{B1} - I_{B2}|$$

put bias current (I_B) = I_B is the verage current flowing in the verting and non-inverting terminal f an op-amp.

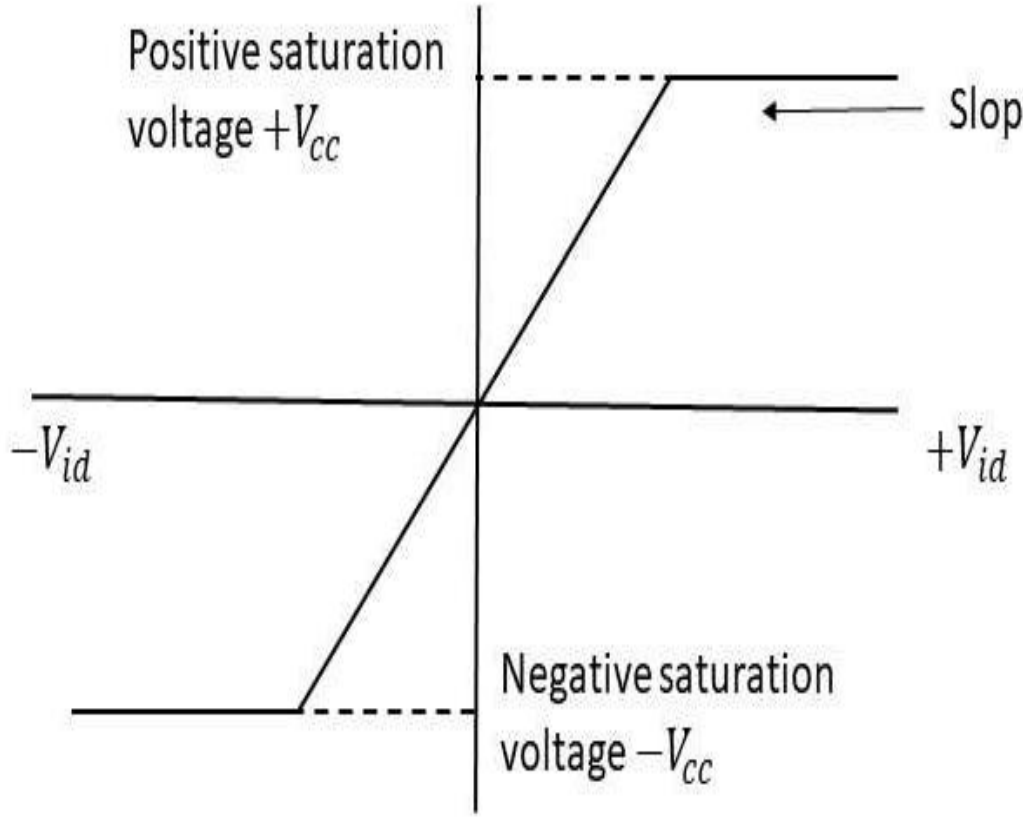
$$I_B = \frac{I_{B1} + I_{B2}}{2}$$



Output Voltage Swing

The **output voltage swing between** the positive and negative saturation voltages and is called output voltage swing.

This parameter indicates the values of **positive and negative saturation voltage** of the op-amp.



rge Signal Voltage Gain (A) : The ratio of the output voltage to the different
put voltage is called large signal voltage gain.

$$= \frac{\text{output voltage}}{\text{Differential input voltage}} = \frac{V_o}{V_{id}}$$

utput Voltage Swing

he **output voltage swing** between the positive and negative saturation volt
nd is called output voltage swing.

his parameter indicates the values of **positive and negative saturation volta**
e op-amp.

fferential input resistance (R_i) :

ifferential input resistance R_i is the equivalent resistance that can be measu
either the inverting or non-inverting input terminals with the other termina
nnected to ground. Typical value for 741 IC is 2 mega ohm.

put capacitance (C_i) : Input capacitance is the equivalent capacitance that
e measured at etither the inverting or non-inverting input terminal with the
her terminal connected to ground. Typical value for a 741 IC is 1.4 Pf.

NMR Spectroscopy

Dr. Honnur Krishna

Assistant Professor of Chemistry

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Belagavi District – 591313,

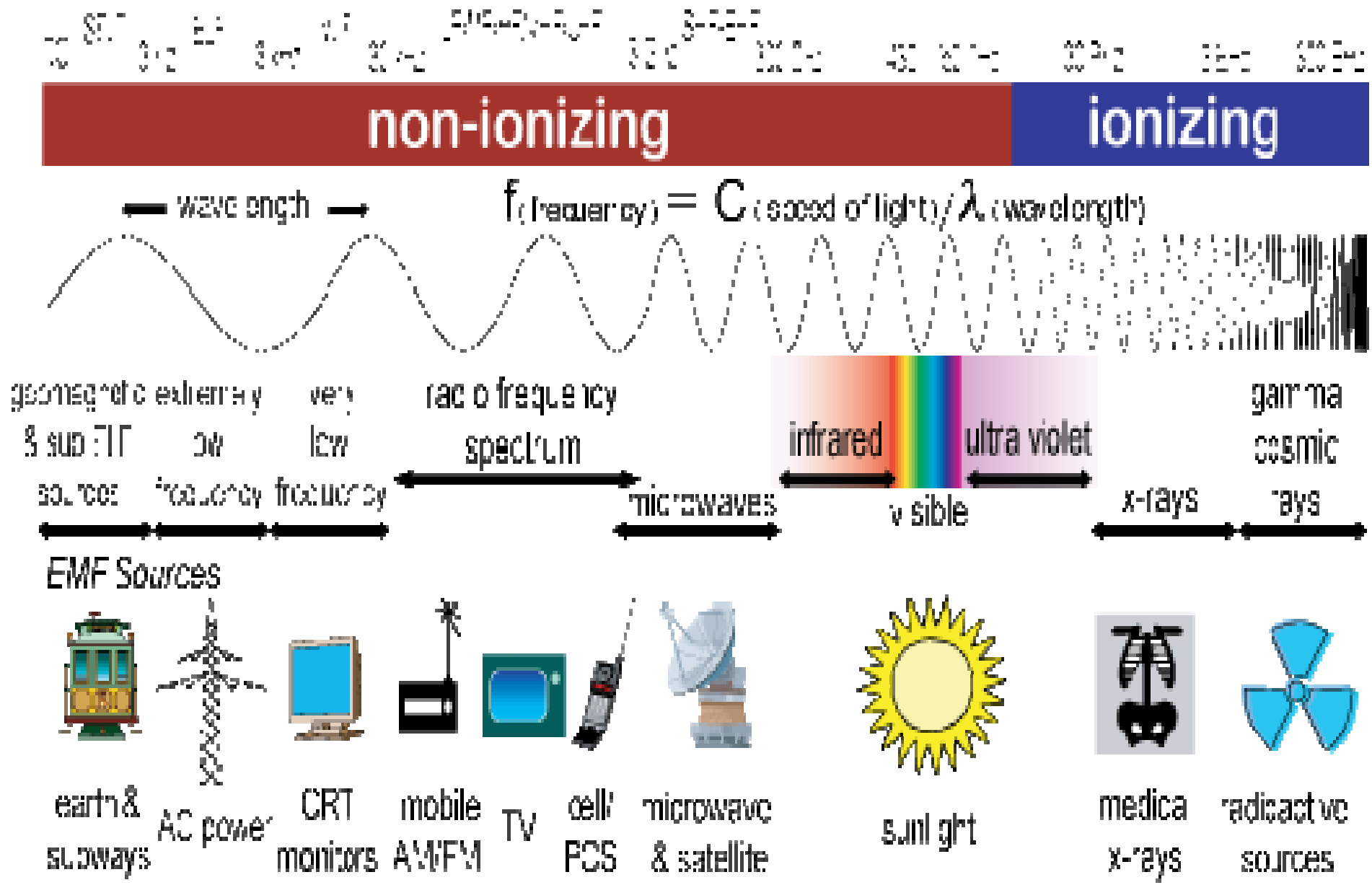
Karnataka,

India

Content

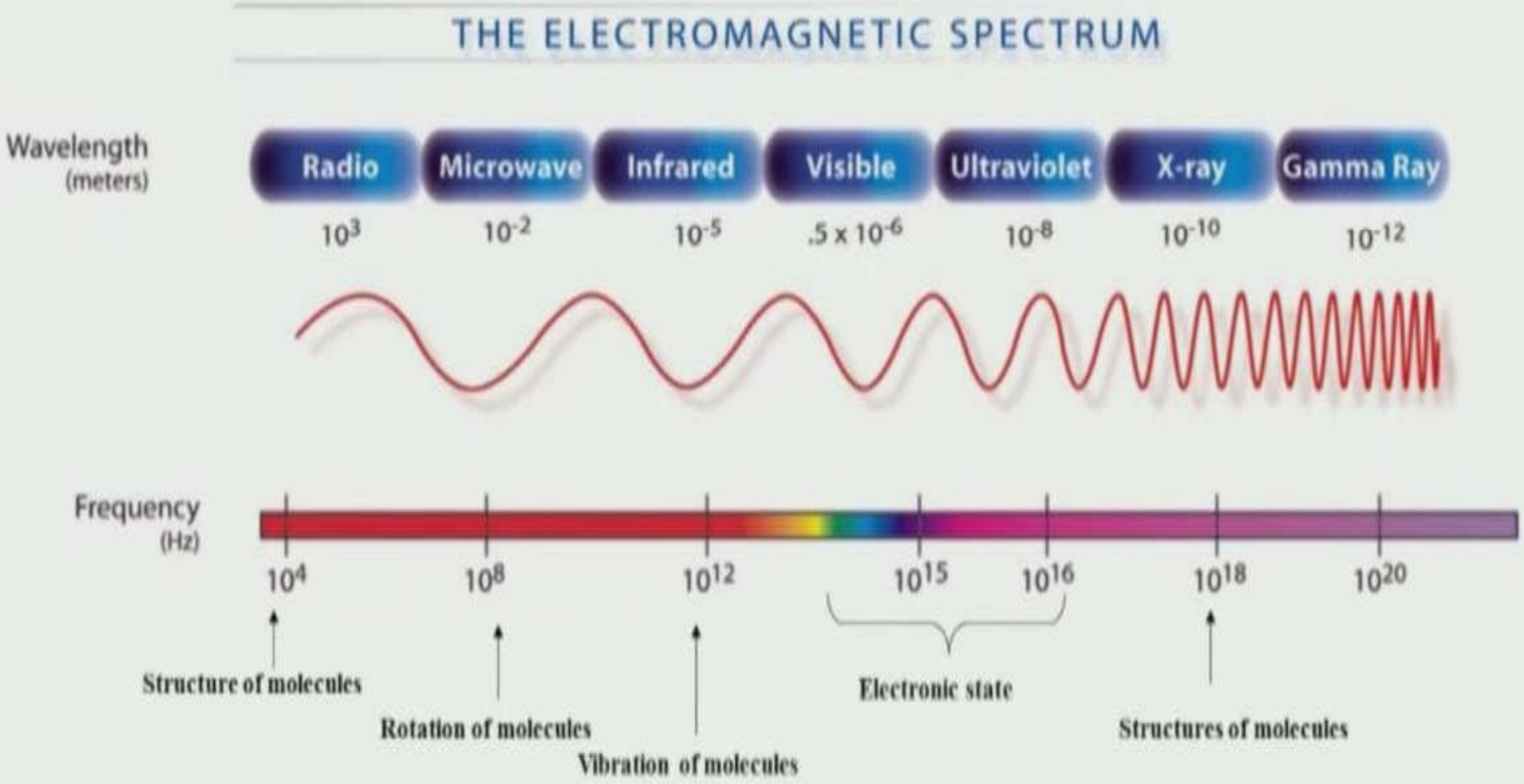
- Principle of Proton Magnetic Resonance(1H NMR) spectroscopy,
- NMRspectrum,
- chemical shift,
- nuclear shielding and deshielding,
- spin-spin coupling(n+1) rule,
- intensity(height) of the signal,
- TMS as internal standard-advantages,
- interpretation of PMR spectra of simple organic molecules such as
- ethyl bromide,
- n-propyl bromide,
- iso propyl bromide,
- ethanol,
- acetaldehyde and benzene

THE ELECTROMAGNETIC SPECTRUM



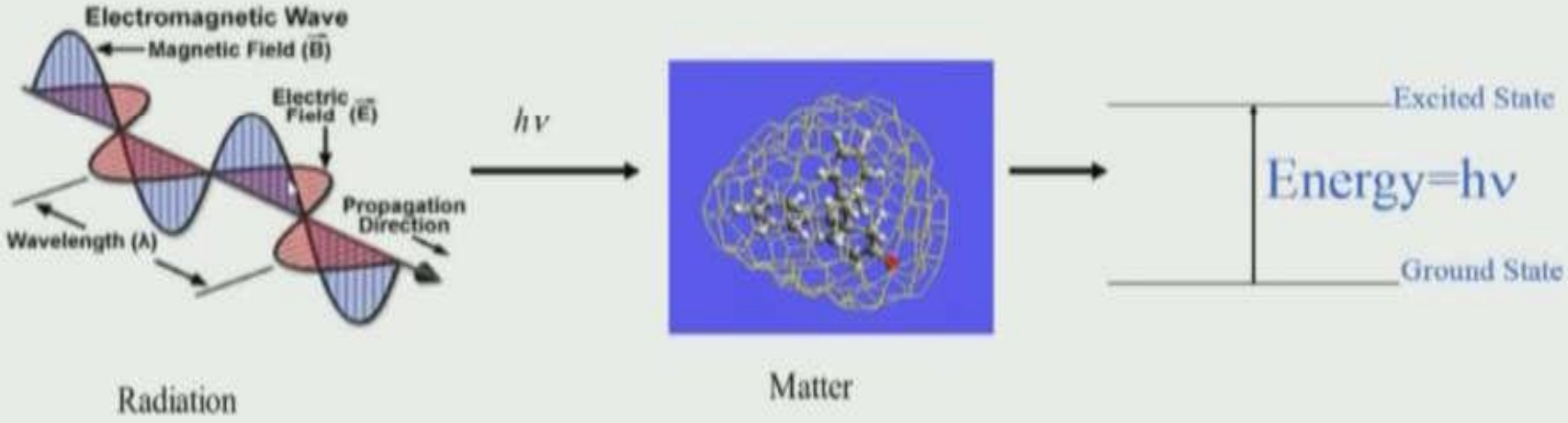
Range of Spectroscopy

Depending on the property being studied, a specific Wavelength of the radiation is chosen to interact with matter

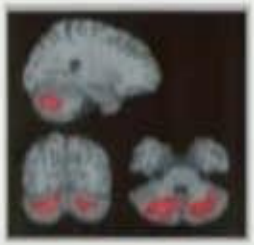


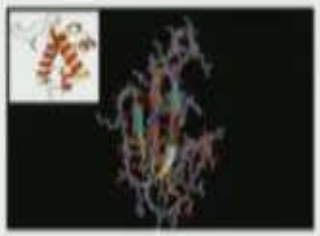
What is Spectroscopy

Spectroscopy involves the study of interaction of radiation with matter



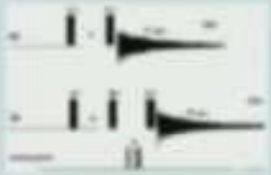
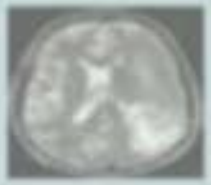
NMR Spectroscopy: A unique spectroscopic tool





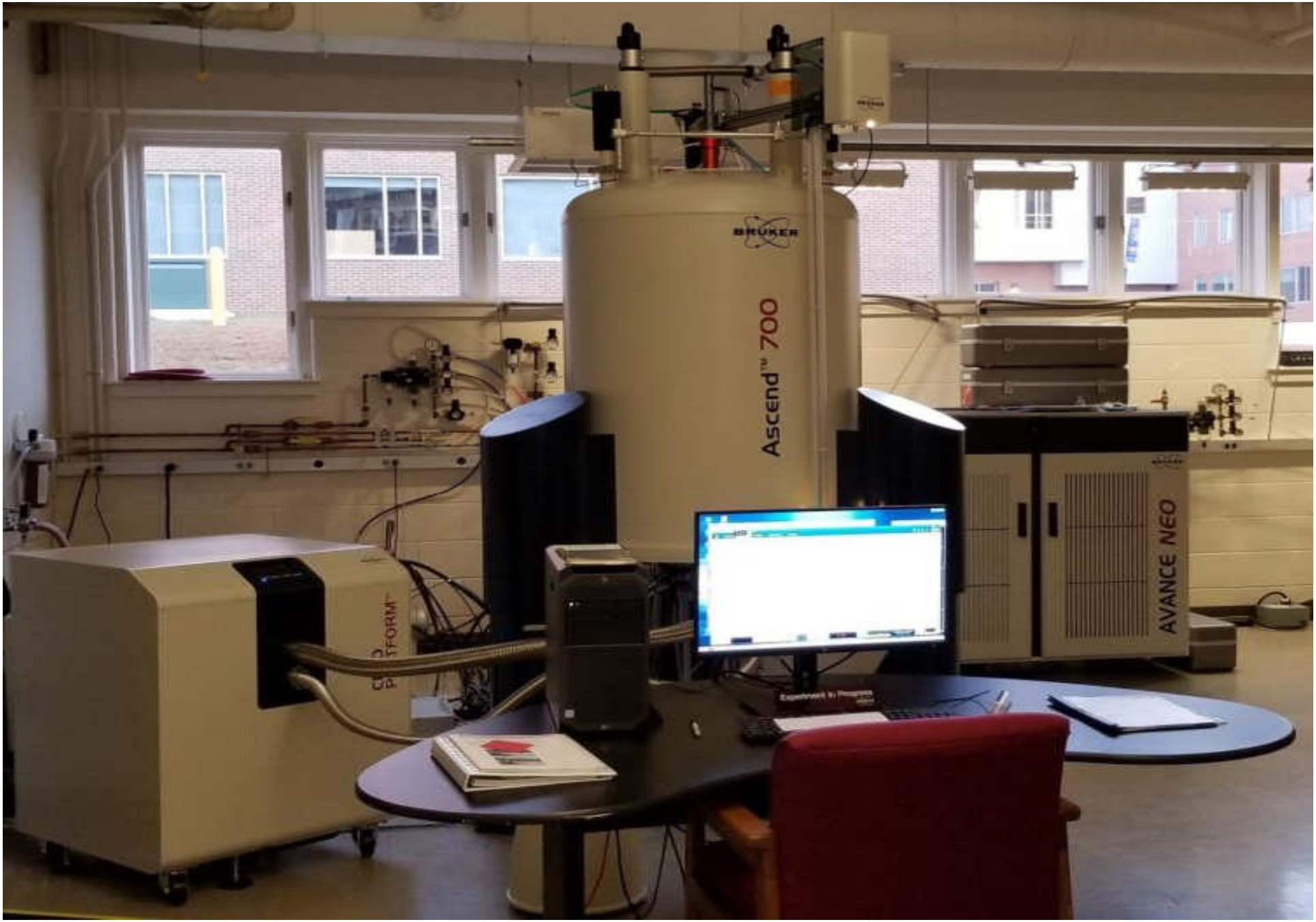
NOBEL PRIZES IN NMR

A True Measure of Multidisciplinary Science

PHYSICS	1952	 Felix Bloch	 E. M. Purcell		Nuclear Magnetic Induction Nuclear Magnetic moments
CHEMISTRY	1991	 R. R. Ernst			High Resolution NMR methods Pulsed - FT NMR Multidimensional NMR
CHEMISTRY	2002	 K. Wüthrich			Methodologies in NMR for 3D structure determination of macromolecules in biological systems
MEDICINE	2003	 P.C. Lauterbur	 Sir P. Mansfield		Discoveries on MRI Most useful disease diagnostic tool today

NMR Spectroscopy: A unique spectroscopic tool

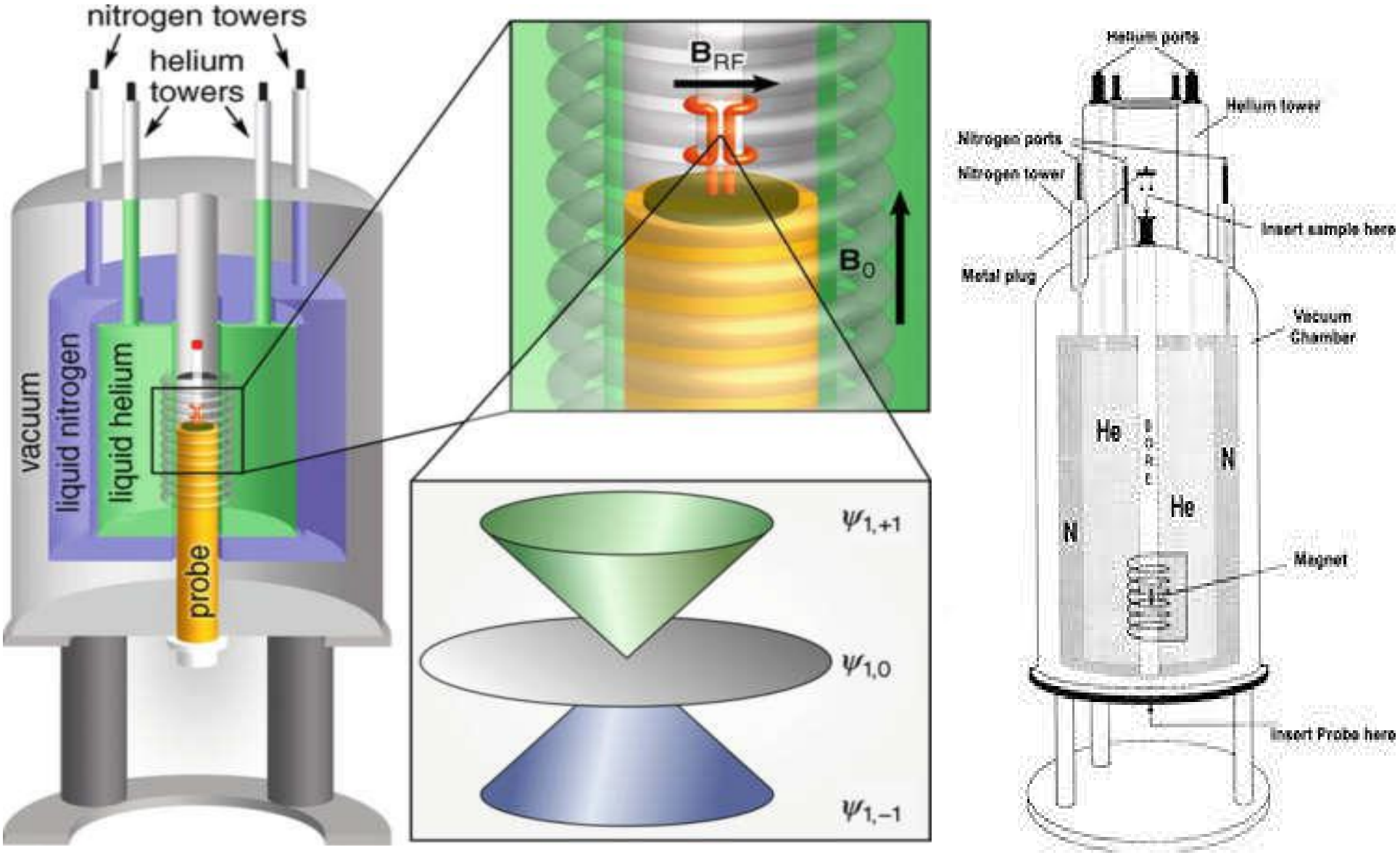
- NMR Spectroscopy is a non-invasive/non-destructive method
- In NMR spectroscopy, each atom in any given molecule can be probed selectively
- The system can be studied at varying conditions of pH, temperature, solvent, pressure etc.
- NMR spectroscopy can be used for accurate quantification of different components in a mixture
- All the three states of matter: solids, liquids and gases are amenable to NMR spectroscopy
- In addition to structure, NMR spectroscopy can used to probe dynamics at an atomic resolution for a wide range of time-scales


BRUKER
Ascend™ 700
AVANCE NEO


DO NOT
400
UltraShield™
AVANCE III 400


Ascend™ 800


CE


nitrogen towers
helium towers
vacuum
liquid nitrogen
liquid helium
probe
B_{RF}
B_0
$\psi_{1,+1}$
$\psi_{1,0}$
$\psi_{1,-1}$
Helium ports
Helium tower
Nitrogen ports
Nitrogen tower
Insert sample here
Metal plug
Vacuum Chamber
He
N
He
N
Magnet
Insert Probe here


TA-55


PS 3
CRYOGEM


NITROGEN

High pressure cryogen tank

Liquid helium tank

Liquid nitrogen

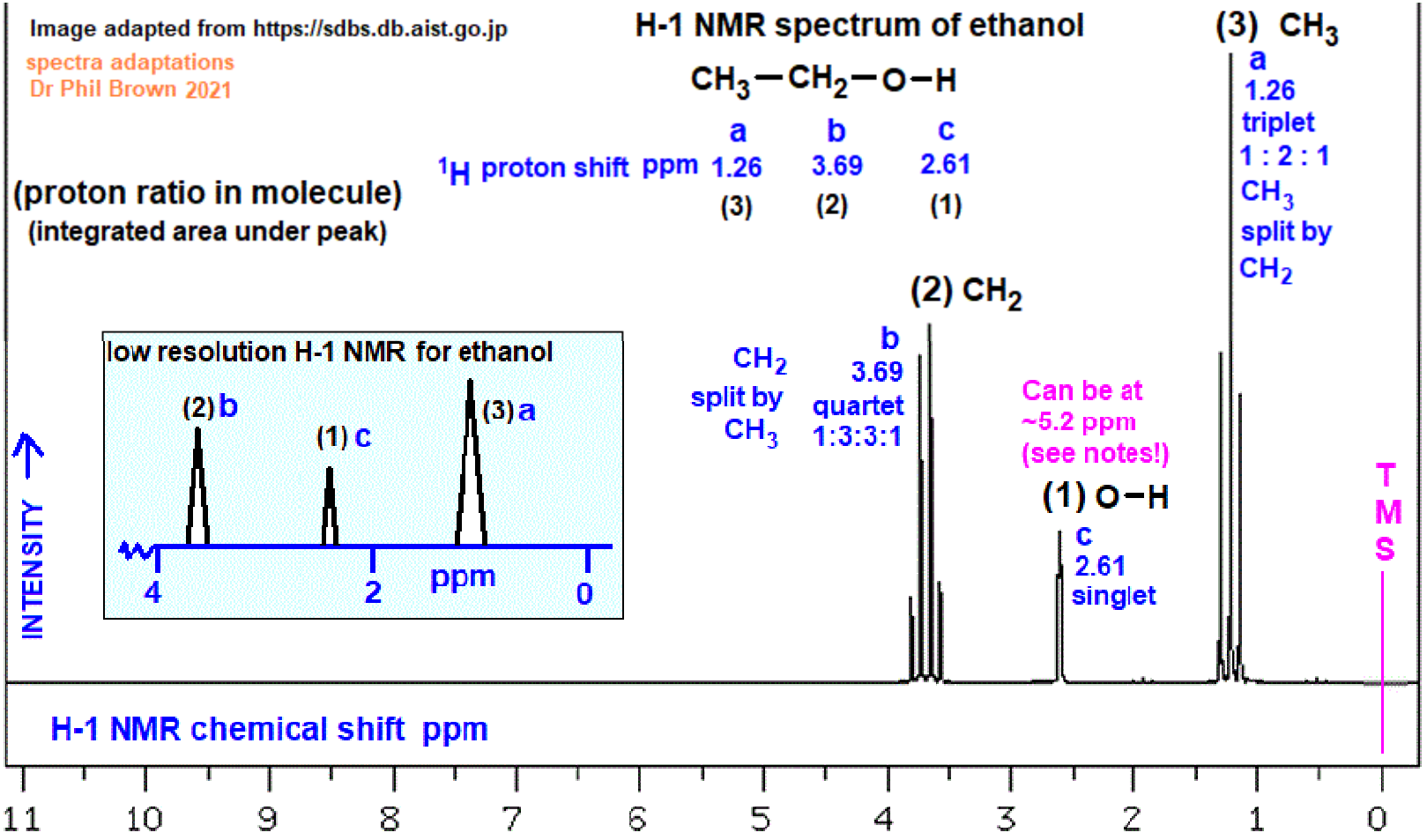
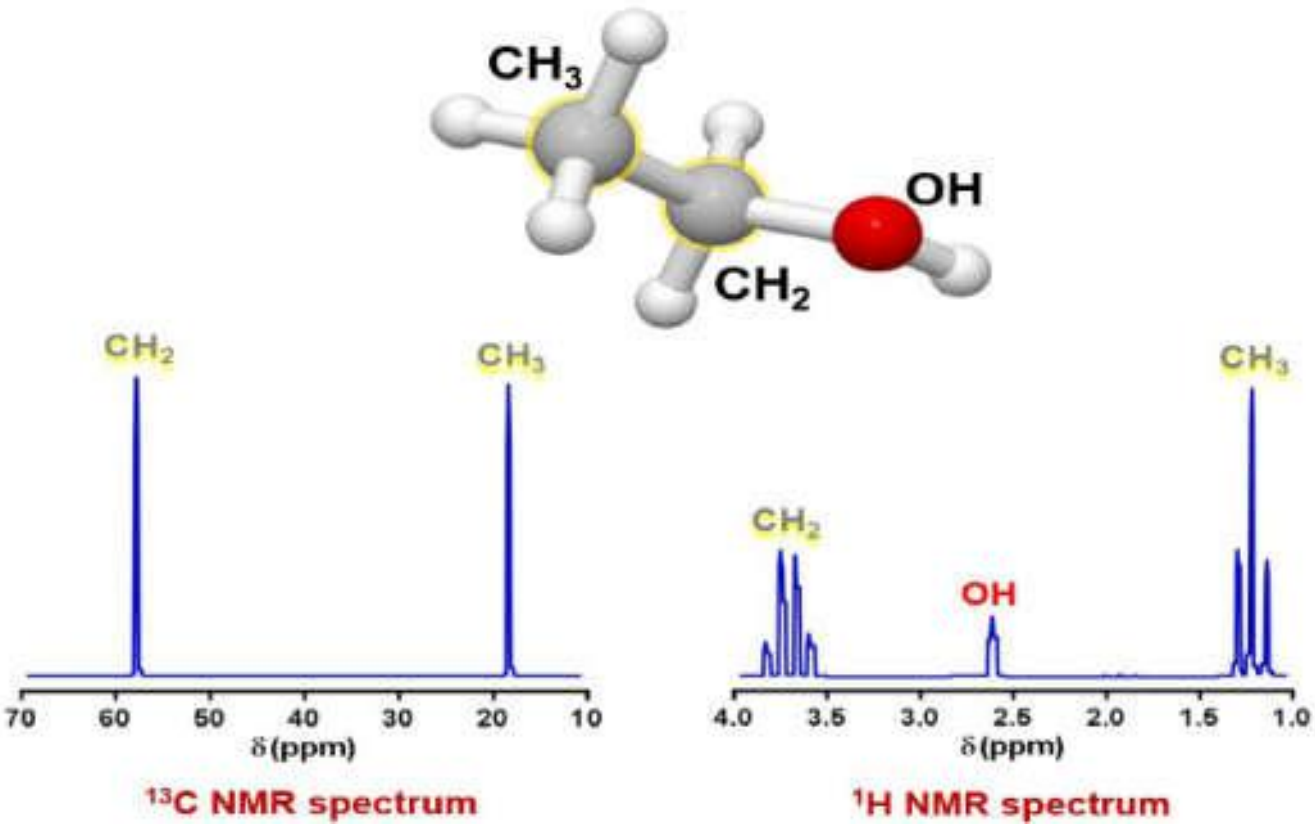
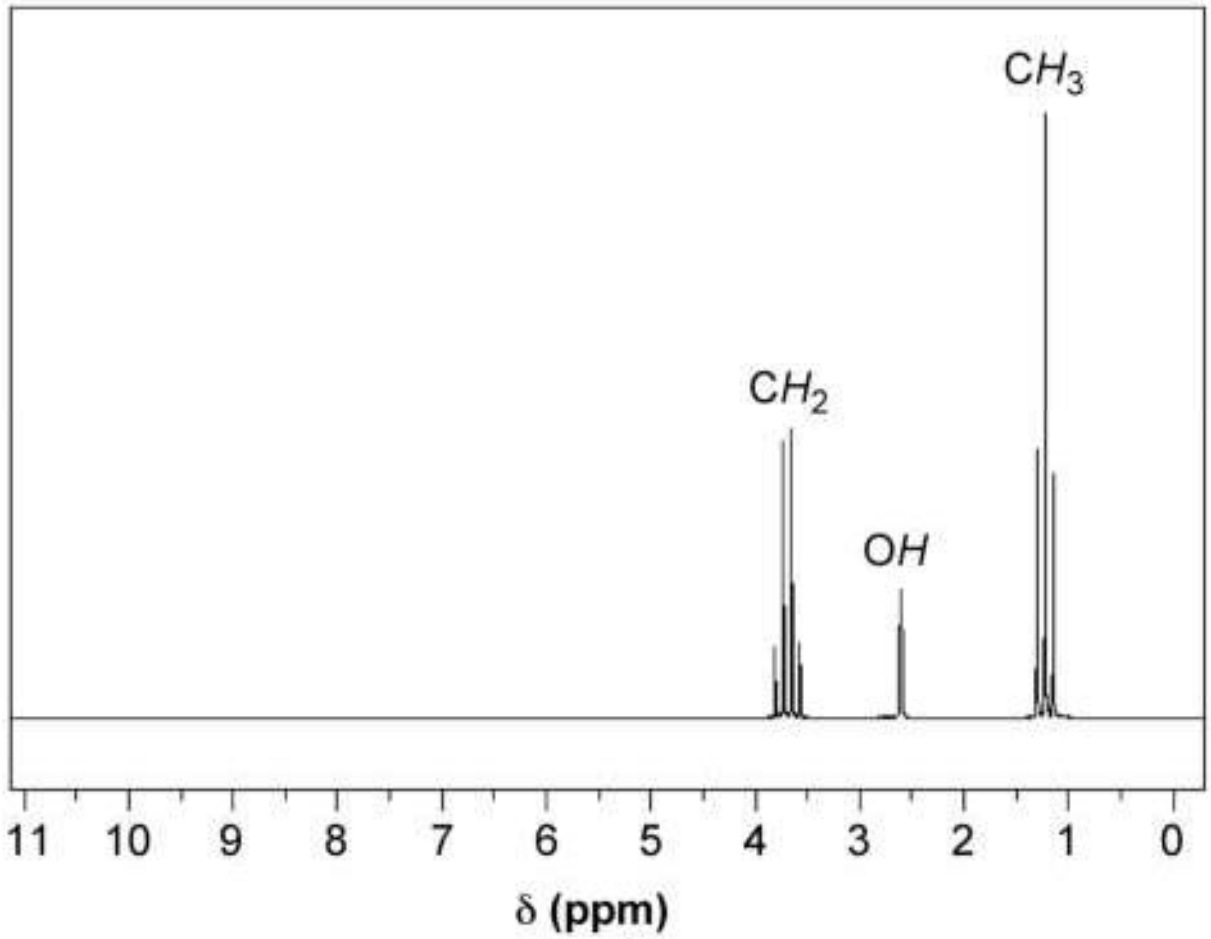


Image adapted from https://sdbs.db.aist.go.jp
spectra adaptations
Dr Phil Brown 2021
H-1 NMR spectrum of ethanol
CH3—CH2—O—H
a b c
1H proton shift ppm 1.26 3.69 2.61
(3) (2) (1)
(proton ratio in molecule)
(integrated area under peak)
low resolution H-1 NMR for ethanol
(2) b
(1) c
(3) a
4
2
ppm
0
INTENSITY
(3) CH3
a
1.26
triplet
1 : 2 : 1
CH3
split by
CH2
(2) CH2
CH2
split by
CH3
b
3.69
quartet
1:3:3:1
Can be at
~5.2 ppm
(see notes!)
(1) O—H
c
2.61
singlet
TMS
H-1 NMR chemical shift ppm
11
10
9
8
7
6
5
4
3
2
1
0


CH3
OH
CH2
CH2
CH3
70
60
50
40
30
20
10
δ (ppm)
13C NMR spectrum
CH3
CH2
OH
4.0
3.5
3.0
2.5
2.0
1.5
1.0
δ (ppm)
1H NMR spectrum


CH3
CH2
OH
11
10
9
8
7
6
5
4
3
2
1
0
δ (ppm)

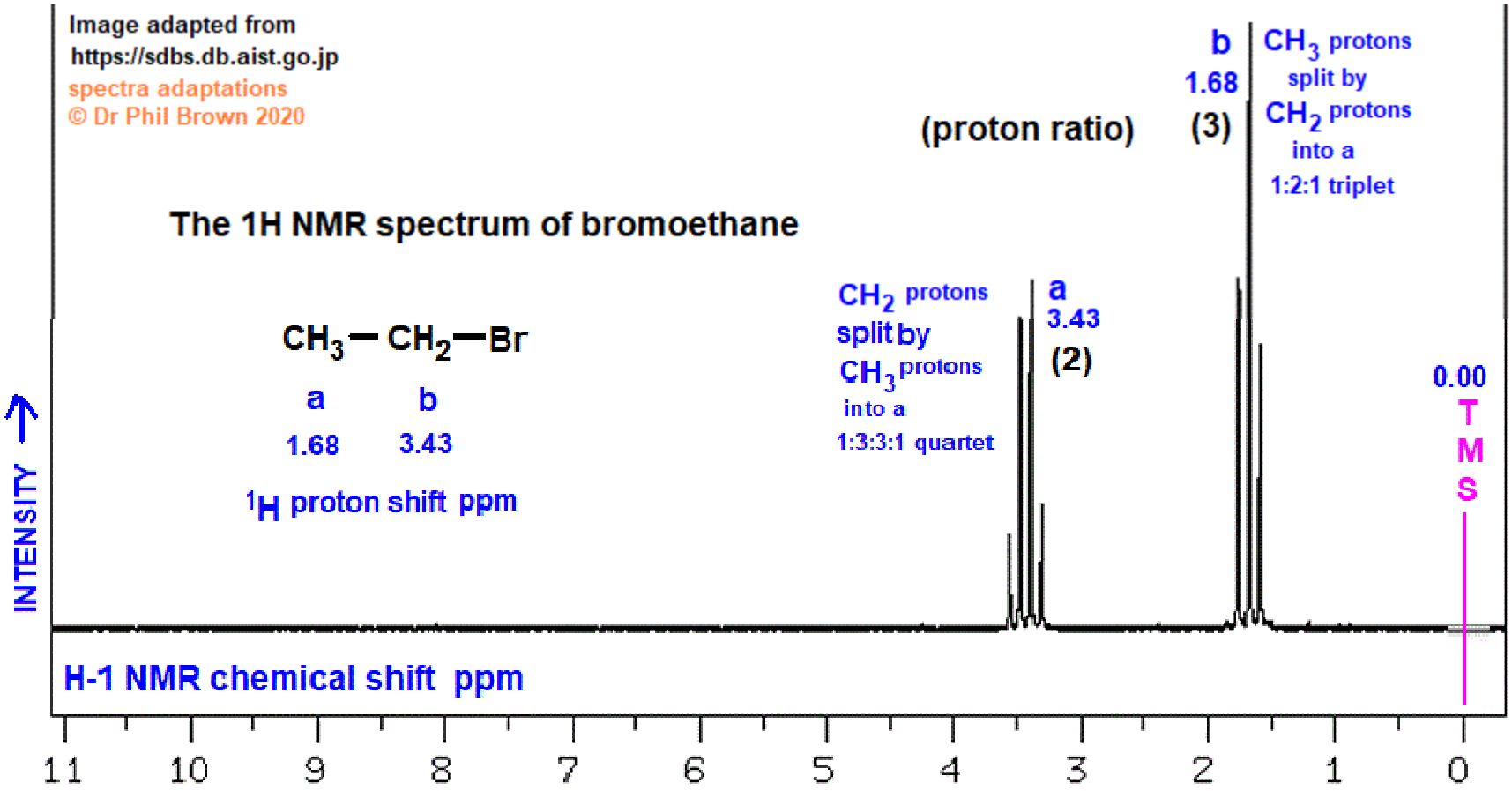


Image adapted from
https://sdbs.db.aist.go.jp
spectra adaptations
© Dr Phil Brown 2020
The 1H NMR spectrum of bromoethane
CH3 — CH2 — Br
a b
1.68 3.43
1H proton shift ppm
(proton ratio)
b
1.68
(3)
CH3 protons
split by
CH2 protons
into a
1:2:1 triplet
CH2 protons
split by
CH3 protons
into a
1:3:3:1 quartet
a
3.43
(2)
0.00
TMS
INTENSITY
H-1 NMR chemical shift ppm
11 10 9 8 7 6 5 4 3 2 1 0

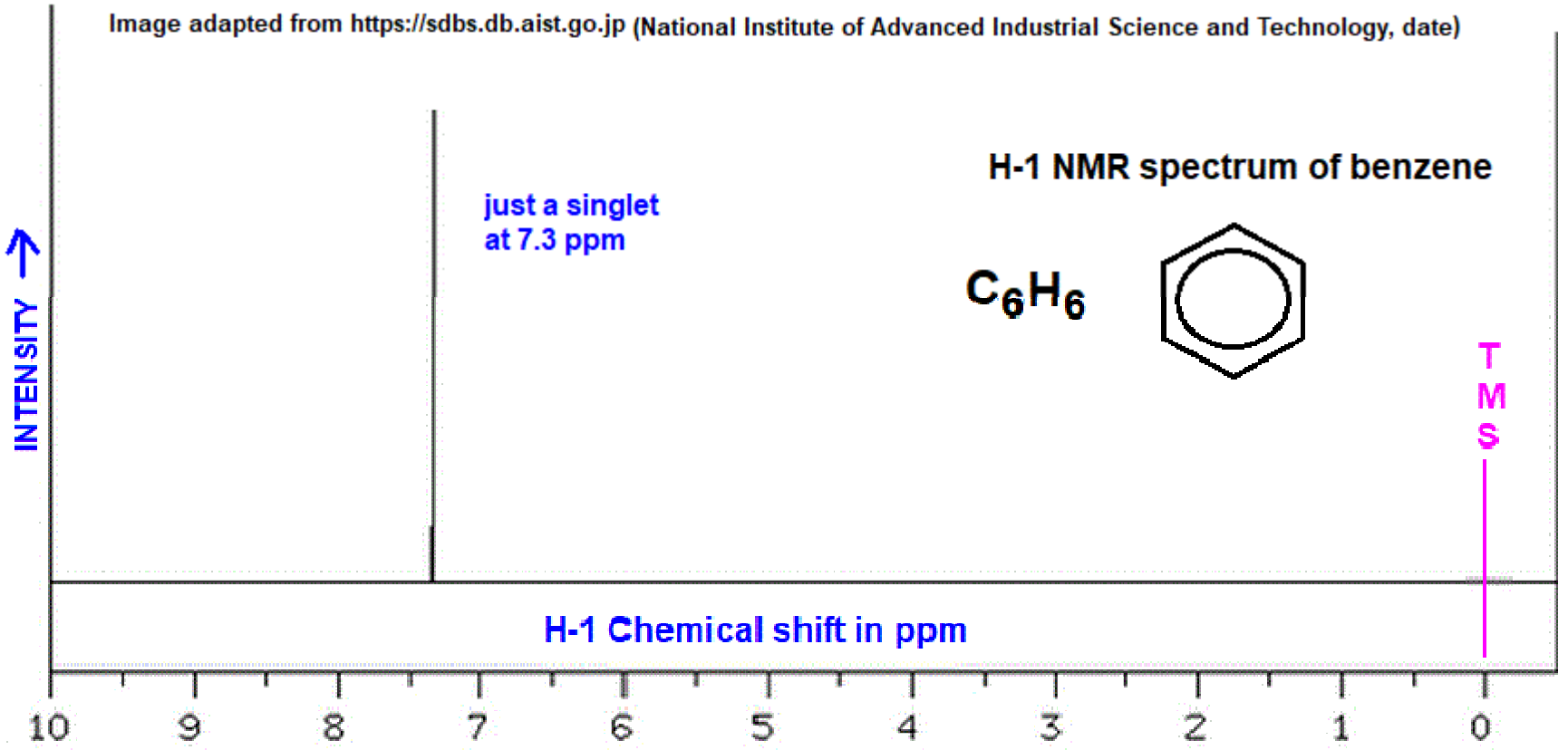
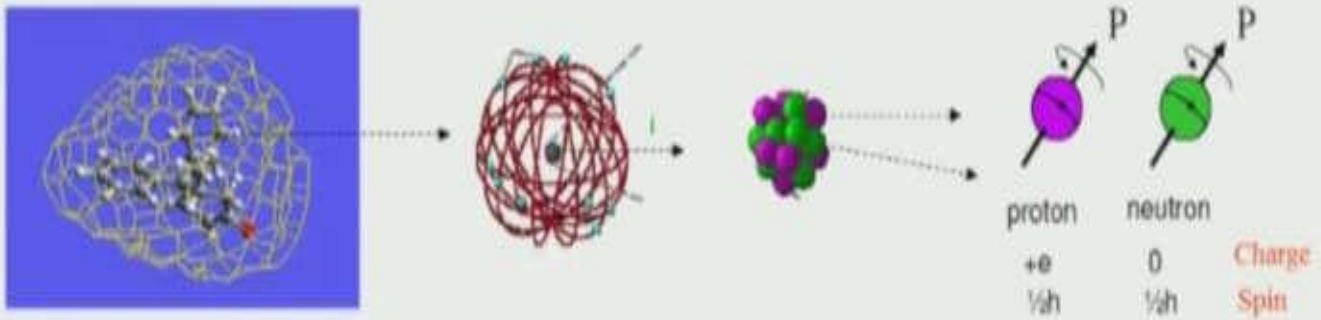


Image adapted from https://sdbs.db.aist.go.jp (National Institute of Advanced Industrial Science and Technology, date)
H-1 NMR spectrum of benzene
just a singlet
at 7.3 ppm
C6H6
INTENSITY
TMS
H-1 Chemical shift in ppm
10
9
8
7
6
5
4
3
2
1
0

Nuclear Magnetic Resonance (NMR) Spectroscopy



- The net (total) spin of the nucleus is equal to the sum total of spins of the nucleons after pairing them up
- The net spin can be zero, half-integer or an integer
- Many elements in the periodic table have non-zero "Nuclear Spin". These elements/isotopes are called **"NMR-active".**
- Any molecule containing such elements (with non-zero nuclear spin) is amenable to study using NMR spectroscopy

NMR Spectroscopy

Estimating the Nuclear Spin

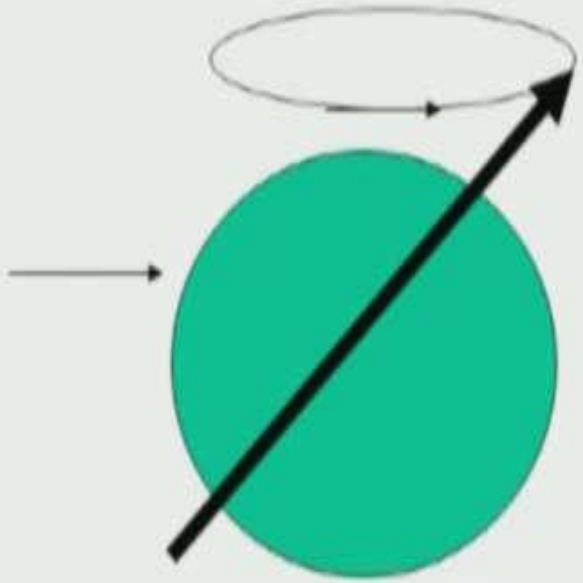
Atomic Mass ↓	Atomic Number: Even	Atomic Number: Odd
Even	0 (NMR In-active) (^{12}C, ^{16}O)	Integral value (e.g., $^{2}H=1$; $^{14}N=1$)
Odd	Half Integer (1/2, 3/2, 5/2 ..) E.g., $^{13}C=1/2$, $^{17}O=5/2$	Half Integer (1/2, 3/2 …) E.g., $^{1}H=1/2$, $^{15}N=1/2$

Most commonly studied nuclei

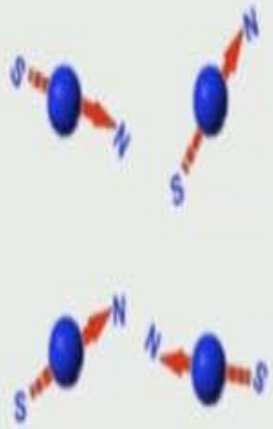
- ^{1}H
- ^{13}C
- ^{31}P
- ^{15}N especially when labeled in proteins
- ^{19}F
- ^{29}Si

All these Spins have I=1/2

Proton/Neutron Inside the Nucleus (spin= ½)

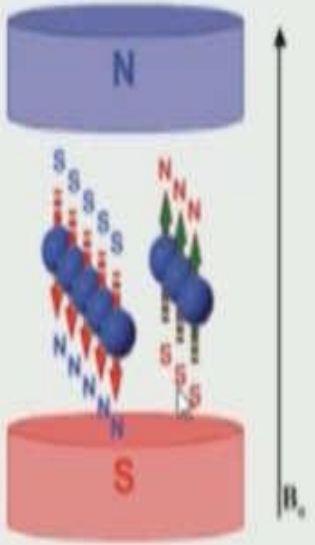


A spinning charge creates a magnetic moment, so these nuclei can be thought of as tiny magnets.



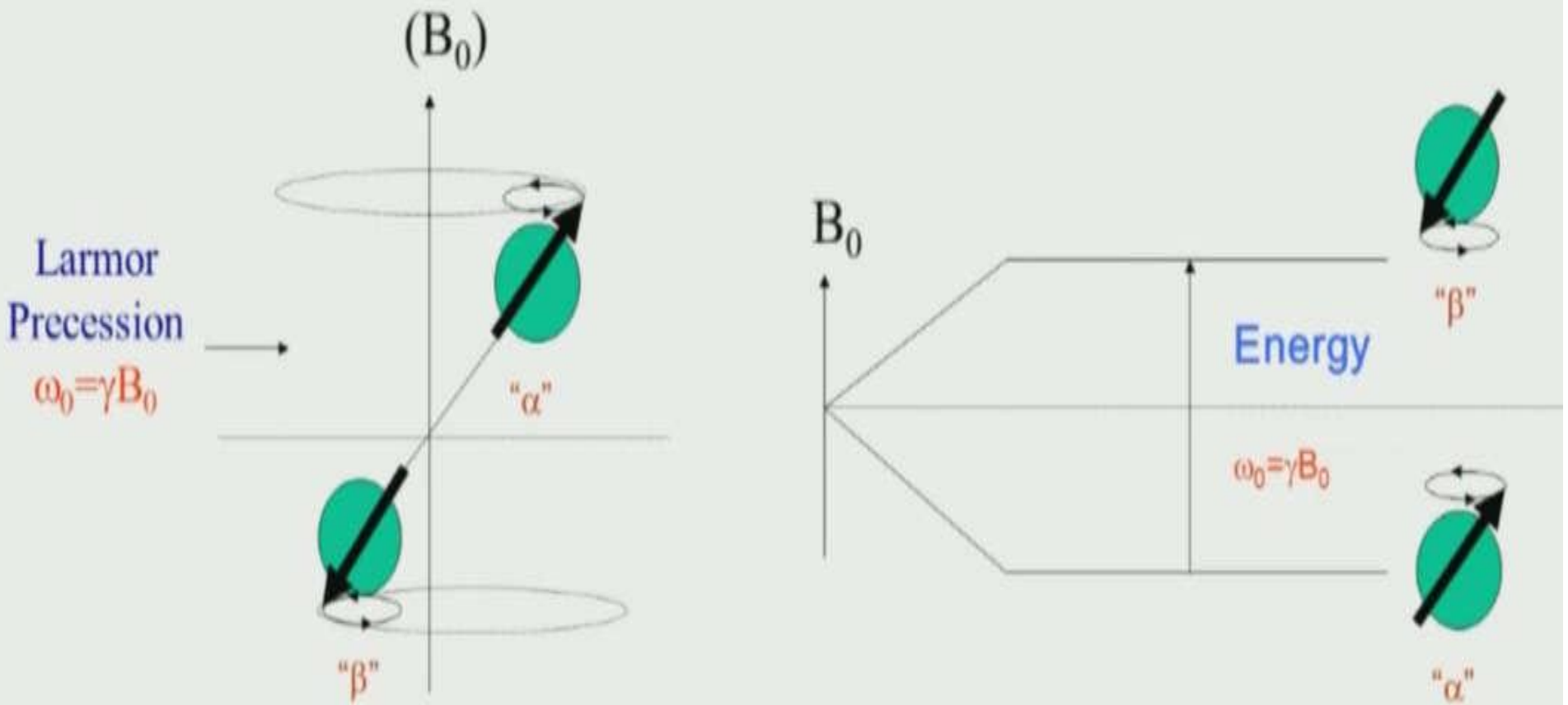
In absence of any external Magnetic field

Applying External Magnetic field



Classical mechanical picture

- The external magnetic field exerts a torque on the spinning nucleus. This causes the nuclear spin to precess around the magnetic field
- The precessional frequency is same as the energy gap between the two spin states



Strength of the magnetic field

- The strength of the magnetic field is given in different units:

  Tesla, Gauss or MHz (1 Tesla = 10^4 Gauss)

- The most common way to indicate the magnetic field strength is to give in terms of the Larmor Precessional frequency: $\nu = \omega_0/2\pi = \gamma B_0/2\pi$ of ^1H nucleus. Higher the Larmor precessional frequency, larger is the magnetic field.

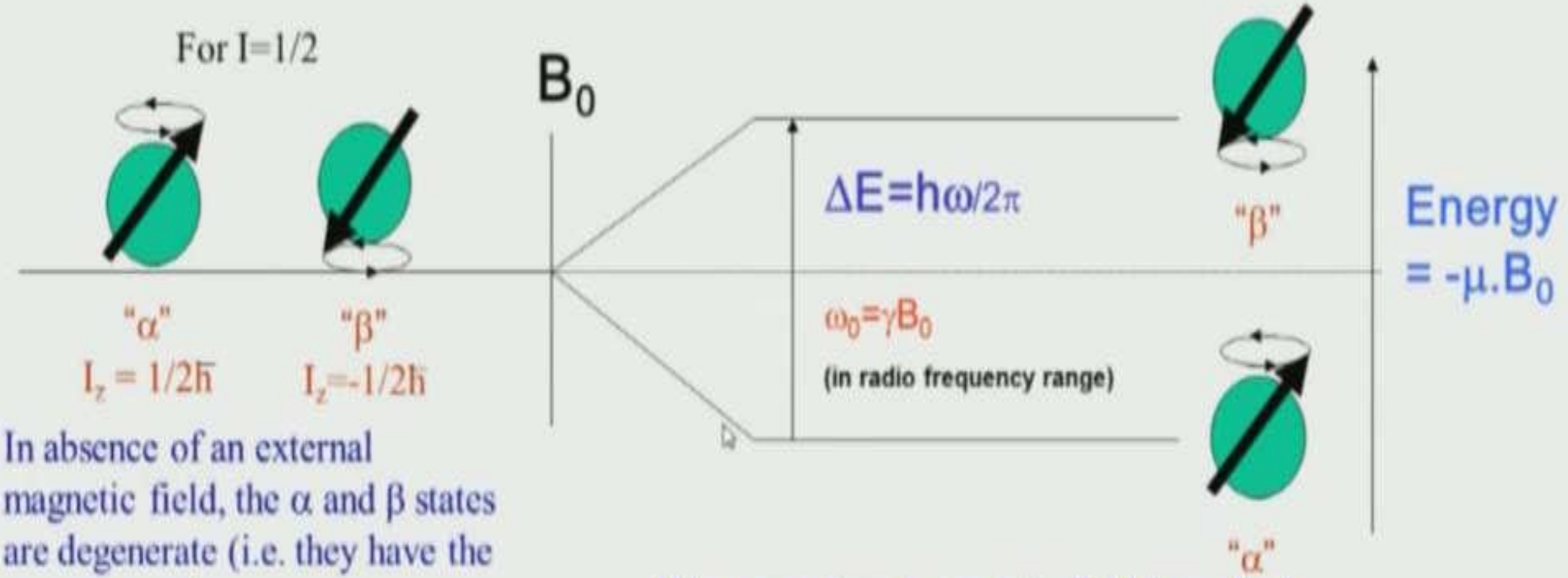
Magnetic field strength	
Tesla	**MHz**
7.05 T	300 MHz
11.75 T	500 MHz
16.45 T	700 MHz
21.15 T	900 MHz

- Earth's magnetic field is 0.5 Gauss

Quantum Mechanical Picture

- The system is thus split into two states with different energies:

$E_{1/2} = -1/2\ h\ B_0$ and $E_{-1/2} = 1/2\ h\ B_0$ => $\Delta E = E_{-1/2} - E_{1/2} = hB_0$

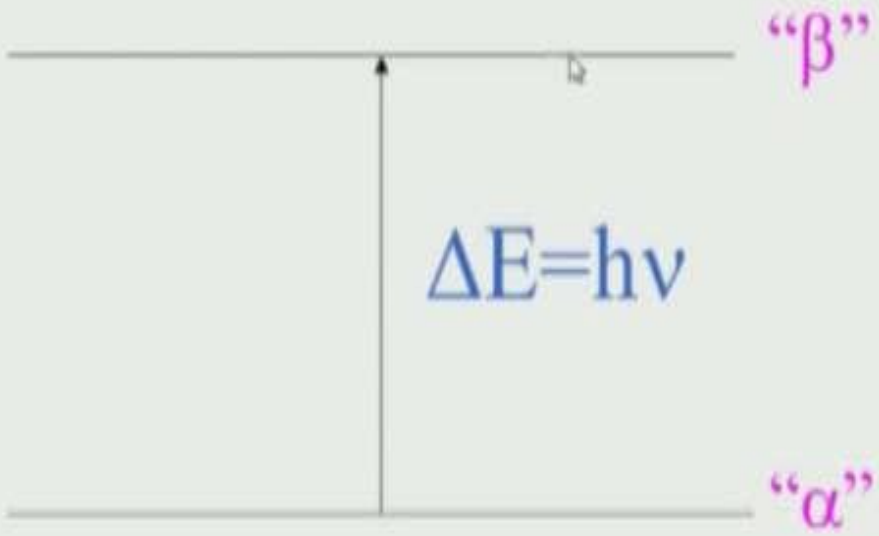


In absence of an external magnetic field, the α and β states are degenerate (i.e. they have the same energy)

When an external magnetic field is applied these two states split into two distinct levels

Quantum Mechanical Picture

- We can induce transition from 'α' to 'β' state or vice-versa by supplying energy *equal* to the gap between the two states



- Hence the name 'nuclear magnetic resonance' (resonance results in energy transfer)

- The number of nuclei in the ground state is more than in the excited state at equilibrium. Hence, there is a net absorption. The strength of the signal is proportional to the net difference in population between the two states.

Quantum Mechanical Picture

- In a sample, if there are *N* number of molecules each containing a given nucleus (I=1/2), the molecules will be partitioned into the two states (I_z =1/2 and I_z= -1/2) as:

$$N = N_{1/2} + N_{-1/2} \text{ (i.e., } N_\alpha + N_\beta)$$

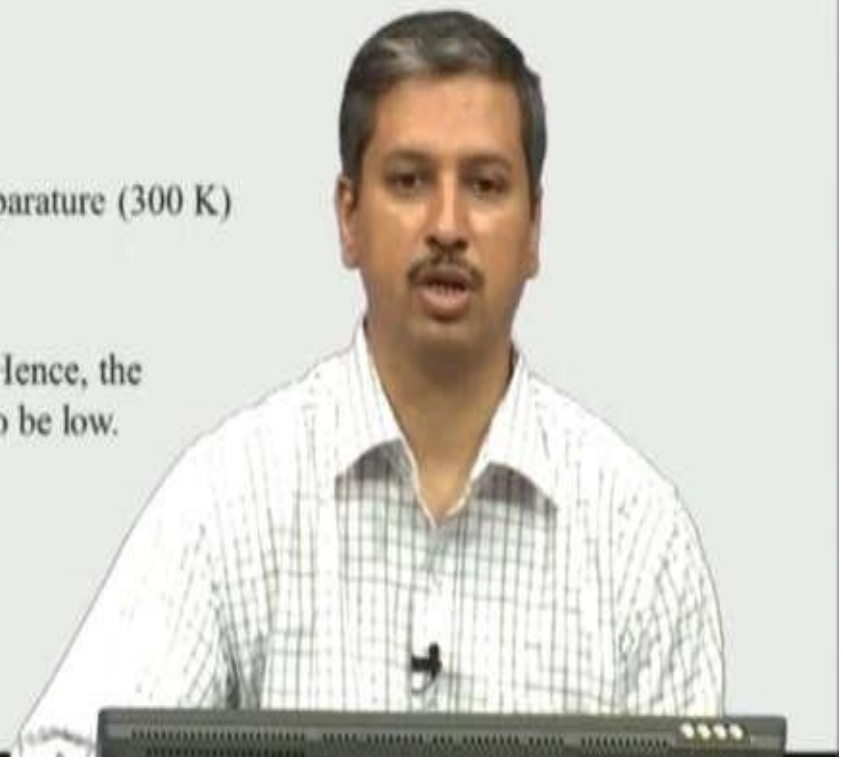
$$N_{1/2} / N_{-1/2} = e^{-\Delta E/kT}$$ (*k*=Boltzmann constant, T=temperature)

This is the well known **Boltzmann law**, an universal law obeyed in nature.

- In NMR spectroscopy: $\Delta E = \gamma h B_0$

$$\Rightarrow N_{1/2} / N_{-1/2} = e^{-\gamma hB0/kT} \sim 1.00001$$ at room temparature (300 K)

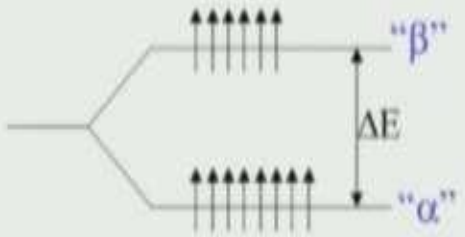
- The difference in population between the two states is very small. Hence, the NMR signal is very weak and this causes the sensitivity of NMR to be low.



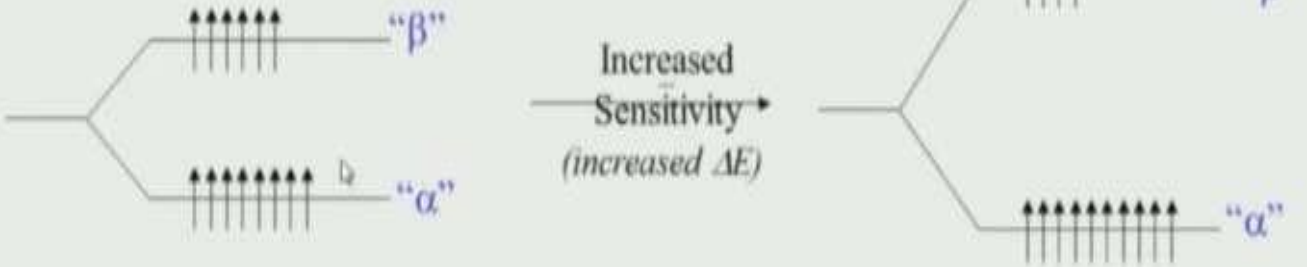
Sensitivity of NMR

- According to Boltzman law, the population ratio or difference is governed as:

$$N_\beta / N_\alpha = e^{-\Delta E} = e^{-\gamma h B0/kT}$$



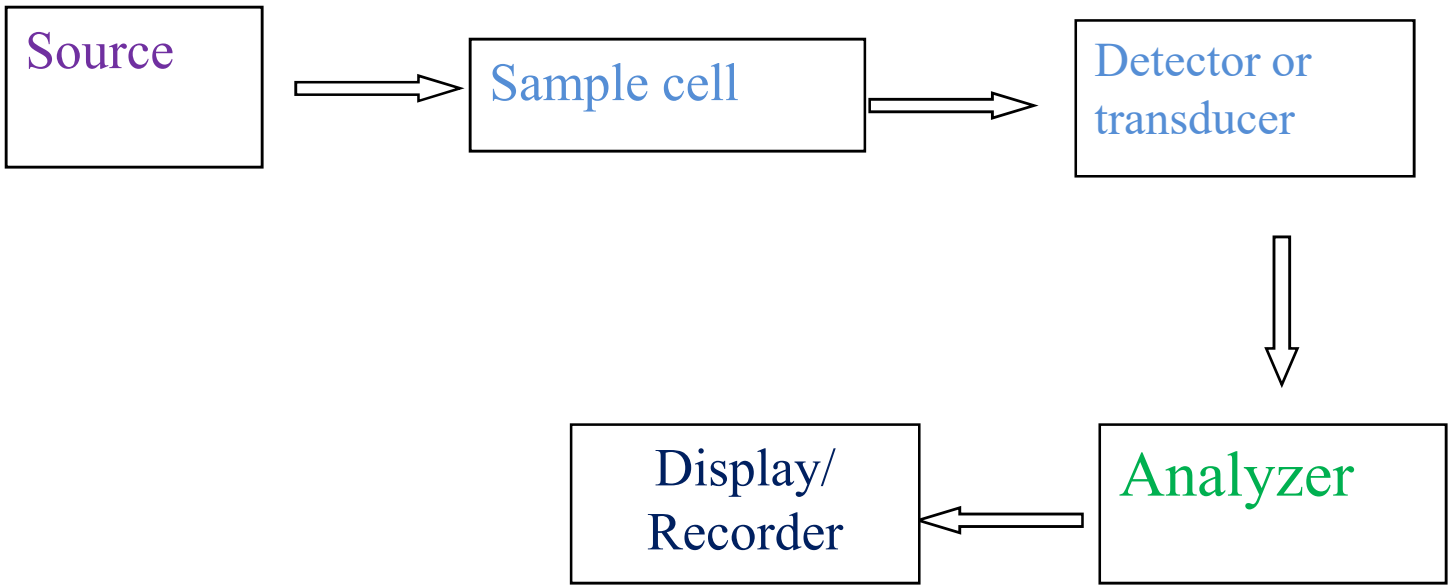
- To increase the population difference, we have to increase energy gap between the α and the β state (i.e., increase ΔE)

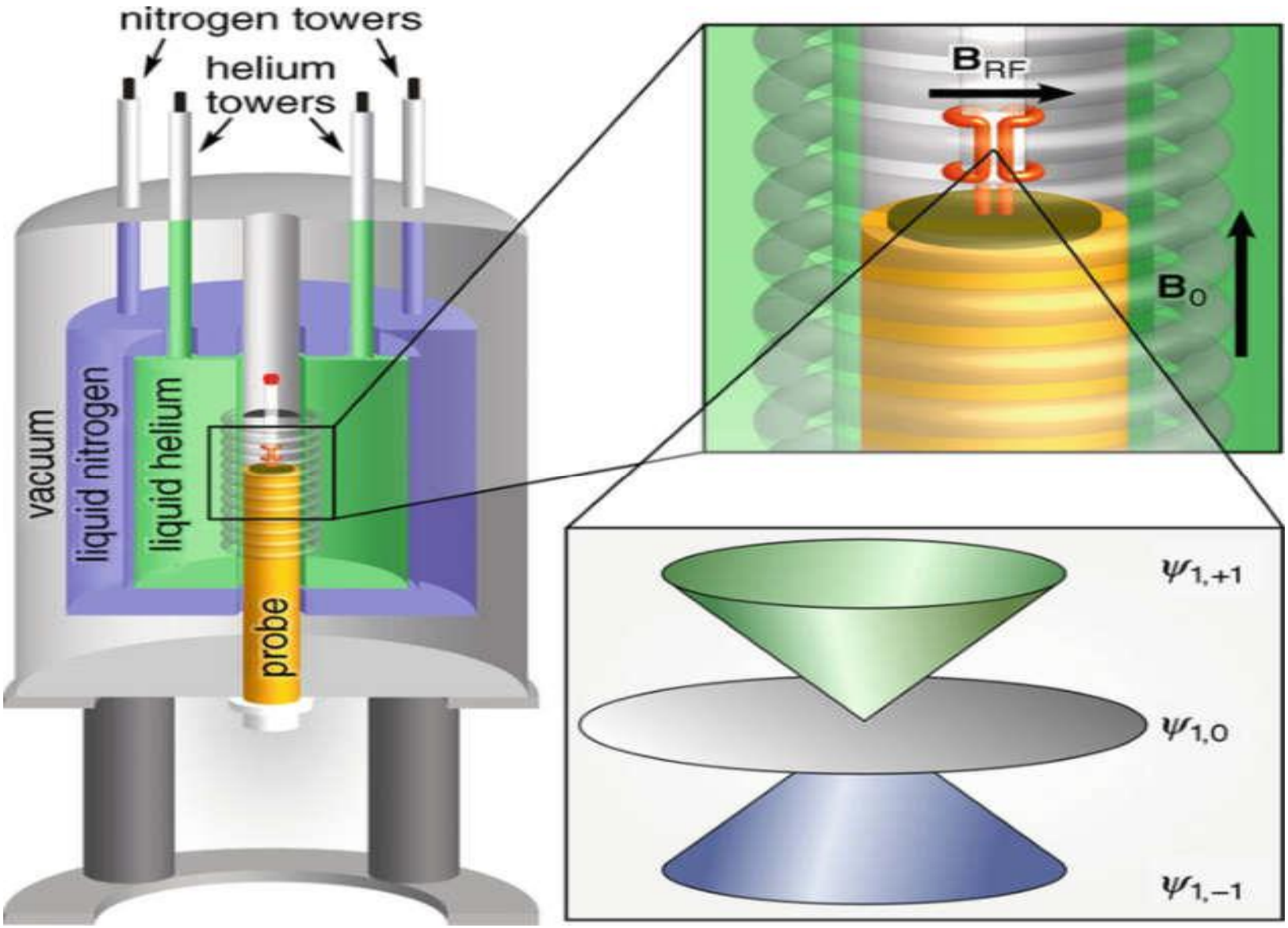


- $\Delta E = \gamma h B_0/kT$ can be increased by: (1) Going to higher γ
  (2) Increasing the magnetic field (B_0)
  (3) Lowering the temperature (T)

- Sensitivity can also be increased by increasing the total number of nuclei (i.e., increasing the concentration of the sample)

General layout of the essential components in a spectrometer




nitrogen towers
helium towers
vacuum
liquid nitrogen
liquid helium
probe
B_{RF}
B_0
$\psi_{1,+1}$
$\psi_{1,0}$
$\psi_{1,-1}$

High pressure cryogen tank

Liquid helium tank

Liquid nitrogen

OPTICAL FIBER

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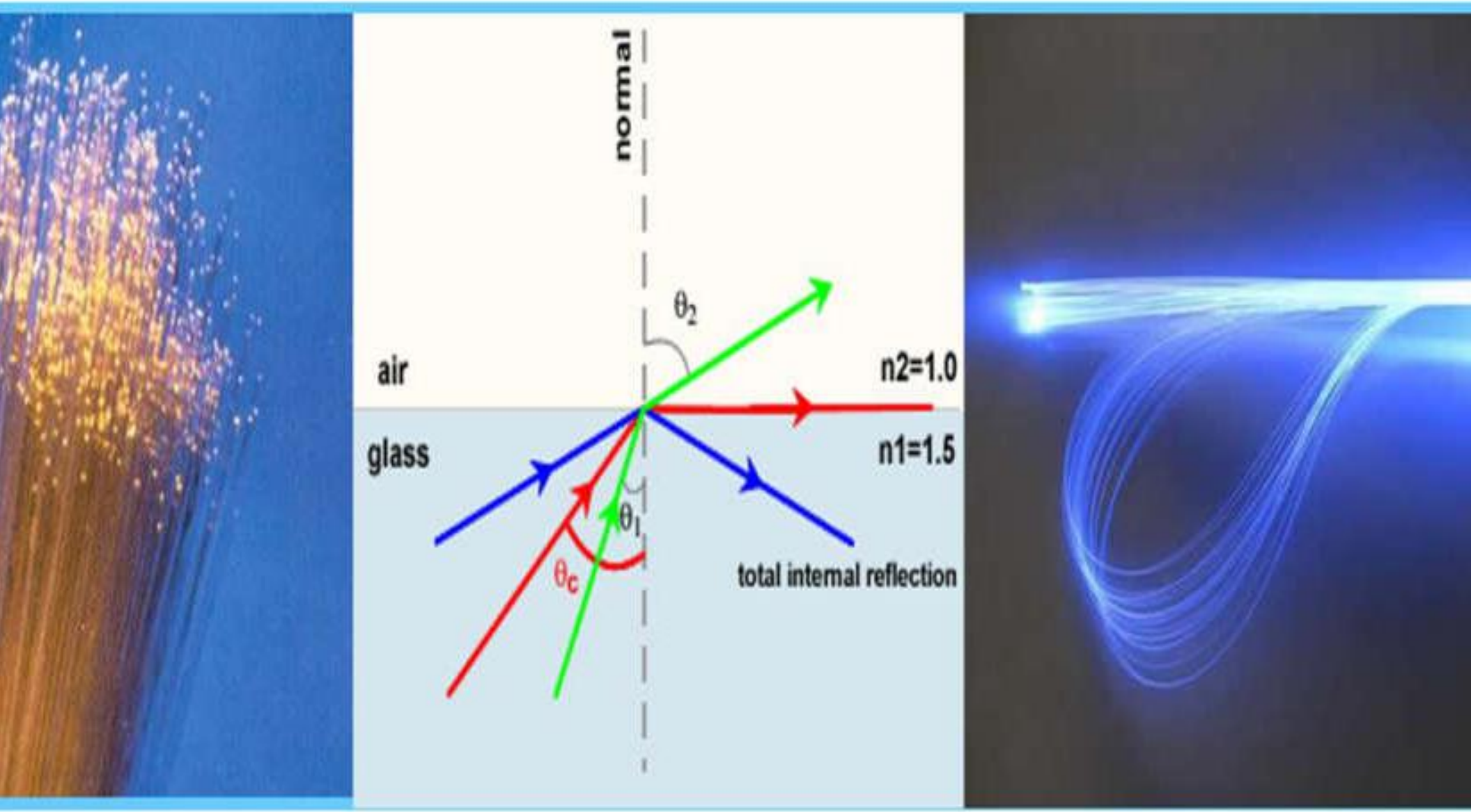
Belagavi

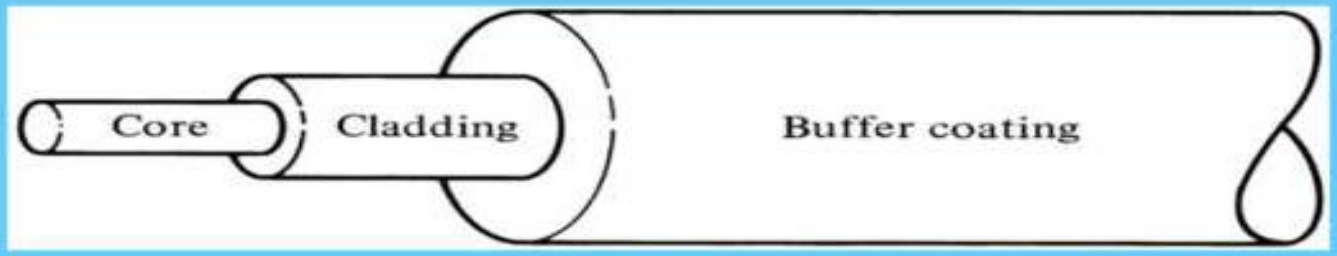

normal
air
glass
n2=1.0
n1=1.5
θ2
θ1
θc
total internal reflection

OPTICAL FIBER

Optical fiber is the technology associated with data transmission using light pulses, which is usually made of plastic or glass

An optical fiber is a long cylindrical dielectric waveguide, usually of circular cross-section, transparent to light over the operating wavelength.

iber Structure



single solid dielectric of two concentric layers.

Inner layer - **Core** of radius '**a**' and refractive index '**n**

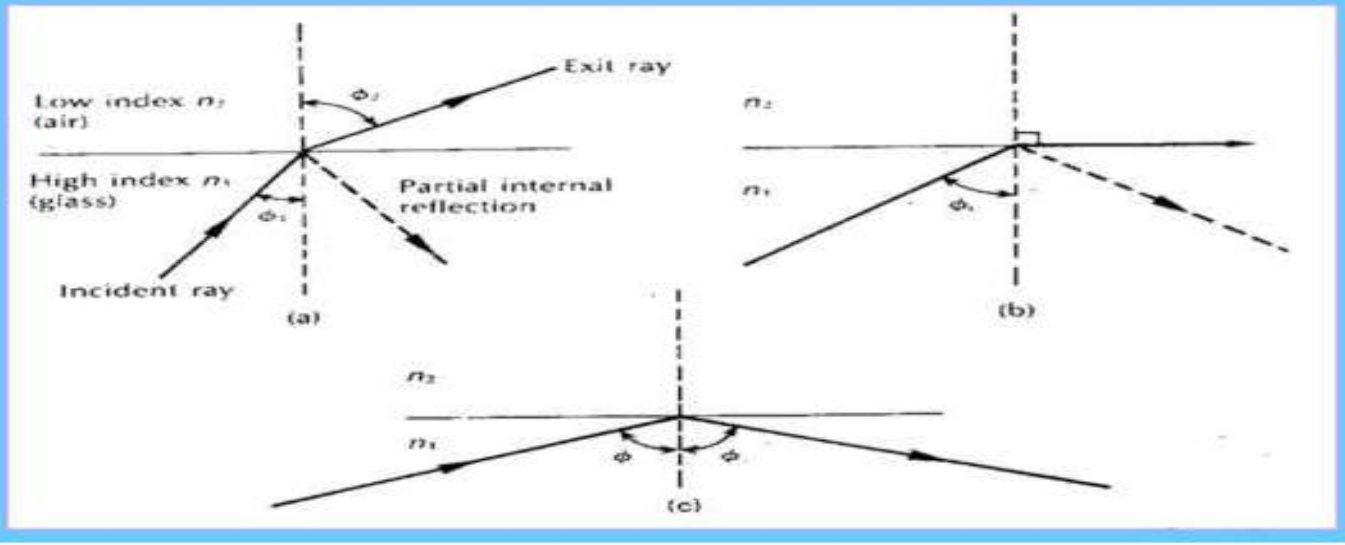
Outer layer – **Cladding** refractive index 'n_2'.

$n_2 < n_1 \rightarrow$ **condition necessary for TIR**

Fiber acts as an open optical waveguide – may be analyzed using simple ray theory – **Geometric Optics**

Total Internal Reflection

Light entering from glass-air interface ($n_1 > n_2$) - **Refraction**



Snell's Law:

$$n_1 \sin \phi_1 = n_2 \sin \phi_2$$

or $$\frac{\sin \phi_1}{\sin \phi_2} = \frac{n_2}{n_1}$$

$$\Rightarrow \phi_2 > \phi_1$$

- At $\phi_2 = 90^\circ$, refracted ray moves parallel to interface between dielectrics and $\phi_1 < 90^\circ$ - **Limiting case of refraction**

  Angle of incidence, $\phi_1 \rightarrow \phi_C$; **critical angle**

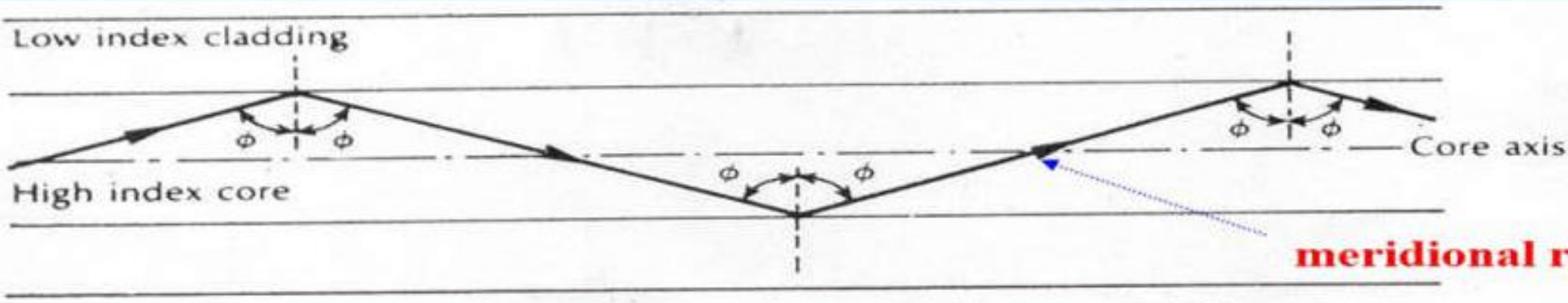
Total Internal Reflection

lue of critical angle (ϕ_C); $\sin \phi_C = n_2/n_1$

Total Internal Reflection

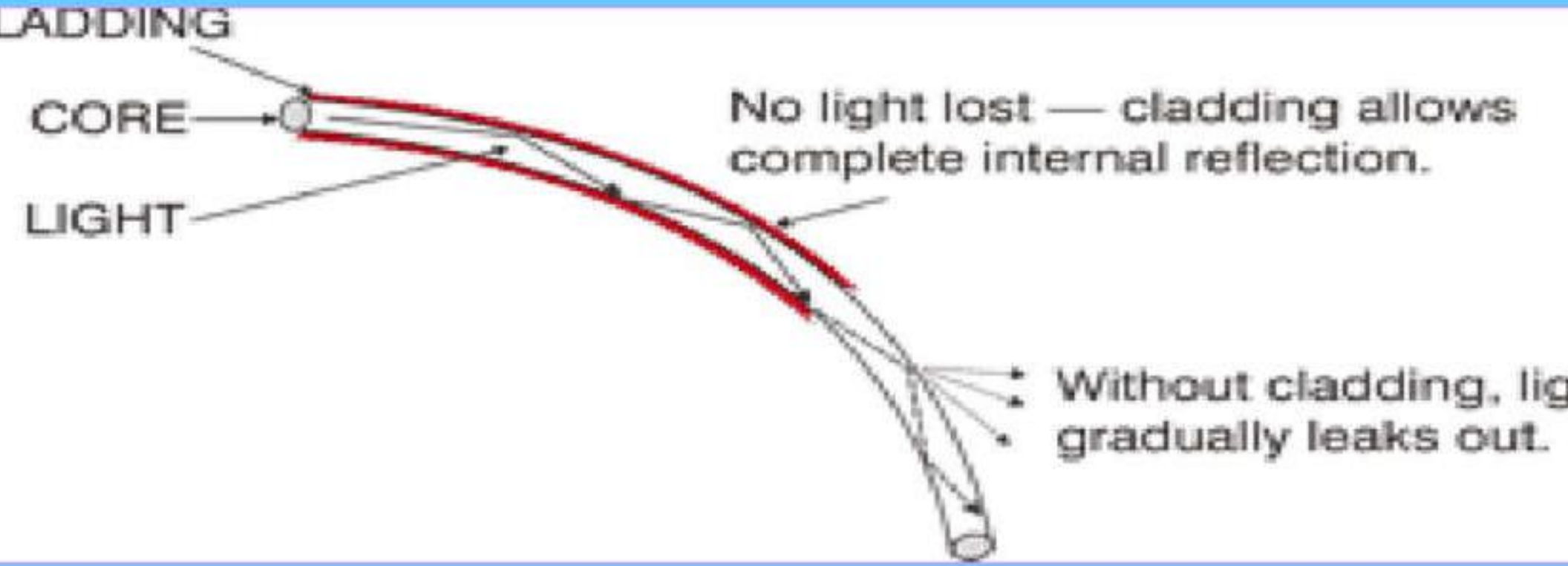
lue of critical angle (ϕ_C); $\sin \phi_C = n_2/n_1$

- At angle of incidence greater than critical angle, the light
  reflected back into the originating dielectric medium (TIR
  with high efficiency ($\approx 99.9\%$)



light propagation through the fiber, the conditio
total internal reflection (TIR) should be met at t
e-cladding interface

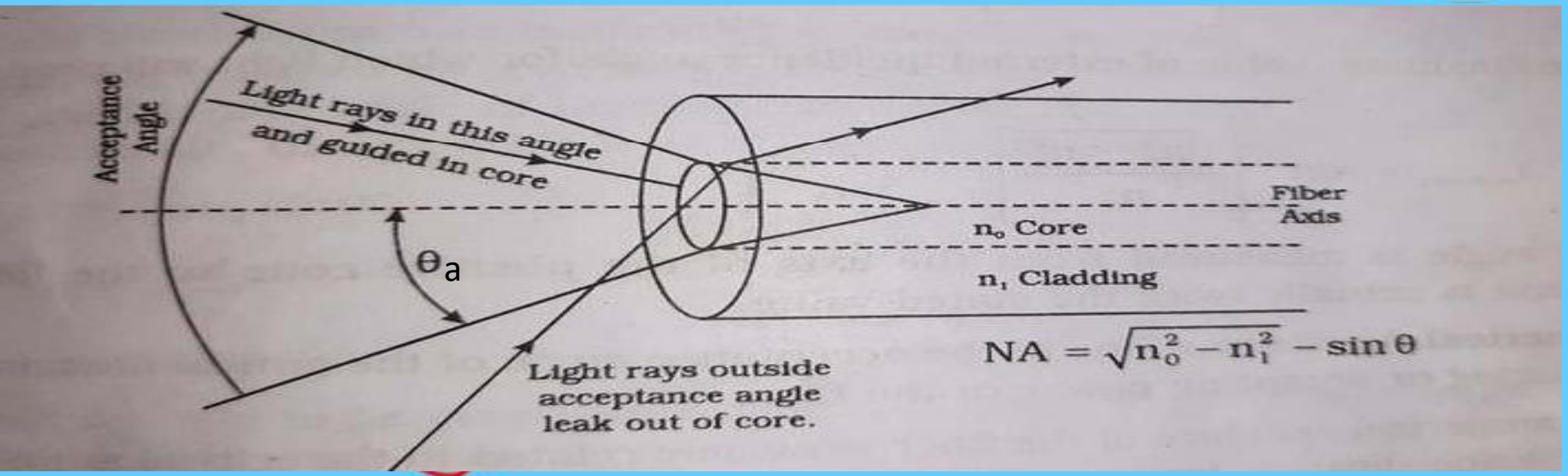
ight Propagation through Optical Fibe



Numerical Aperture (NA)

ry useful parameter : measure of light collecting abili
ber.

arger the magnitude of NA, greater the amount of light accepted by
ber from the external source



$$NA = \sin\theta_a = \sqrt{n^2_{core} - n^2_{cladding}}$$

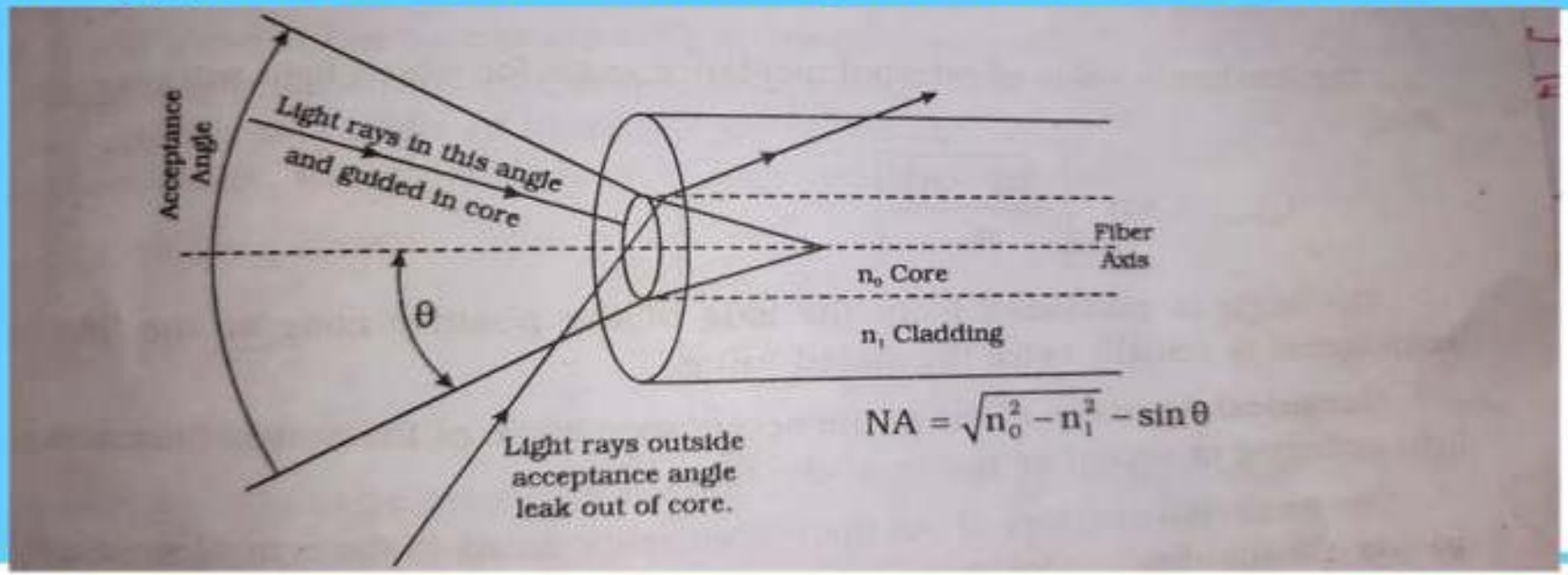
- Note

- θ_a and i_m both are acceptance angle
- n_{core} and n_1 are same, refractive index of the core medium
- $n_{cladding}$ and n_2 are same, refractive index of the cladding medium

ACCEPTANCE ANGLE

t all rays entering the fiber core will continue to be propagated
wn its length

ly rays with sufficiently shallow grazing angle (i.e. angle to the
rmal > ϕ_C) at the core-cladding interface are transmitted by TI

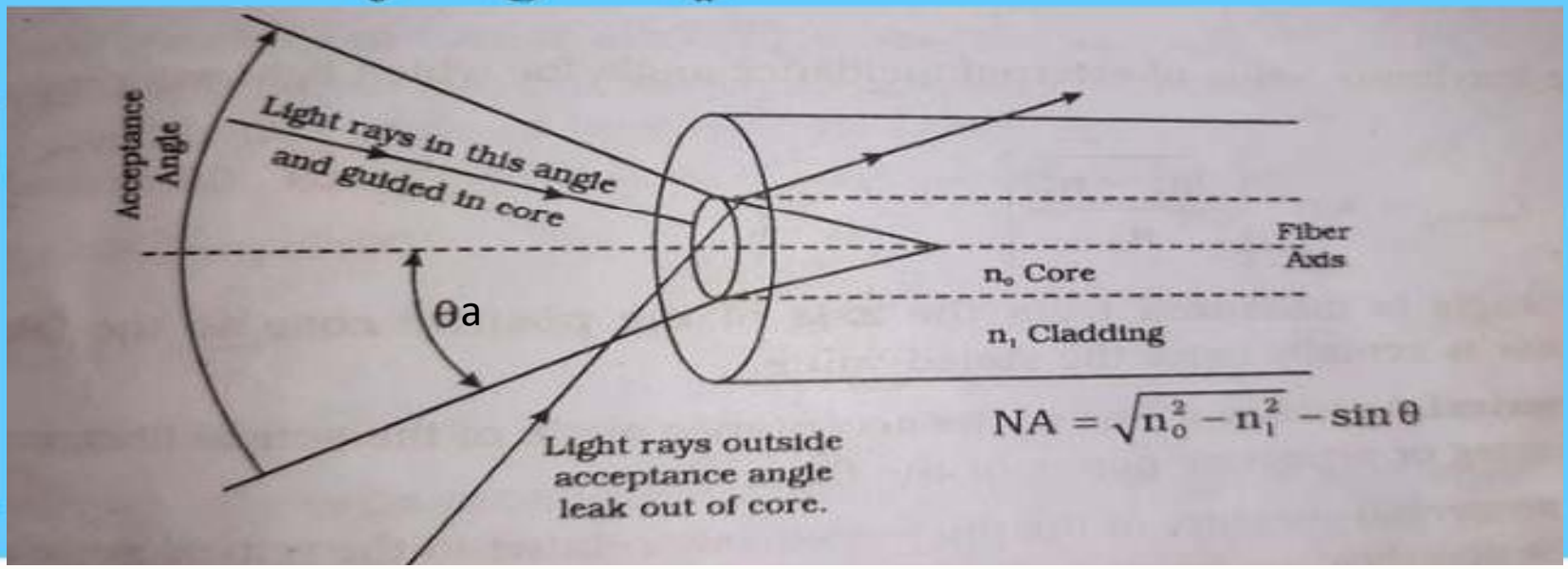


- Any ray incident into fiber core at angle > θ_a will be transmitted to core-cladding interface at an angle < ϕ_C and will not follow TIR.

⇒ ***Lost (case B)***

Acceptance Cone

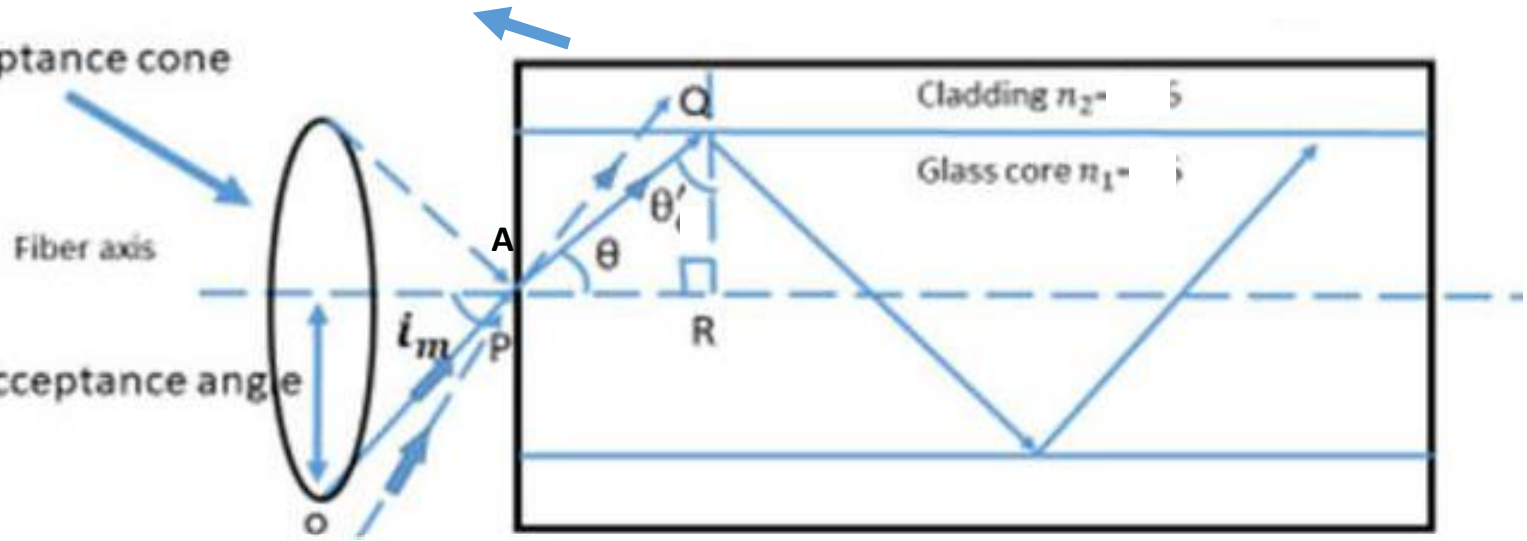
For rays to be transmitted by TIR within the fiber core, they mus be incident on the fiber core within an acceptance cone defined by the ***conical half angle*** "θ_a" .

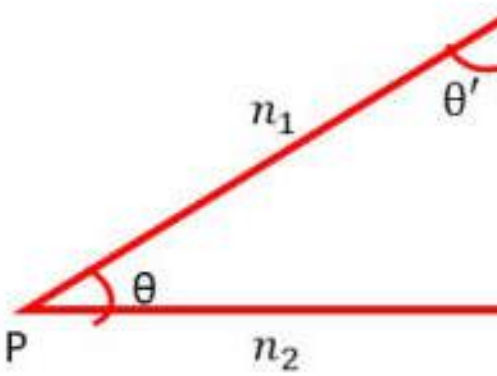


θ_a' is the maximum angle to the axis at which light may ent he fiber in order to be propagated

$\Rightarrow$ **Acceptance angle** for the fiber

ACCEPTANCE ANGLE





Consider a light ray entering from a medium air of refractive index n_o into the fiber with a core of refractive index n_1 which is slightly greater than that of the cladding n_2.

ng Snell's law of reflection at point A,

$$\frac{\sin\theta_1}{\sin\theta_2} = \frac{n_1}{n_o} = \quad = {}_1\theta\ i_m$$

$$NA = n_o \sin i_m = n_1 \sin\theta$$

$$\theta = (90 - \theta')$$

$$n\theta = \sin(90 - \theta') = \cos\theta'$$

ting $\sin\theta$ in the above equation,

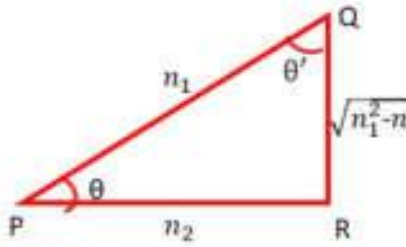
$$\sin i_m = n_1 \cos\theta'$$

$$\sin i_m = \frac{n_1}{n_o}\cos\theta'$$

Applying Pythagorean theorem to ΔPQR,

$$\cos\theta' = \frac{\sqrt{n_1^2 - n_2^2}}{n_1} \qquad \sin i_m = \frac{n_1}{n_o}\cos\theta'$$

$$\sin i_m = \frac{n_1}{n_0}\left[\frac{\sqrt{n_1^2 - n_2^2}}{n_1}\right] = \left[\frac{\sqrt{n_1^2 - n_2^2}}{n_0}\right]$$



$$i_m = \sin^{-1}\left[\frac{\sqrt{n_1^2 - n_2^2}}{n_0}\right]$$

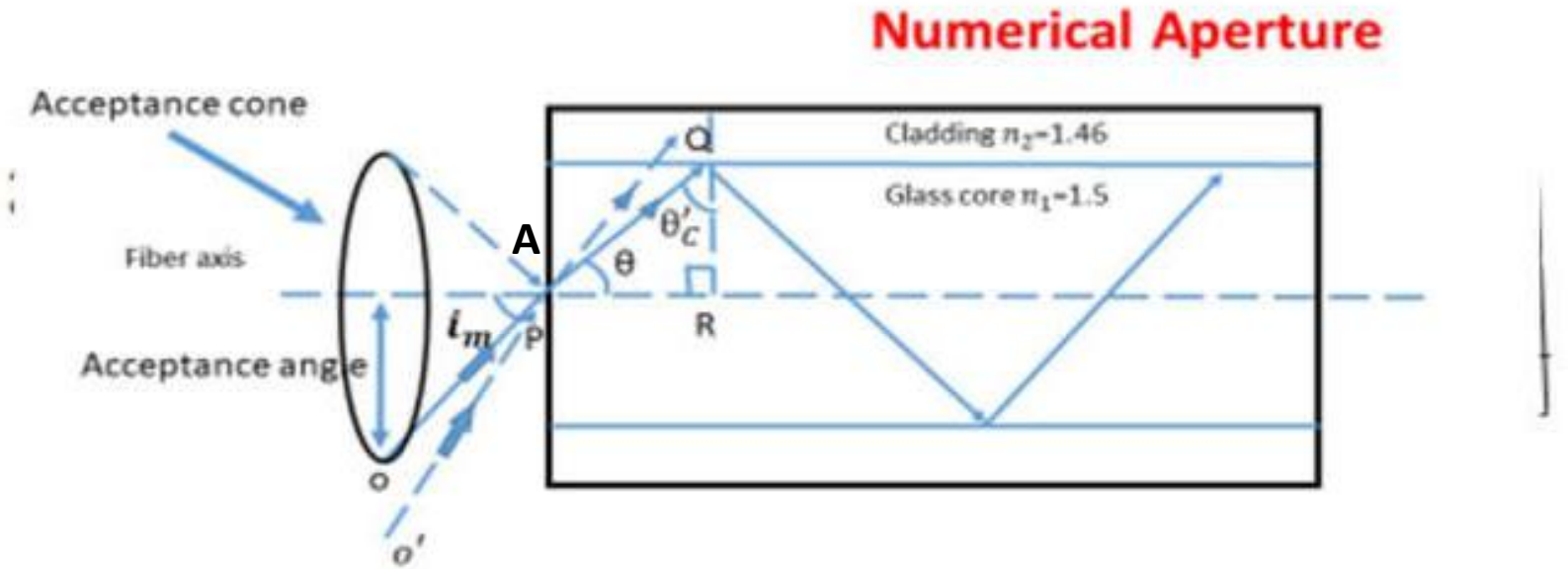
The maximum value of external incidence angle for which light will propagat
er.

$$i_{m(max)} = \sin^{-1}\left[\frac{\sqrt{n_1^2 - n_2^2}}{n_0}\right]$$

The angle is measured from the axis of the positive cone so the total a
vergence is actually twice the stated value.

Numerical Aperture

- Numerical Aperture is the ability of fiber to collect the light from the source and save the light inside it by maintaining the condition of total internal reflection.



- Consider a light ray entering from a medium air of refractive index n_o into the fiber with a core of refractive index n_1 which is slightly greater than that of the cladding n_2.

Applying Snell's law At core cladding interface ,

$$\frac{sin\,\theta}{sin\,\theta'_C} = \frac{n_1}{n_2} \qquad n_1 \text{Sin}\,\theta'_C = n_2 \text{Sin}\,90 \qquad sin\theta'_c = \frac{n_2}{n_1}$$

n the TIR takes place, $\theta' = \theta'_c$ & $i = i_m$

er θ'_c=critical angle and i_m= acceptance angle

efore,

$n_o \sin i_m = n_1 \sin\theta$ NA = $n_o \sin i_m = n_1 \sin(\frac{\pi}{2} - \theta'_c) = n_1 \cos\theta'_c$

In right angled △PQR

$$\theta = \frac{\pi}{2} - \theta'_c$$

$$\cos\theta'_c = (1 - \sin\theta'^2_C)^{1/2}$$

From the above equation

NA = $\sin i_m = n_1(1 - \sin\theta'^2_C)^{1/2}$

$$\sin i_m = n_1(1 - \sin\theta'^2_C)^{1/2}$$

we know,

$$\sin\theta'_c = \frac{n_2}{n_1}$$

$$\text{NA} = n_1\left[1 - \left(\frac{n_2}{n_1}\right)^2\right]^{1/2}$$

$$N.A. = sin i_m$$

- sin i_m represents all the light rays within cone of i_m , which maintain the condition of TIR inside the fiber.
- The NA is always chosen so as to accept maximum incident light, satisfying other requirements

$$NA = \sqrt{n_1^2 - n_2^2}$$

$$n_1^2 - n_2^2 = (n_1 + n_2)(n_1 - n_2)$$

$$= \left(\frac{n_1 + n_2}{2}\right)\left(\frac{n_1 - n_2}{n_1}\right)2n_1$$

Generally n_1 is only few percentage greater than n_2 i.e., approximately $\frac{n_1 + n_2}{2} = n_1$.

we can express the above relation as $(n_1^2 - n_2^2) = 2n_1^2\Delta$. Where $\Delta = \frac{n_1 - n_2}{n_1}$

It gives.

$$NA = \sqrt{2n_1^2\Delta}$$

$$NA = n_1\sqrt{2\Delta} \quad \ldots(7)$$

Numerical aperture is thus considered as a light gathering capacity of an optical fiber It is a measure of light that can be accepted by a fiber. From the equation (6) it is clear that numerical aperture is dependent only on the refractive indices of the core and cladding materials and does not dependent on the physical dimension of the fiber.

1. Numerical Aperture:

- It is defined as the light gathering capability of an optical fiber.
- It is the ability of fiber to collect the light from the source and save the light inside it by maintaining the condition of total internal reflection.

The Numerical Aperture is given by:

$$\text{N.A} = n_1 * (2\Delta)^{1/2}$$

or

$$\text{N.A} = \sqrt{n_1^2 - n_2^2} = sin\theta_a$$

where n_1 = refractive index of core.

n_2 = refractive index of cladding.

θ_a = acceptance angle.

- The NA is always chosen so as to accept maximum incident light, satisfying other requirements.

OPTICAL FIBER

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Classification of Optical Fiber

Classified on basis of :

- Core and Cladding materials
- Refractive index profile
- Modes of propagation

Glass core and cladding (SCS: silca-clad silica)

- Low attenuation & best propagation characteristics
- Least rugged – delicate to handle

Glass core with plastic cladding (PCS: plastic clad silic

- More rugged than glass; attractive to military applications
- Medium attenuation and propagation characteristics

Plastic core and cladding

- More flexible and more rugged
- Easy to install, better withstand stress, less expensive, weigh 60% less than glass
- High attenuation- limited to short runs.

ractive Index Profile: Two types

Step Index : Refractive index makes abrupt change

Graded Index : Refractive index is made to vary as a functio
the radial distance from the centre of the fibe

de of propagations : Two types

- **Single mode** : Single path of light
- **Multimode** : Multiple paths

Step Index

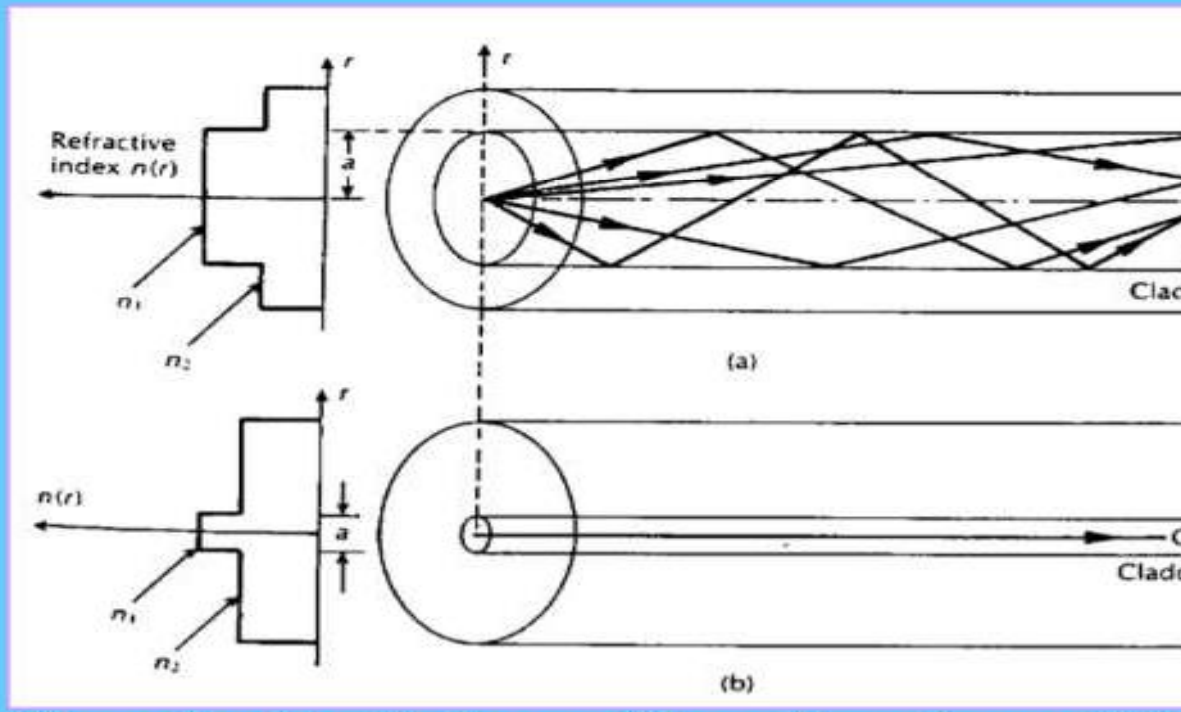
r with a core of constant refractive index n_1 and a claddi
ghtly lower refractive index n_2 .

Refractive index profile makes a step change at the core-cladding interf

active index profile

$$n(r) = \begin{cases} n_1 & ; \quad r < a \quad \text{(core)} \\ n_2 & ; \quad r \geq a \quad \text{(cladding)} \end{cases}$$

- Multimode Step Index
- Single mode Step Index



The refractive index profile and ray transmissi in step index fibers: (a) multimode step index f (b) single-mode step index fiber.

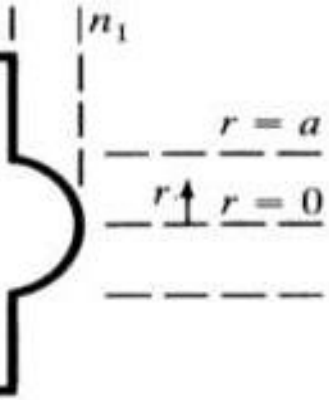
Graded Index Fiber Structure

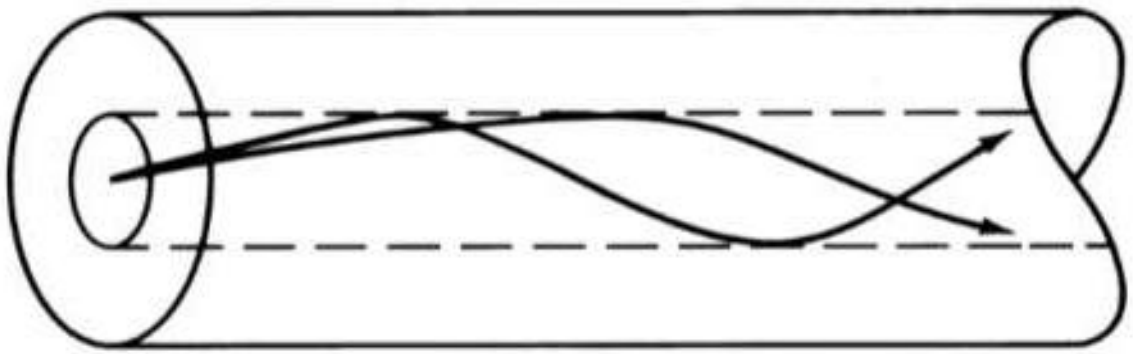
I fibers do not have a constant refractive index in the core, bu
creasing core index n(r) with radial distance from a maxim
lue of n_1 at the axis to a constant value n_2 beyond the core
dius 'a' in the cladding. – ***Inhomogeneous core fibers***

dex variation is represented as

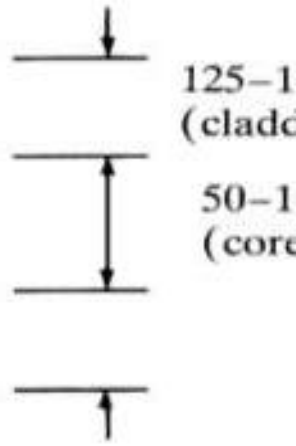
$$n(r) = \begin{cases} n_1\left[1 - 2\Delta\left(\frac{r}{a}\right)^{\alpha}\right]^{1/2} & \text{for} \quad 0 \le r \le a \\ n_1(1-2\Delta)^{1/2} \simeq n_1(1-\Delta) = n_2 & \text{for} \quad r \ge a \end{cases}$$

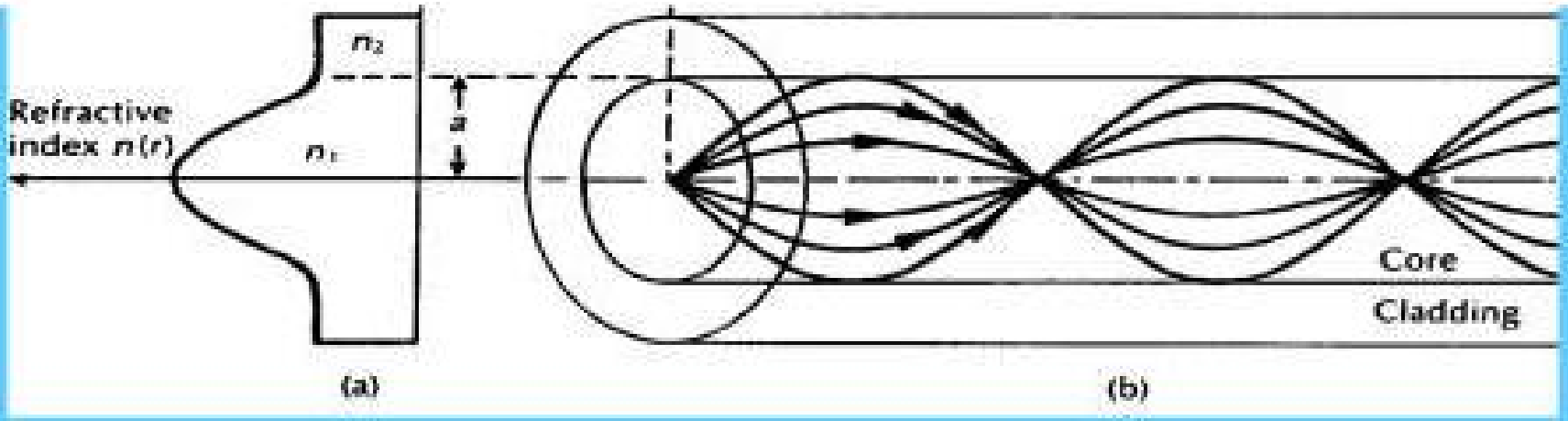
where, Δ is relative refractive index difference and α is the profile parameter which gives the characteristic RI profile of the fiber core.



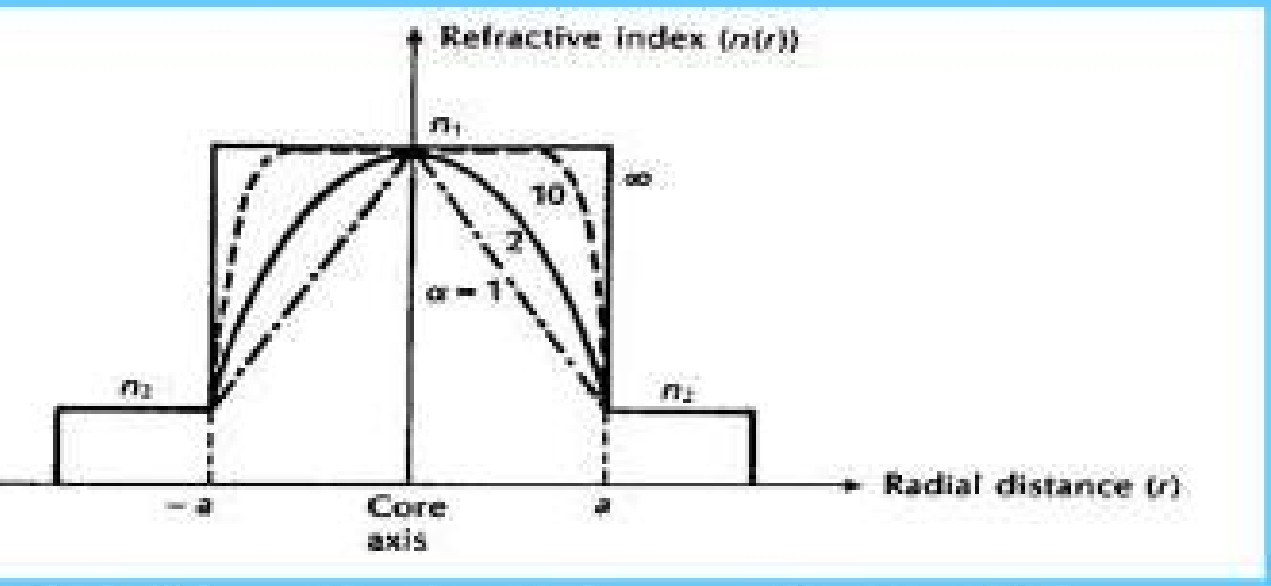


Multimode graded-index fiber





The refractive index profile and ray transmission in a multimode graded index fiber.



$\alpha = \infty$; Step index profile

$\alpha = 2$; Parabolic profile

$\alpha = 1$ Triangular profile

lost widely used optical fibers consist of a core
nd cladding, both made of glass.

lthough, it give a lower NA for fiber, but
rovides a far more practical solution.

Single mode (mono-mode) Fibers

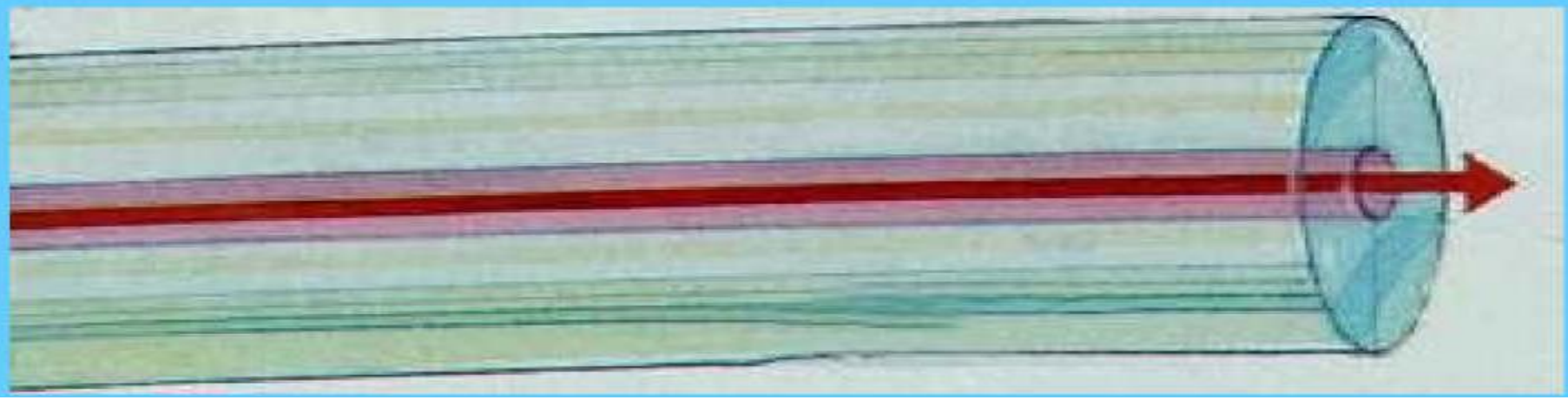
IFs: Most important for long-haul use (carrier and Internet cor

nall core (8 to 10 microns) that forces the light to follow a l
gle path down its length.

sers are the usual light source.

st expensive and delicate to handle,

ghest bandwidths (GHz) and distance ratings (more than 100



Multimode Fibers

tively large diameter core (50 to 100 microns)

-index multimode cable has an abrupt change between core
ding. It is limited to about 50 Mbits/sec

ded-index multimode cables has a gradual change between
cladding. It is limited to 1 Gbit/sec.

3.8 ATTENUATION OR LOSSES IN FIBER

he losses of signal power when the light propagates from one end of the fiber to end in single mode or multi mode fibers is known as attenuation. The b nism in fiber are absorption, scattering and radiative losses of the optical cne

here are different types of attenuation or losses in fiber optics. They are.

- Absorption losses
- Material, or Rayleigh Scattering losses
- Bending losses
- Core and Cladding losses.

gnal attenuation or loss is defined as the ratio of optical output power P_{out} fr f length L to the optical power input P_{in}. This power ratio is a functio ngth. The symbol α is commonly used to express attenuation in decibels ter.

$$P_{out} = P_{in} e^{-\alpha L}$$

here 'α' is the signal attenuation in dB/km and L is the fiber length in km.

$$\alpha = \frac{1}{L} ln \frac{P_{in}}{P_{out}}$$

units of dB α is defined through the equation,

$$\alpha = \frac{10}{L} log_{10} \left(\frac{P_{in}}{P_{out}} \right)$$

e power loss is given by.

$$\text{Power loss (dB)} = -10 \, log \left(\frac{P_{out}}{P_{in}} \right)$$

$$\text{Attenuation } A = \frac{\text{Power loss}}{\text{fiber length}}$$

$$A = \frac{-10 log \times \left(\frac{P_{out}}{P_{in}} \right)}{L}$$

$$A = -10 log \left(\frac{P_{out}}{P_{in}} \right) \times \frac{1}{L}$$

$$\text{Power loss (dB)} = -10\log\left(\frac{P_{out}}{P_{in}}\right)$$

$$\text{Attenuation } A = \frac{\text{Power loss}}{\text{fiber length}}$$

$$A = \frac{-10\log\times\left(\frac{P_{out}}{P_{in}}\right)}{L}$$

$$A = -10\log\left(\frac{P_{out}}{P_{in}}\right)\times\frac{1}{L}$$

Substituting the value of power loss from equation (2) to equation (3), we get,

$$\log\left(\frac{P_{out}}{P_{in}}\right) = \frac{[-A\times L]}{10}$$

$$\frac{P_{out}}{P_{in}} = e^{-AL/10}$$

$$P_{out} = P_{in}\, e^{-AL/10}$$

Where P_{out} and P_{in} are in watts and L is in km.

The length in km can be derived from $L = \frac{10}{A}\log_{10}\left(\frac{P_{in}}{P_{out}}\right)$

1. Absorption losses (Uv absorption. IR absorption and Ion resonance absorption)
2. Scattering losses
3. Bending losses or Extrinsic attenuation (Macroscopic and Microscopic bending)

2. $$\alpha_{scat} = \frac{8\pi^2}{3\lambda^4}\left(n^2 - 1\right)^2 k_B T_f \beta_T$$

Where λ = wavelength

n = refractive index

k_B = Boltzmann constant

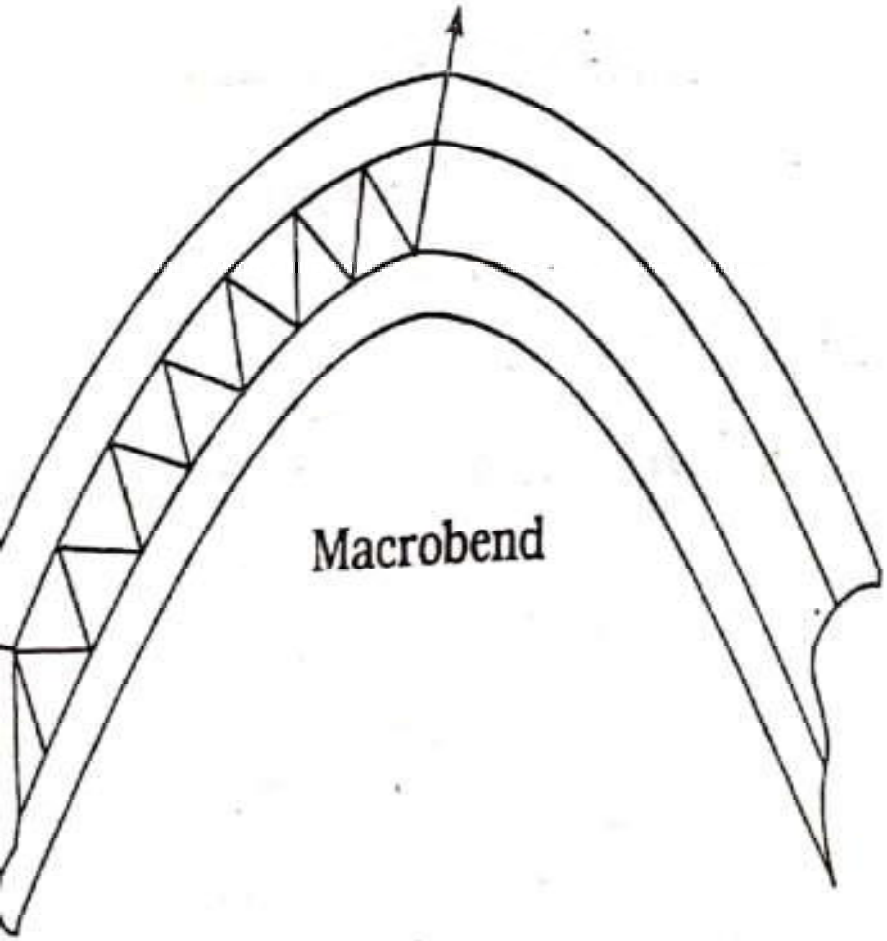
β_T = isothermal compressibility

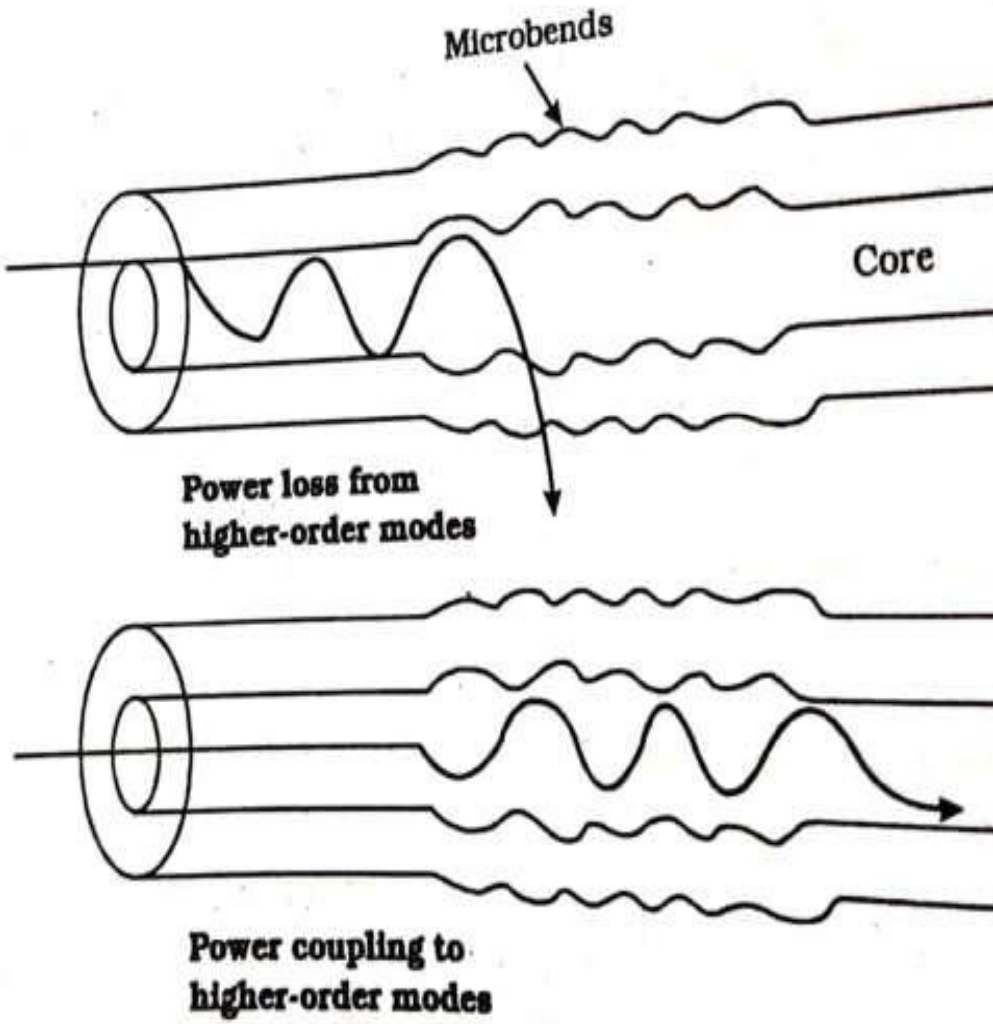
T_f = fictive temperature

The in homogeneities in glass and the attenuation of light is proportional to $1/\lambda^4$. Th
yleigh scattering coefficient is given by,

$$\alpha_R = \frac{8\pi^2}{3\lambda^4} n^8 p^2 k_B T_f \beta_T$$

Absorption losses (Uv absorption. IR absorption and Ion resonance absorption)
Scattering losses
Bending losses or Extrinsic attenuation (Macroscopic and Microscopic bending)
Core and cldding materials





Thank you

Note:

By making use of this PPT make your own notes by referring book.

OPTICAL FIBER

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Comparison between Step index and Graded index

No.	Step Index	Graded Index
Profile	The refractive index of the core is uniform throughout and undergoes an abrupt (or) step change at the cladding boundary.	The refractive index of the core is mad to vary in the parabolic manner such th the maximum refractive index is presen at the centre of the core.
path	Light ray travels in zig zag path	Light ray travels in oscillatory fashion
Variation Δ	$\frac{n_1 - n_2}{n_1}$	$\frac{n_1^2 - n_2^2}{2n_1^2}$
merical aperture	Numerical aperture remains constant	Numerical aperture changes along the radial distance from fiber axis
es	Step index fiber is of two types viz; mono mode fiber and multi mode fiber.	Graded index fiber is of only one type,that is multi mode fiber.
terials used	Normally plastic or glass is preferred	Only glass is preferred
	Data rate is low	Data rate is higher
a rate	Typically 0.34 dB/km at 1.3 μm	0.6 to 1 dB/km at 1.3 μm
enuation	*In local area network*	In LAN and WAN

Signal distortion in Optical waveguide

When optical energy travels along the fiber, spreading of light pulses takes place due to Inter and Intramodal dispersion which causes distortion in the output.

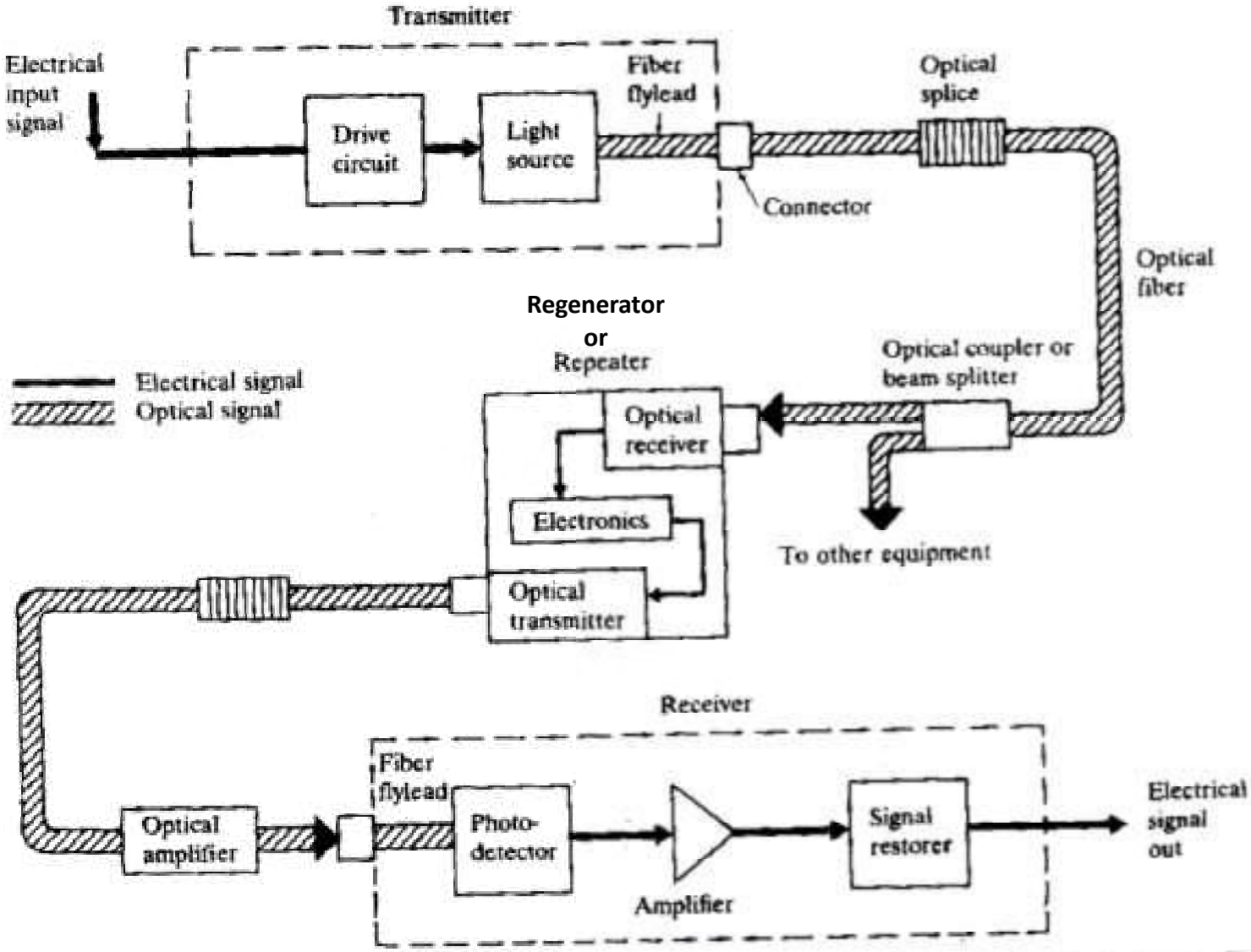
It takes place in both digital and analog transmission

This limits the bandwidth attainable in the fiber

Therefore, the digital signal bit rate must be less than the reciprocal of the broadened pulse duration to avoid dispersion.

- Intermodal Dispersion
- Intramodal Dispersion (Material dispersion and Waveguide dispersion)

BLOCK DIAGRAM OF FIBER OPTIC COMMUNICATION SYSTEM



AGRAM OF FIBER OPTIC COMMUNICTION SYSTEM:

rmation to be conveyed is converted into electrical input signal and enter into the
l transmitter. This optical transmitter converts electrical signal into optical form
ne resulting light signal is transmitted over optical fiber.
he receiver end, an optical detector converts the light back into an electrical signal.

ITTER:

eart of the transmitter is the light source. The major function of the light source

nvert an information signal from its electrical form into light.
optic communication system use light source as, either light emitting diodes
s) (or) laser diodes (LDs). Both are semiconductor device that effectively
rts electrical signal into light.

PTIC FIBER:

- The transmission medium is fiber optic communication systems is an optic fiber.
- Optical fiber is the transparent flexible filament that guides light from the transmitter to a receiver.
- Optical fiber is generally made from a type of glass called silica (or) less commonly from plastic. It is about human hair in thickness.

PTICAL RECEIVER:

- The key component of an optic receiver is its photo detector. The major function of photo detector is to convert an optical information signal into an electrical signal.
- Photo detector in today's fiber optic communication system is a semiconductor photodiode (PD)(P-n, PIN or avalanche) and in some instances, phototransistors and photoconductors .

ENERATOR:

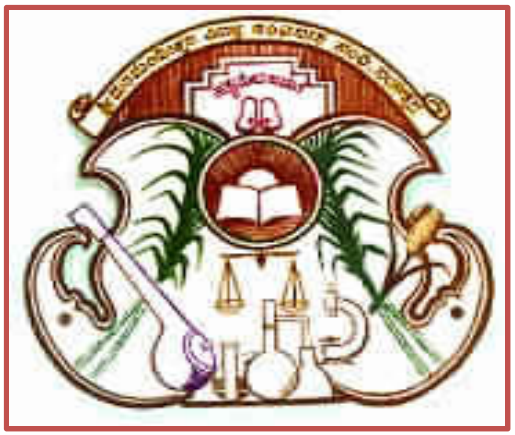
- **Regenerator** is used to boost an optical signal to transmit information over a long distance.

- A regenerator accept an optical signal, converts into electrical signa makes a decision whether it is bit 0(or)bit 1,generates a new electric pulse, converts back into an optical signal, and transmits reshaped signa farther along the fiber.

Note

Workout all Optical fiber problems in your book

Thank you



Paper – II, Unit - IV

PHOTOCHEMISTRY

BSc VI semester

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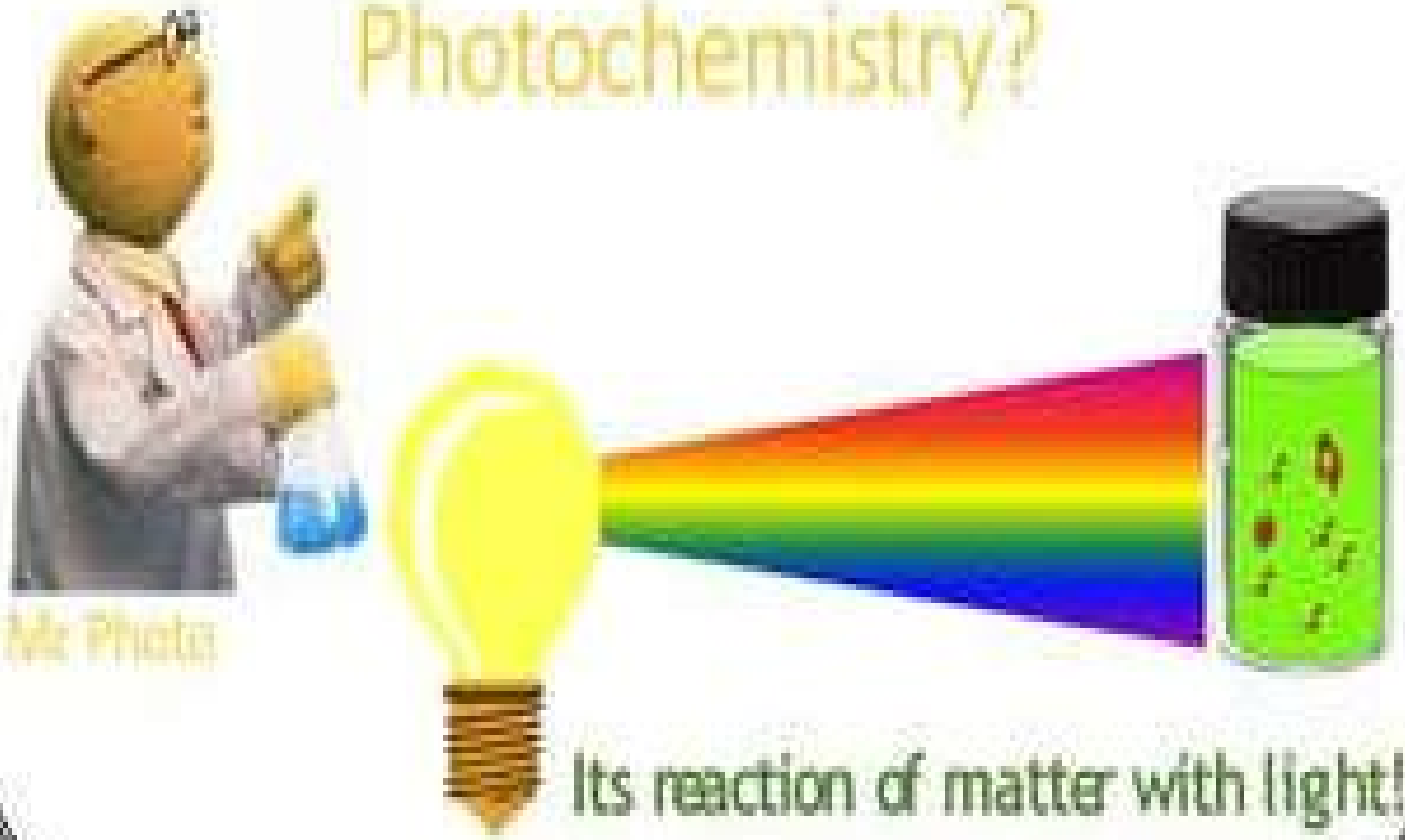
CONTENT: Photochemistry

- Photochemical reactions
- Laws of photochemistry
- Beer's law,
- Lambert's Law,
- Beer- Lambert's Law,
- Grothus-Draper Law and
- Einstein's Law of photochemical equivalence,
- Quantum efficiency or yield, reasons for high and low quantum efficiencies with examples,
- Fluorescence
- Phosphorescence
- Photosensitization and
- Chemiluminescence.

What is Photochemistry?



What Is Photochemistry ?

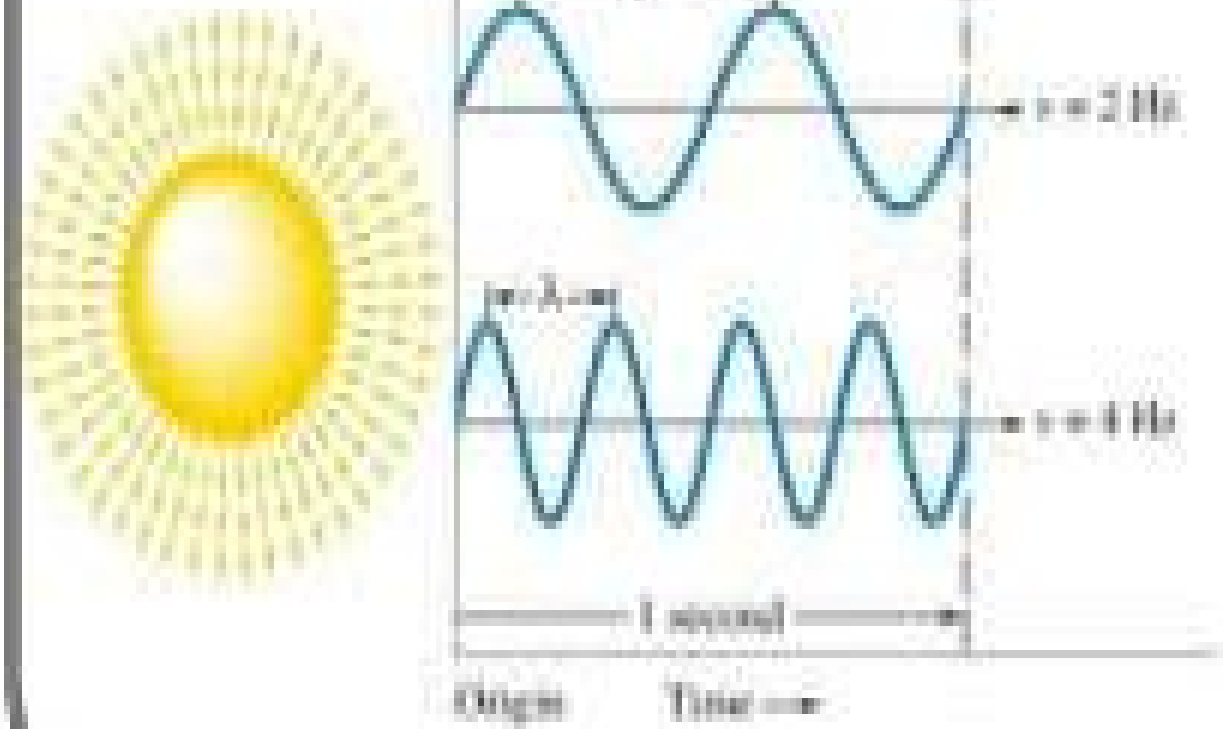
- Giacomo Ciamician is regarded as father of Photochemistry.
- Photochemistry is the study of chemical reactions that produce with the absorption of light radiation by atoms molecules.
- It also includes the reactions that are accompanied by the emission of chemical energy as radiation.

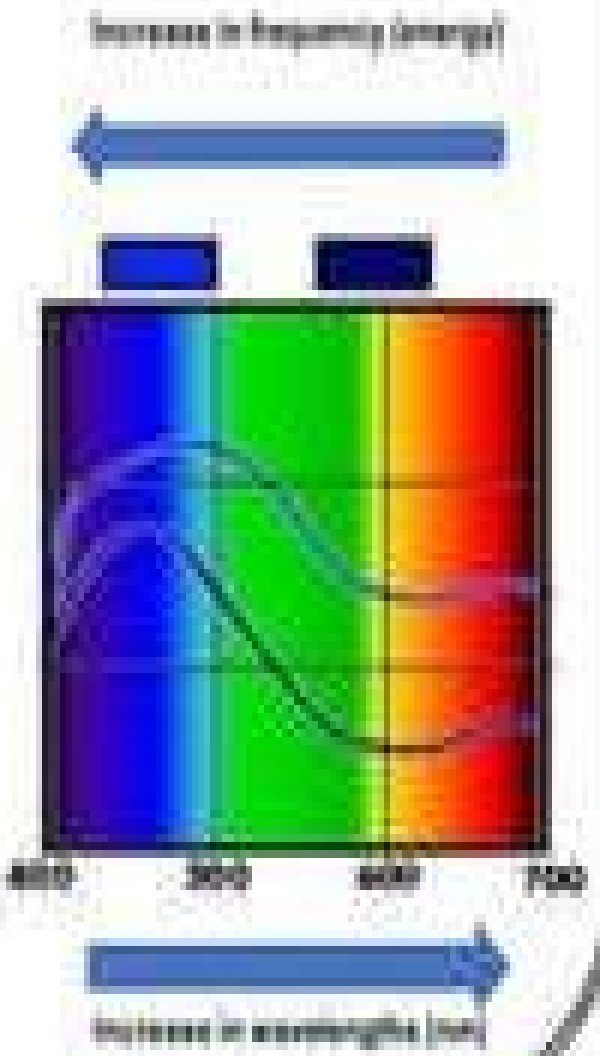
INTRODUCTION

- Photochemistry is concerned with the absorption, excitation and emission of photons by atoms, atomic ions, molecules and molecular ions etc.
- It deals with the study of interaction of radiation with matter resulting into physical changes or into a chemical reaction.
- The term radiation includes all type of electromagnetic waves from very low frequency microwave to high frequency X-ray and γ-rays.
- The radiation of photochemical importance are visible and UV radiation.

CHARACTERISTICS OF LIGHT

- Light = band of waves of different wavelengths





LAW GOVERNING ABSORPTION OF LIGHT

The fraction of light absorbed (I/I0) is given by the Lambert's-Beer's law:

Lambert's law: When a monochromatic light is passed through a pure homogeneous medium, the decrease in the intensity of light with thickness of the absorbing medium at any point is proportional to the intensity of the incident light.

Mathematically:

$$dI/dx \propto I$$

$$\text{or } dI/dx = kI$$

Beer's law: When a monochromatic light is passed through a solution, the decrease in the intensity of light with thickness of the solution is directly proportional to the intensity of the incident light and the concentration of the solution.

Mathematically :

$$dI/dx \; \alpha \; I \times c$$

$$\text{or } dI/dx = Ic\varepsilon$$

Combined Lambert-Beer's Law is given as:

$$\log I_0 / I = \varepsilon c l = A$$

Where I_0 = Intensity of the incident light.

I = Intensity of the transmitted light.

C = Concentration of the solution in moles/litre.

l = Path length of the sample usually 1cm.

ε = Molar absorptivity or molar extinction coefficient.

A = Absorbance or optical density.

LAW OF PHOTOCHEMISTRY

The photochemical process are governed by the following laws:

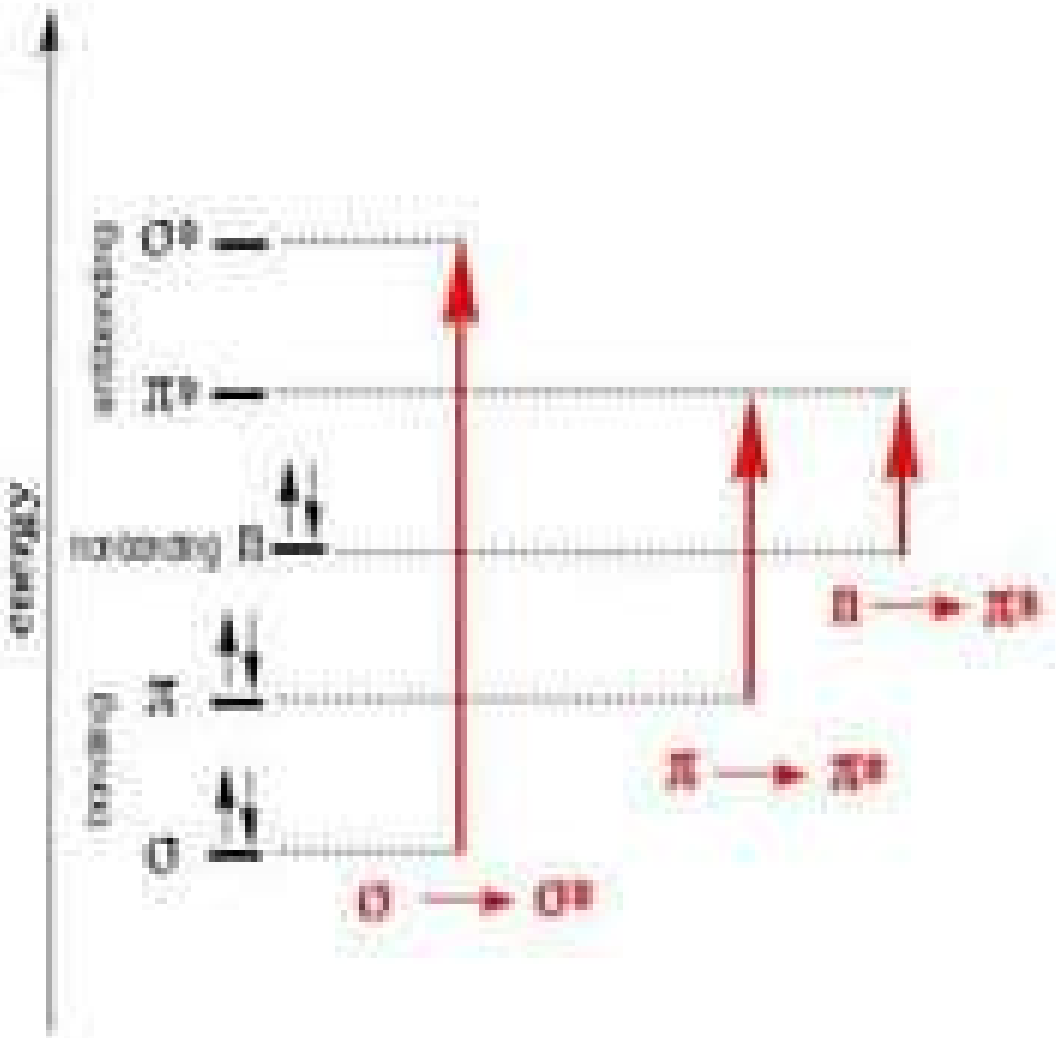
1. Grotthurs-Drapper law.
2. Einstein Stark law of photochemical equivalence

- **Grotthuss-Draper Law** :When light falls on a substance ,only the fraction of light which is absorbed by the substance can bring about a chemical change.

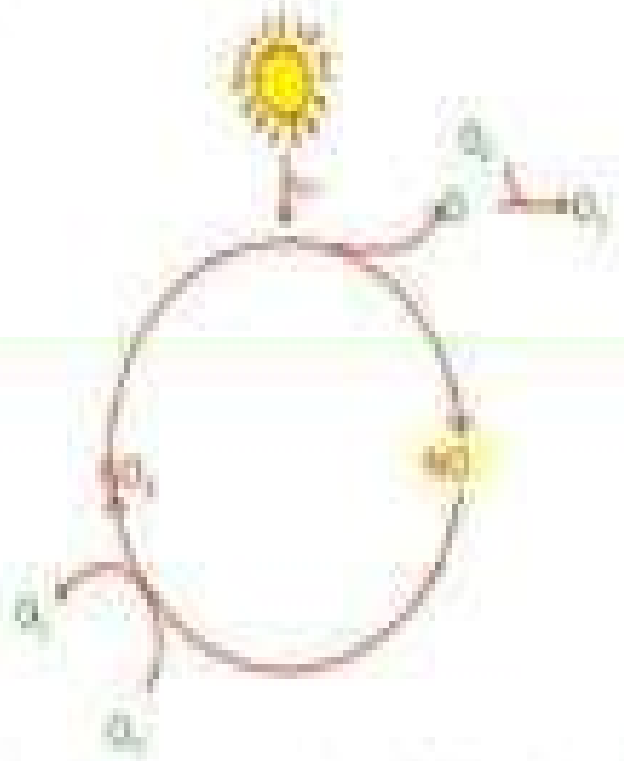
- **Stark-Einstein Law** :One quantum of light is absorbed per molecule of absorbing and reacting substance .

Electronic Transitions

- σ - σ* Transition
- n - σ* Transition
- π- π* Transition
- n - π* Transition



- **Photochemical reaction:**
- Its a reaction which takes place by absorption of the visible and ultraviolet radiations (200-800 nm)
- Photochemical reaction leads to the heating of the atmosphere during the daytime by absorption of ultraviolet radiation.



- Mechanism of photochemical reactions occurring during atmospheric: Photochemical change occurs only by absorption of photons

- **Photochemistry:**
- **Its the branch of chemistry which deals with the study of photochemical reactions.**

- **Demonstration of a Photochemical reaction**

$$H_2 + Cl_2 \xrightarrow{dark} \text{No reaction}$$

$$H_2 + Cl_2 \xrightarrow{light} 2HCl$$

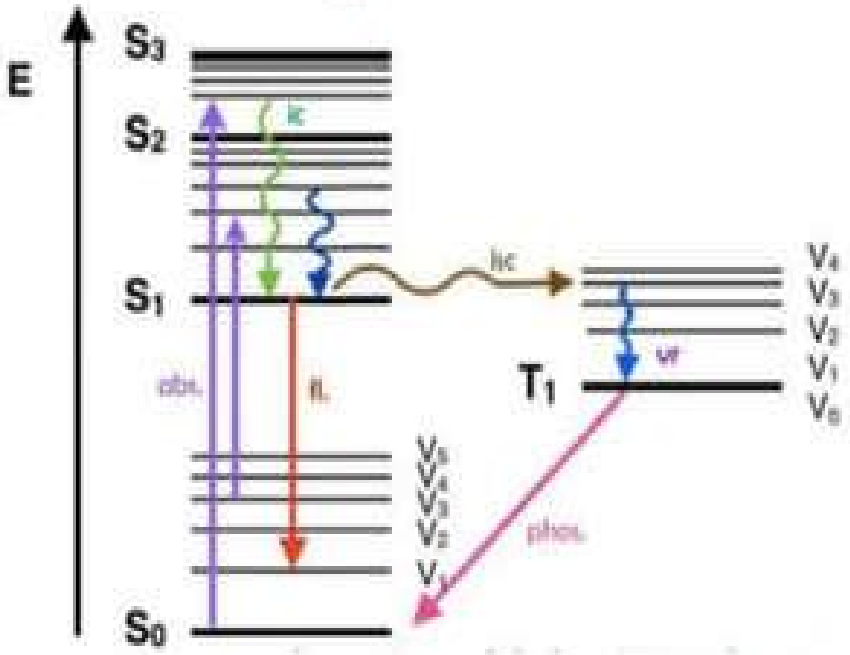
Figure 32.1
The 'HCl-canon' experiment.

Photo Physical Process

Photo physical process involves :

- Fluorescence
- Phosphorescence
- Chemiluminescence

Jablonski Diagram :



Mechanism:

- Fluorescent material at ground state exposed to Uv or visible radiation ,it absorbs radiation and excited to singlet excited state.

$A(S_0) + h\nu \longrightarrow A^*(S_1)$

- As life time of singlet excited state is very small it returns back to its ground state.

$A^*(S_1) \longrightarrow A(S_0) + h\nu_f$

Mechanism:

- Molecules in ground state excited to 1st singlet excited state.
- The excited molecules return to ground state by the emission of fluorescence.

$S_1 \longrightarrow S_0$ + fluorescence

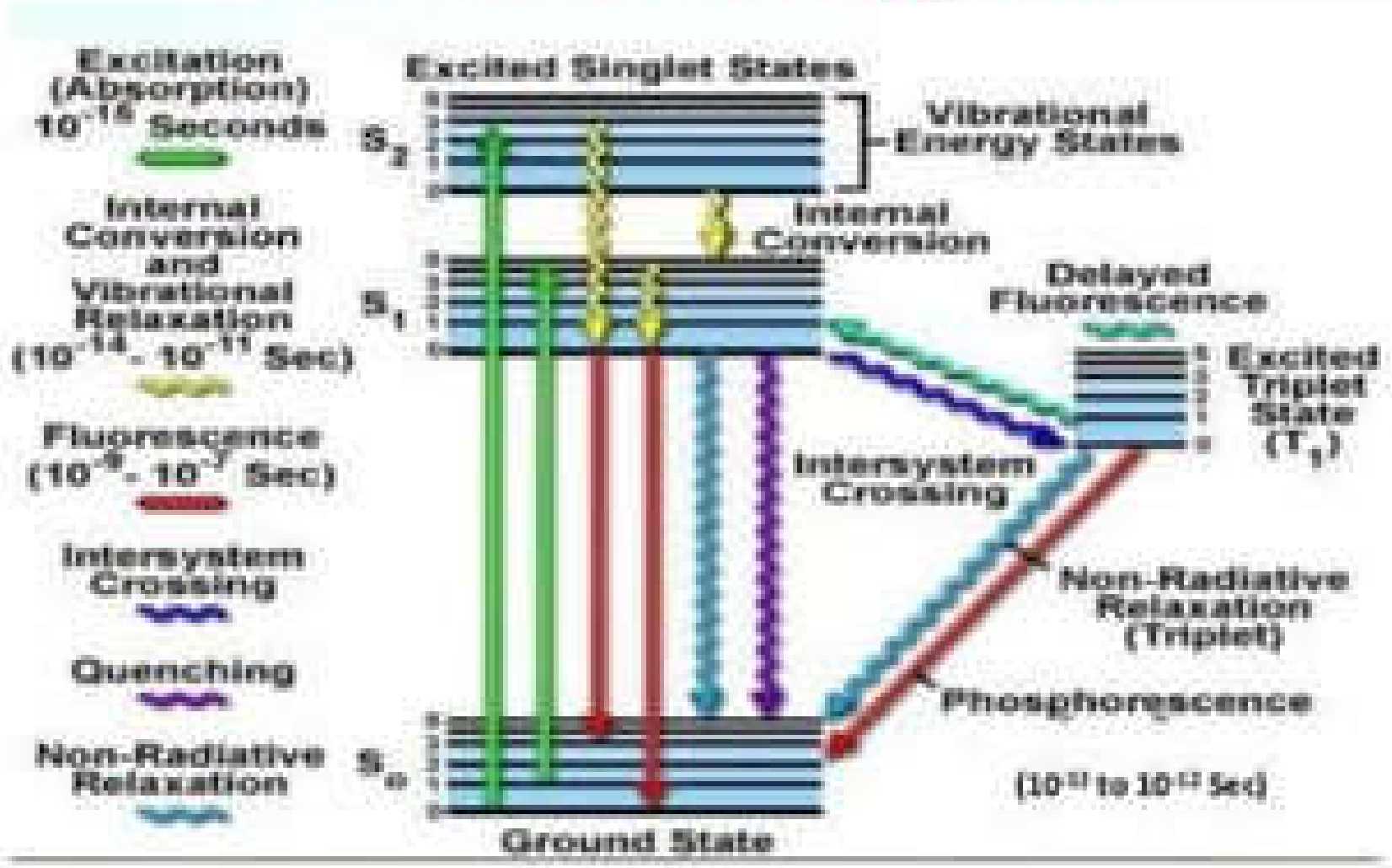
- Excited molecule may return to1st triplet excited state through inter system crossing(ISC)

$S_1 \xrightarrow{ISC} T_1$

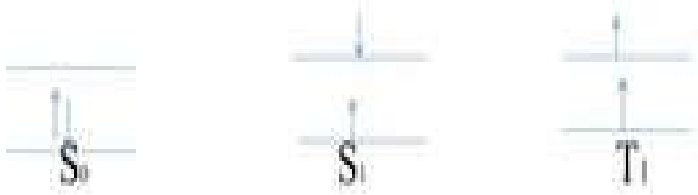
- Molecules may return to ground state by the emission of phosphorescence

$T_1 \longrightarrow S_0$+ phosphoresence

Jablonski Diagram



- When excitation occurs ,paired electron from ground state (S_0) become unpaired.
- Absorption of light may occur without inversion of spin .This state is called excited singlet state(S_1)
- Electron excitation followed by spin inversion give rise a new excited state with 2 unpaired electron .This state is called excited triplet state(T_1)



- After absorption of energy
  - The molecule may be excited to S_2 from S_0
  - It may rapidly deeays to S_1 .It is called IC
- S_1 may undergoes following transition
  - Emits energy &drops to S_0.It is called fluorescence
  - It may drops to S_0 by a non radiation process
  - It may undergo chemical reaction
  - It may drops to T_1.It is called ISC.
- T_1 may undergoes following transition
  - Emits energy & drops to S_0. It is called phosphorescence.
  - It may drops to S_0 by a non radiation process.
  - It may start the reaction.

Mechanism :

- **Two chemicals react to form an excited intermediate with higher energy .**

- **This intermediate breaks down by releasing some of its energy as photon of light.**

QUANTUM YIELD

Quantum yield is defined as the number of molecules reacting per quantum of light absorbed. It is denoted by Φ.

Mathematically:

$$\phi = \frac{\text{Number of molecule reacting in given time}}{\text{Number of quantum of radiation absorbed in same time}}$$

- The quantum yield of the product formation is given by

$$\phi = \frac{\text{Number of molecule of product formed}}{\text{Number of einstein of radiation absorbed}}$$

- The quantum yield may be as high 106 or as low as for several photochemical reactions.

Reasons of high quantum yield

High Quantum Yield Reaction

$H_2 + Cl_2 \xrightarrow{>4500\ \text{Å}} 2HCl$ Quantum yield= 10^4 to 10^6

$CO + Cl_2 \xrightarrow{4000 \text{ to } 4300\ \text{Å}} COCl_2$ Quantum yield= 10^3

There are some reasons which may be responsible for the high quantum efficiency.

- The primary process of absorption of radiation produce excited atoms, molecules or free radicals which initiates a series of chain reaction called **secondary processes**. Thus, by absorbing only one quantum of radiation, several reactant molecules undergo chemical reaction. Hence Φ will be greater than unity.
- Formation of an intermediate product acts as a catalyst and readily propagate the reaction.
- The secondary reaction may be exothermic which activates other secondary process as a result, more reactant molecules undergo chemical change without absorption of radiation.
- Free radical gives chain reaction which increases quantum yield of the reaction.

LOW QUANTUM YIELD

- A reaction is said to have a low quantum efficiency if the value of Φ is less than 1 for that reaction. Let's see some examples of such reactions.

Low Quantum Yield Reaction

$$H_2 + Br_2 \xrightarrow{5100\ \text{Å}} 2HCl$$ Quantum yield= 0.01

$$2NH_3 \xrightarrow{2100\ \text{Å}} N_2 + 3H_2$$ Quantum yield= 0.2

Reasons for low quantum yield

❖If excited molecules formed in primary process are such that they can't react due to their deactivation by collisions or by internal arrangement, the quantum yield will be extremely low.

❖ Collision of excited molecules with non-excited molecules may cause to loss their energy. This is another cause of low quantum yield.

❖ The excited molecules produced in the primary process may recombine to form the reactant so as to give low quantum yield.

❖ If a reacting molecules is initially present at such a low energy level (EL), so that it doesn't acquire an optimum EL to take part in photochem. process by photoexcitation.

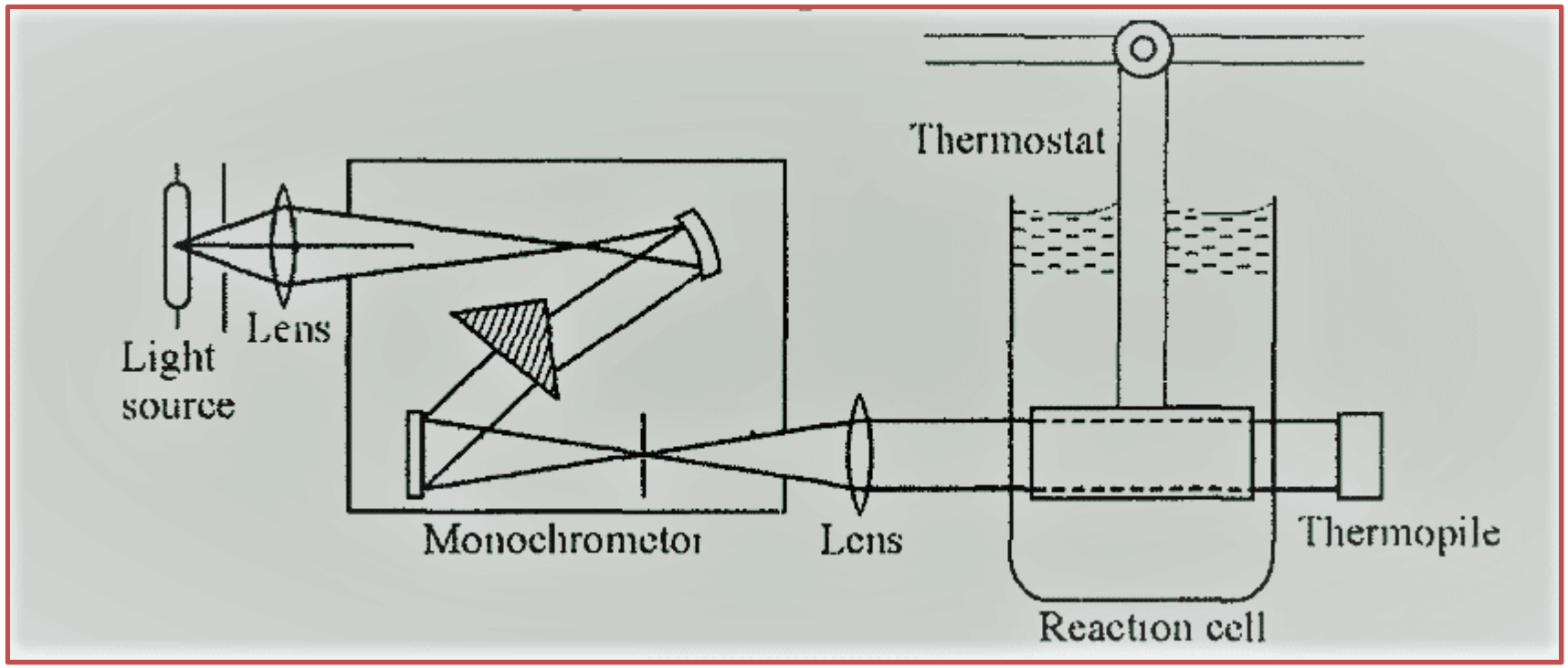
❖ Some of the photochemically excited molecules in primary process do not undergo secondary reaction. Thus, there is some time interval between primary and secondary process. And they lose some energy. This will give low quantum yield.

REASON FOR LOW QUANTUM YIELD:

- 1. Excited molecules may get deactivated before they form products.
- 2. Collisions of excited molecules with non excited molecules may cause the former to lose energy.
- 3. The primary photochemical process may get reversed.
- 4. The dissociated fragments may recombine to form the original molecule.

HOW TO MEASURE QUANTUM EFFICIENCY ?

- In order to calculate the quantum efficiency experimentally, we must measure the number of moles of the reacting substance that undergoes a chemical change in a given time and the number of Einstein's of radiation absorbed by the light-absorbing substance during that time.
- The experimental setup for the determination of quantum efficiency is shown as:



CONTINUED…

- First of all, the empty cell or the cell filled with solvent is placed in the path of the light beam and the intensity of light is measured. Then, the reaction cell is filled with the reaction mixture. The light is passed through the reaction cell for a certain period of time. After then, the intensity of light is measured after the completion of the reaction.
- The difference between these two data will give the total energy absorbed by the reaction system in the given time period. The intensity of the radiation absorbed is given by the total energy absorbed divided by the volume of the reaction mixture if the time is one second. Then compute the number of moles that reacted in a given time period. The following formula is used to compute the value of Φ.

$$\Phi = \frac{\text{No.of moles reacting in a given time}}{\text{No.of einsteins absorbed in the same time}}$$

Energy transfer in photochemical reactions : Photosensitization & Quenching Reactions.

- Among the **photosensitizers** commonly used are mercury, cadmium and zinc as atomic sensitizers and the molecular photosensitizers such as benzophenone and SO_2.

EXAMPLE FOR PHOTOSENSITIZATION

Dissociation of H_2 molecule: Irradiation of a mixture of hydrogen gas and mercury vapour with light of wavelength 253.7 nm brings about dissociation of H_2 in to hydrogen atoms.

- $Hg + h\upsilon \longrightarrow Hg^*$
- $Hg^* + H_2 \longrightarrow H_2^* + Hg$
- $H_2^* \longrightarrow H + H$
- Here Hg acts as photosensitizer

DIFFERENCE BETWEEN PHOTOCHEMICAL AND THERMOCHEMICAL REACTIONS

Photochemical Reaction	Thermal reaction
These involve absorption of light radiations	These reactions involve absorption or evolution of heat
The presence of light is the primary requirement for reactions to take place	These reactions can take place in dark as well as in light.
Temperature has a very little effect on the rate of photochemical reactions.	Temperature has a significant effect on the rate of a thermochemical reaction.
ΔG for photochemical spontaneous reactions may be +ve or –ve.	ΔG for a thermochemical reaction is always negative.
Photochemical activation is highly selective. The absorbed photon excites a particular atom or group of atoms which become site for the reaction.	Thermochemical activation is not selective in nature.

CHEMILUMINESCENCE

- Chemiluminescence is the emission of light as a result of chemical reaction at room temperature. It must be clearly understood that Chemiluminescence is not due to any photophysical process like fluorescence or phosphorescence. Some examples of Chemiluminescence are given below :

❖ Ex. Glow of phosphorus is due to slow oxidation ; it is not due to phosphorescence as name suggests.

❖ Oxidation of Grignard compounds by air or oxygen results in greenish-blue luminescence.

- Will-o-the-wisp (mistaken as light produced by evil spirits) is the glow caused by the oxidation of decaying wood in marshy places.
- Emission of light by fuefly is due to oxidation of some proteins in its body (this is also called bioluminescence – Luciferin protein, Luciferase enzyme).

ಪಂಪನ ಧರ್ಮಪುರ : ಕ್ಷೇ
ಕಾರ್ಯ

ಡಾ.ಎಂ.ಎಂ.ಕಲಬುರ್ಗಿ

ತಾಳ ಬಿಲಕ್ಕೆ ಬಾಗಿಲ್:

ಳೆ ಬಿಸಿಲು ಕಾಲೂರಲು ಪ್ರಾರಂಭಮ್ಮಾಡಿತ್ತು. ದಾರಿಯ ಬಲದಲ್ಲಿ
ಶಾಲವಾದ ಬತ್ತದ ಗದ್ದೆಗಳು. ಎಡದಲ್ಲಿ ಒಂದು ಮೈಲು ವಿಸ್ತಾರವ
ತ, ಗದ್ದೆಯಲ್ಲಿ ಬತ್ತದ ಸೆಸಿ ಬಂಗಾರ ಬಣ್ಣಕ್ಕೆ ತಿರುಗಿತ್ತು. ಕೆರೆಯಲ್ಲಿ
ರತೆರೆ ನಿರಿಗೆ ಮುರಿಯುತ್ತಿತ್ತು.

ಊರ ಜನತೆ ಇದನ್ನು ಪಾತಚೆರು ಎಂದು ಕರೆಯುತ್ತಾರೆ. ಈ ತೆಲು
ುದ್ದಕ್ಕೆ ಪುರಾತನ ಕೆರೆ ಎಂದು ಅರ್ಥ.

ಸನದಲ್ಲಿ ಈ ಕೆರೆಯನ್ನು ಕವಿತಾಗುಣಾರ್ಣವ ಎಂದು ಕರೆಯಲಾ

ನು ಪಂಪನ ಬಿರುದು. ಅಣ್ಣನ ಬಿರುದಿನ ಈ ಕೆರೆ ಕಟ್ಟಿಸಿದವನು,
ುಮ್ಮ ಜಿನವಲ್ಲಭ.
ಯನ್ನು ನೋಡುತ್ತಲೇ ನನ್ನ ನಾಲಗೆ 'ಇದು ಪಾತಾಳ ಬಿಲಕ್ಕೆ

ಸನದಲ್ಲಿ ಹೇಳಲಾದ ಮದನವಿಳಾಸ' ಎಂಬ ಬನ ಈ ಕೆರೆಯ
ೆಯಲ್ಲಿರುವ ಸಂಭವವಿದೆ. ಆದರ ಅವಶೇಷ ಈಗ ಒಂದೂ ಇ

ಕೆರೆಯ ನೆಲೆಯಲ್ಲಿ, ಕಂಸನದ ಪ್ರಕಾರ ಪುರಾತನ ಹೆಸರು
ೃಷಭಪರ್ವತ್, ಜಿನವಲ್ಲಭನು ಕೊರೆಯಿಸಿದ ಪ್ರತಿಮೆಗಳನ್ನು
ನ ಅದನ್ನು ಈಗ ಗೊಮಲಗುಟ್ಟ (ಗೊಂಬೆಗಳ ಗುಡ್ಡ) ಎಂದು
ೆಯುತ್ತಾರೆ .

್ಯಪ್ತಿ ಸುಮಾರು ಮೂರು ಮೈಲು, ಎತ್ತರ ಸುಮಾರು ೪೦೦ರ
ಡಿ,ಅದೊಂದು ಬಂಡೆಗಳ ಬೆಟ್ಟ, ಗಜಗಾತ್ರದ ಶಿಲೆಗಳಿಂದಾಗಿ
ದು ಆನೆಗಳ ಒಟ್ಟಲು ಎಂಬ ಅನುಭವ ನೀಡುತ್ತದೆ.
ೂರದಿಂದ ಕಮನೀಯವಾಗಿದ್ದ ಬೆಟ್ಟ, ಸಮೀಪ ಹೋದಂತೆ
ಣ ಶ ಕಂಡಿತು.

ದ್ಧಶಿಲೆ

ಲ್ಲು ಸಣ್ಣಗೆ ಸುಡುತ್ತಿತ್ತು. ಮತ್ತೆ ನೂರು ಅಡಿ
ತ್ತರ ಹೋಗಿ, ಶಾಸನವಿದ್ದ ಸ್ಥಳವನ್ನು
ಲುಪಿದೆವು. ಈಗ ನಾವು ವೃಷಭಾದ್ರಿಯ ಒಟ್ಟು
ತ್ತರದ ಮಧ್ಯಭಾಗಕ್ಕೆ ಬಂದಿದ್ದೆವು. ಕೆಳಗೆ ಎರ
ೂರು ಅಡಿ ಬಂಡೆಗಳ ಸಮೂಹವಿದ್ದರೆ, ಮೇಲೆ
ರಡು ನೂರು ಅಡಿ ಎತ್ತರದ ಒಂದೇ ಬಂಡೆ,
ಲೆಯೆತ್ತಿದರೆ ಆ ಬೃಹತ್ ಶಿಲೆ ಎದೆಯ ಮೇಲೆ
ದ್ದು ಬರುವ ಭಯ. ಈ ವೃಷಭಾದ್ರಿಯ ದಕ್ಷಿಣ
ಟ್ಟದಲ್ಲಿರುವ ಇದನ್ನೇ ಶಾಸನದಲ್ಲಿ 'ಸಿದ್ಧ ಶಿಲೆ'

ಶಿಲೆಯ ಮೇಲೆ ಶಾಸನ, ಶಾಸನದ
ೀಲ್ಬಾಗದಲ್ಲಿ ಜಿನಪ್ರತಿಮೆಗಳು ಕೆತ್ತಲ್ಪಟ್ಟಿವೆ. ಈ
ಶ್ಯ ಪಂಪನ ಆದಿಪುರಾಣದ
ರತಚಕ್ರವರ್ತಿಯು, ವಿಜಯಾರ್ಧ ಪರ್ವತದಲ್ಲಿ
ರೆಯಿಸಿದ 'ನಿಜವಿಜಯಪ್ರಶಸ್ತಿ' ಯನ್ನು ನೆನಪಿ
ಂದಿತು. ನಾವು ನಿಂತ ಕಲ್ಲು ಮತ್ತು ಈ
ನ್ಮಶಿಲೆಯ ಮಧ್ಯ ಆರು ಅಡಿ ಅಗಲ, ಎಂಟು ಅ
ಳವಾಗಿರುವ ಒಂದು ಕೊರಕಲು ಇದ್ದು, ಇದು
ನ್ಮಶಿಲೆಯಲ್ಲಿ ಕೆತ್ತಿದ ಶಾಸನ ಮತ್ತು ನಾವು ನಿಂ
ಲ್ಲು ಬಂಡೆಯ ಮಧ್ಯ ಅಂತರವನ್ನು ಕಲ್ಪಿಸಿದೆ

ಾಸನದ ಎತ್ತರ ೨.೧/೨ ಅಡಿ, ಉದ್ದ ೧೪೧/೨ ಅ
ದೊಂದು ಅಡ್ಡಪಟ್ಟಿಕೆ ಶಾಸನದ ಮೇಲ್ಭಾಗಕ
ೂಂದಿ ಎಡದಲ್ಲಿ ಮೂರು, ಬಲದಲ್ಲಿ ಮೂರು
ನಪತಿಮೆಗಳು.

ಧ್ಯ ಚಕ್ರೇಶ್ವರಿಯ ಪ್ರತಿಮೆ, ಚಕ್ರೇಶ್ವರಿಯ
ೀಲ್ಭಾಗದಲ್ಲಿ ಮತ್ತೆ ಮನುಷ್ಯ ಎತ್ತರದ ಎರಡ
ನಪ್ರತಿಮೆಗಳು, ಈ ಬರೆಹ ಮತ್ತು
ತಿಮೆಗಳೆಲ್ಲವನ್ನು ಕೊರೆದುದು ಆ
ಖಂಡಶಿಲೆಯ ಕೆಳಗಣ ಕಾಲು ಭಾಗದಲ್ಲಿ, ಮೆ

ಂಬತ್ತುವರೆ ಗಂಟೆಗೆ ಕೊಮರಯ್ಯ ಶಾಸನದ
ಡಿಯಚ್ಚು ತೆಗೆಯಲು ಆರಂಭಿಸಿದ. ನಾಯಕ
ೋಟೋ ತೆಗೆಯಲು ತೊಡಗಿದ. ಡಾ.
ರೇಮಠರು ಮತ್ತು ನಾನು ಶಾಸನ
ಗಳಾದೆವು. ಸ್ವಲ್ಪ ಹೊತ್ತಿನ ನಂತರ ನಮ್ಮ ತ್ರಿವಿಧ
ಯ

ನ್ನೊಂದು ಶಾಸನದ ಅನ್ವೇಷಣೆಪ್ಪೋಟೋ
ಗೆಯುವುದು, ಶಾಸನ ಓದುವುದು ಮುಗಿಯಿತು.
ಾಮರಯ್ಯ ಪಡಿಯಚ್ಚು ಪ್ರಯತ್ನ ನಡೆದೇ ಇತ್ತು.

ಾ ವೃಷಭಪರ್ವತದ 'ಉನ್ನತ ಶಿಲಾತಳದೊಳ್
ನ್ನೊಂದು ಶಾಸನವಿರುವುದಾಗಿ ಈಗ ಲಭಿಸಿದ
ಾಸನ ಸೂಚನೆ ನೀಡುವುದರಿಂದ, ನಮಗೆ ಅದನ್ನು
ುಡುಕುವ ಚಾಪಲ್ಯವುಂಟಾಯಿತು.

ಡಿಯಚ್ಚಿನ ಮೇಲ್ವಿಚಾರಣೆಗೆ ಡಾ. ಹಿರೇಮಠರು
ುಡುಬಿಸಿಲಿನಲ್ಲಿ ನಿಂತರು. ನಾನು ಮತ್ತು ನಾಯಕ
ನ್ನೊಂದು ಶಾಸನದ ಅನ್ವೇಷಣೆಗಾಗಿ ಬೆಟ್ಟ ಹತ್ತ

ನ್ನ ಕೈಯಲ್ಲಿ ಚಾಕ್‌ಪೀಸ್, ನಾಯಕನ ಬಗಲ
್ಯಮರಾ, ಹೊಸ ಶಾಸನ ಹುಡುಕುವ ಭರದಲ್ಲಿ
ೀರೆ ಯಾವುದೇ ವ್ಯವಸ್ಥೆ ಮಾಡಿಕೊಳ್ಳದೆ ಹೆಜ್ಜೆ
ಾಕಿದೆವು.

ುತ್ಸಾಹದ ಉನ್ಮಾದದಲ್ಲಿ ಓಡಿದಂತೆಯೇ
ಡೆದವು. ಹತ್ತು ಅಡಿ ಹೋಗುವಷ್ಟರಲ್ಲಿ,
ಾದಿದರೆ ಉರುಳು ಬೀಳುವುದೆಂಬ ಭಾವನೆ
ುಟ್ಟಿಸುತ್ತ ಸಿದ್ಧಶಿಲೆಯ ಹೆಗಲ ಮೇಲೆ
ಜಗಾತ್ರದ ಬಂಡೆಯಿದ್ದುದು ಕಂಡುಬಂದಿತು.
ೀಲೆ ಬಿದ್ದರೆ ನಮ್ಮ ಗತಿ! ಎನ್ನುತ್ತ ಉಸಿರು
ಿಸಿದಿದ್ದು 'ಪಪ್ಪನ ಪೆಗ್ಗಲ್ಲಿಪ್ಪ ಕಪ್ಪೆ ಯುಂಡೆ'

ಮಯ ೧೧. ೧/೨ ಗಂಟೆ, ಕಲ್ಲು
ಂವೇರತೊಡಗಿತ್ತು. ನಡಿಗೆಯನ್ನು
ರುಕುಗೊಳಿಸಿ ಸರಿಯಾಗಿ ೧೨ ಗಂಟೆಗೆ
ದ್ಮಶಿಲೆಯ ತಲೆಯಲ್ಲಿ ನಿಂತೆವು.

ತ್ತಲೂ ಕಣ್ಣಾಡಿಸಿದಾ
ಂತರದಲ್ಲಿ ೩-೪ ಶಿಲಾ
ಗ್ಗಲು ಕಿರು ವಿಸ್ತಾರದ
ಯಲುಗಳಲ್ಲಿ ಮರಡಿ
ಂದರ್ಶಕರ ಅಡಿಗೆಯ
ಾಡಿರಬಹುದಾದ ೩-೪
ಡುಬಂದವು.

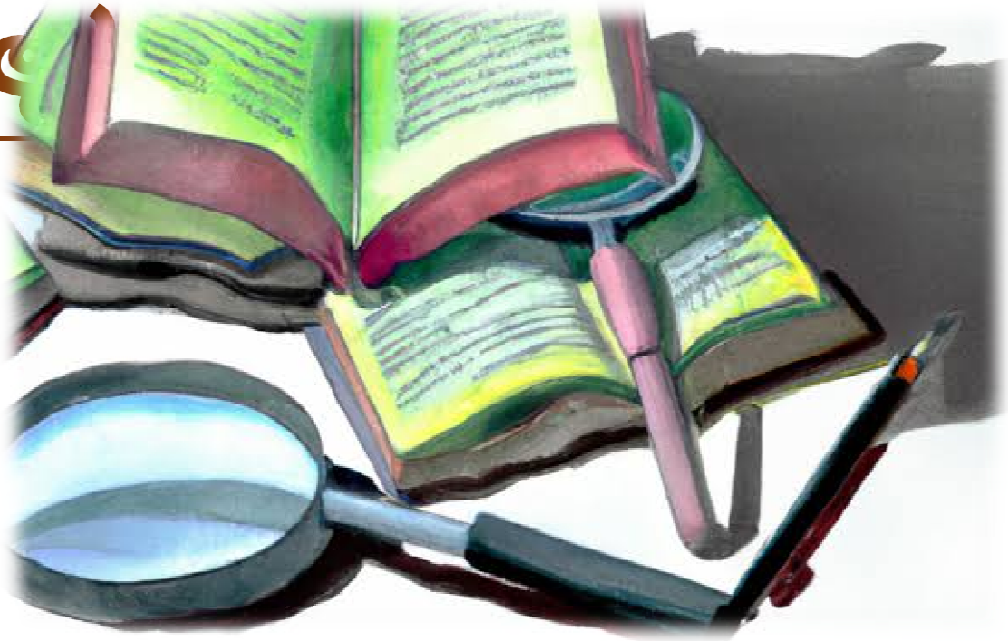
```
ERROR: typecheck
OFFENDING COMMAND: bind

STACK:

-dictionary-
```

ಸಂಶೋಧನೆ

ಅರ್ಥ ಸ್ವರೂಪ ವಿನ್ಯಾಸ ಮತ್ತು ಪ್ರಕಾರಗಳು



ಸಂಶೋಧನೆ ಎಂಬುದನ್ನು ಜ್ಞಾನದ
ಸಲುವಾಗಿ ನಡೆಸುವ ಹುಡುಕಾಟ
ಎಂದು
ವ್ಯಾಖ್ಯಾನಿಸಬಹುದು,ಅಥವಾ ಮುಕ್ತ
ಮನಸ್ಸಿನಿಂದ ಯಾವುದೇ ಶಿಸ್ತುಬದ್ಧ
ಶೋಧನೆ,ತನಿಖೆ ಮೂಲಕ ನವೀನ
ಸಂಗತಿಗಳ ಹುಟ್ಟುಹಾಕಿ ಹೊಸ
ಅಥವಾ ಅಸ್ತಿತ್ವದಲ್ಲಿರುವ
ಸಮಸ್ಯೆಗಳಿಗೆ ಪರಿಹಾರ
ಕಂಡುಕೊಳ್ಳುವುದು.

ುಡುಕುವಿಕೆ ಮಾನವನ ಮೂಲಭೂತವಾದ ಸಹಜ
ಣ.

ೃಜನಶೀಲತೆ ಮತ್ತು ವಿಚಾರಶೀಲತೆ.

ೂವಿನ ಸೌಂದರ್ಯವನ್ನು ಕಂಡು ಹರ್ಷದಿಂದ
ಪ್ಪಳಿಸಿದ ಮಗು ಸೃಜನಶೀಲ ಮನಸ್ಸಿಗೆ,
ಹೃದಯತೆಗೆ ಸಾಕ್ಷಿಯಾಗುತ್ತದೆ. ಕುತೂಹಲ ನಿರೀಕ
ಲ್ಪನೆ, ಪರಿಶ್ರಮ, ಆನಂದ ಮುಂತಾದ ಅನೇಕ
ಂಶಗಳನ್ನು ಈ ಎರಡು ಪ್ರಕಾರದ ಸ್ವಭಾವಗಳುಳ್ಳ
ಕ್ಕಳು ಪಡೆದಿರುತ್ತಾರೆ. ಆದರೆ ಒಂದು ಮಗು ಹೃದ
ಂವಾದದಲ್ಲಿ ಖುಷಿಪಡುತ್ತದೆ. ಮಕ್ಕಳು
ೂಡ್ಡವರಾದಾಗಲೂ ಈ ಪ್ರವೃತ್ತಿ, ಇವೇ ಗುಣಗಳು
ಕಾಸವಾಗಿ ಅವರು ಸೃಜನಶೀಲ ಸಾಹಿತಿ,ವಿಮರ್ಶಕ

ಮನುಷ್ಯ ದ್ವಿಪಾದಿಯಾಗಿ ಪರಿವರ್ತನೆಗೊಂಡಾಗ
ಅವನ ಕೈಗಳು ಸ್ವತಂತ್ರವಾದವು, ಮಾತು ಕಲಿತ
ಅವನಿಗೆ ಅದ್ಭುತ ಶಕ್ತಿ ಕರಗತವಾಯಿತು.

ಸಾಹಿತ್ಯ ಸೃಜನಶೀಲತೆಯ ಗಂಗೋತ್ರಿ.
ಕಾಲಕಾಲಕ್ಕೆ ಪ್ರದೇಶ ಪ್ರದೇಶಕ್ಕೆ ಆ ಗಂಗೋತ್ರಿ
ಹರಿದು ಬರುವ ಬಗೆಯ ವೈಚಿತ್ರ್ಯ ವೈಶಿಷ್ಟ್ಯ, ಮೂಲ
ಸತ್ವ, ಸತ್ಯಗಳನ್ನು ಕಂಡುಹಿಡಿದು ತೋರುವ
ಕಾರ್ಯವನ್ನು ಮಾಡುವುದೇ ಸಾಹಿತ್ಯ ಸಂಶೋಧನೆ

ಾಹಿತ್ಯ ಮತ್ತು ಸಂಶೋಧನೆ :

ಾಹಿತ್ಯ ಹೃದಯಗಮ್ಯವಾದರೂ ಸಾಹಿತ್ಯ
ಂಶೋಧನೆಯು ಬುದ್ಧಿಗಮ್ಯ ವಾಗಿದೆ. ಸಾಹಿತ್ಯ
ಲಭವಾಗಿ ಆಹ್ಲಾದ ನೀಡಿದರೆ ಸಾಹಿತ್ಯ
ಂಶೋಧನೆ ಪರಿಶ್ರಮದ ಮೂಲಕ ಆಹ್ಲಾದವನ್ನು
ಡುತ್ತದೆ. ಸಾಹಿತ್ಯ ಸುಲಿದ ಬಾಳೆಯ ಹಣ್ಣಾದರೆ,
ಾಹಿತ್ಯ ಸಂಶೋಧನೆ ತೊಗಟೆ ಚಿಪ್ಪುಗಳಿಂದ
ಾಡಿದ ತೆಂಗಿನಕಾಯಿ.

ಾಹಿತ್ಯ ಅನುಭವ ಪ್ರಧಾನವಾದರೆ
ಾಹಿತ್ಯ ಸಂಶೋಧನೆ ಬುದ್ಧಿ ಪ್ರಧಾನ,
ೌದ್ಧಿಕ ಕಾಳಜಿ, ತಾತ್ವಿಕ ಚಿಂತನೆಯ,
ಲ್ಪಕತೆಯ ಮೂಲಕ ವಾಸ್ತವಿಕತೆಯ
ಹೂಸೆಯಲ್ಲಿ ಘಟನೆಗಳನ್ನಿಟ್ಟು
ಂಶೋಧನೆ ಅವುಗಳನ್ನು
ಾನಿಸಿ ತೋರಿಸುತ್ತಾನೆ.

ಪ್ರಜ್ಞಾಪಾತಳಿಯಲ್ಲಿ ಬದುಕಿ
ನಿಗೂಢಗಳನ್ನು ಕಲಾತ್ಮಕವ
ಮನ ಸೃಷ್ಟಿ ಮಾಡುವ ಮೂಲ
ತಾನು ಕಾಣುವ, ಕಂಡದ್ದನ್ನು

ತ್ಪತ್ತಿಯಿಂದ ಬೆಳಕಿನೆಡೆಗೆ, ಅಜ್ಞಾನದಿಂದ
ಜ್ಞಾನದೆಡೆಗೆ, ಅಳುಕಿನಿಂದ
ತ್ಮವಿಶ್ವಾಸದೆಡೆಗೆ, ಅನಾಗರಿಕತೆಯಿಂದ
ಾಗರಿಕತೆಯಡೆಗೆ, ಸಂದೇಹದಿಂದ
ಸ್ಪಂದೇಹದೆಡೆಗೆ, ಅಲ್ಪವಿರಾಮದಿಂದ
ೂರ್ಣವಿರಾಮದೆಡೆಗೆ ಸಾಗಲು ನಡೆಸುವ
ಯತ್ನವನ್ನು ಪ್ರತಿಫಲಿಸಲಾಗಿದೆ. ಜನ ಪ್ರಕಾರದ
ಲೆಯಲ್ಲಿ ನೋಡದೆ ಸಾಂಸ್ಕೃತಿಕ
ಲೆಗಟ್ಟುಗಳಲ್ಲಿ ಸಾಹಿತ್ಯ ಕೃತಿಗಳಲ್ಲಡಗಿದ
ತ್ಯಗಳನ್ನು ಗುರುತಿಸಿಕೊಳ್ಳುವ
ಯಿಂದ ಸಾಹಿತ್ಯ ಸಂಶೋಧನೆಗೆ ಹೊಸ
ಆಯಾಮವನ್ನು ತಂದುಕೊಡಲಾಗಿದೆ

ರಶೋಧನೆ ಬಸ್ನೆಪುದು
ಂಗ್ಲ ವಿದ್ವಾಂಸರು ನಮಗೆ
ೋರಿಸಿಕೊಟ್ಟ ಹೊಸ
ೃಷ್ಟಿಕ ಶಿಸ್ತು,
ಾರಂಭದಲ್ಲಿ Oriental
tudies ಅಂದರೆ, ಪ್ರಾಚ್ಯ
ಂಶೋಧನೆಯ ಹಾದಿಯಲ್ಲಿ
ಾರಂಭವಾದ ಈ ಕ್ರಿಯೆ
ಕರಗಳ ಶೋಧ, ಆಮೇಲೆ
ಕರಗಳ ವಿಶ್ಲೇಷಣಾತ್ಮಕ
ೋಧ, ಆಕರಗಳ
ಾಖ್ಯಾನಾತ್ಮಕ
ೋಧಗಳೆಂಬ ಘಟ್ಟಗಳಲ್ಲಿ

ಪ್ರಬಂಧಗಳ ಬರವಣಿಗೆ, ಕರ್ನಾಟಕಕ್ಕೆ
ಸಂಬಂಧಿಸಿದ ಪಿಎಚ್.ಡಿ. ಅಧ್ಯಯನ
ಮೊದಲು ಪ್ರಾರಂಭವಾದುದು ದೂರದ
ಲಂಡನ್ ವಿಶ್ವವಿದ್ಯಾಲಯ ಇಂಗ್ಲಿಷ್
ಮಾಧ್ಯಮದ ಮೂಲಕ ೧೯೩೦ರಲ್ಲಿ ಲಂಡನ್
ವಿಶ್ವವಿದ್ಯಾಲಯ ಬಾರ್ನೆಟ್ ಅವರ
ಮಾರ್ಗದರ್ಶನ ದಲ್ಲಿ ಡಾ. ಎಸ್. ಸಿ. ನಂದೀಮಠ
ತಂಡದವರು ಪ್ರಾರಂಭಿಸಿದ ಕನ್ನಡಕ್ಕೆ
ಪ್ರಥಮ ಪ್ರಬಂಧ ಲಭಿಸಿತ್ತು.
ಅಧ್ಯಯನ ಪರಿಶೀಲಿಸಿ
ಇತಿವೃತ್ತಗಳೊಂದಿಗೆ ಅದರ ಅಂದಂದಿನ
ಪ್ರಸ್ತುತತೆಯನ್ನು ಸ್ಪಷ್ಟಪಡಿಸುವುದಾಗಿದೆ.
“Past is to be made perfect in present” ಎಂದು,

ಶೋಧಕ ಮತ್ತು ಸಂಶೋಧನೆ:

ಸಂಶೋಧಕನಿಗಿರಬೇಕಾದ ಪ್ರಮುಖ ಗುಣಗಳು.

ಆಸಕ್ತಿ, ಅಧ್ಯಯನ, ಪರಿಶ್ರಮಶೀಲತೆ, ಉದ್ವೇಗರಹಿತ ಸಮತೋಲನ ಮಾನಸಿಕ ಸ್ಥಿತಿ, ಹಠಮಾರಿಯಾಗದ ಧೈರ್ಯ, ಪೂರ್ವಾಗ್ರಹಪೀಡಿತ ಭಾವನೆಗಳಿಂದ ಮುಕ್ತಮನಸ್ಸು, ಯಾವುದನ್ನೂ ಇನ್ನೊಬ್ಬರ ಪ್ರಭಾವಕ್ಕೆ ಒಳಗಾಗದೆ ಒರೆಗೆ ಹಚ್ಚಿ ನೋಡುವ ಪ್ರವೃತ್ತಿ, ಆರೋಗ್ಯಕರವಾದ

ಂಶೋಧನೆ:

ಹೊಸ ಹೊಸ ಸಂಗತಿಗಳನ್ನು ಶೋಧಿಸಿ
ೀರಿಸಬಲ್ಲುದು.

ಸತ್ಯವನ್ನು ಹೊರಗೆಡಹಬಲ್ಲುದು.

ಶೋಧಿತ ಸಂಗತಿಗಳನ್ನು ಹೊಸ
ಷ್ಟಿಯಿಂದ ಪರಿಶೀಲಿಸಬಹುದ
ಶ್ಲೇಷಿಸಬಹುದು.

ಶೋಧಿತ ಸಂಗತಿಗಳನ್ನು ಪರೀಕ್ಷಿಸಬಹುದು,
ಾಮಾನ್ಯೀಕರಣ ಮಾಡಬಲ್ಲುದ

ಮಾನವ ಜೀವನಕ್ರಮದ ಮೇಲೆ ಹೊಸ ಬೆಳಕ
ೀರಬಲ್ಲುದು.

ಊಹಾಪೋಹಗಳಿಗೆ ಕೊನೆಯ
ಿಯನ್ನೆಳೆಯಬಲ್ಲುದು.

ಅಂಧವಿಶ್ವಾಸ, ದುರಭಿಮಾನಗಳನ್ನು
ಾರಮಾಡಬಲ್ಲುದು.

ು. ವ್ಯವಸ್ಥಿತ ಆಲೋಚನಾಕ್ರಮವನ್ನು
ಳೆಸಬಲ್ಲುದು.