Introduction Of Waveplates

The Interaction of light with a the atoms or molecules of a material is wavelength dependent a result of this dependence is the resonant Interactions related to material dispersion birefringence is another consequence of such resonant interaction which is the change in refractive index with the polarisation of light. The orderly management of atoms in some Crystals results in different refractive indices such as Nacl or GaAs we Can also use birefringence to modify the polarisation state of light which is useful thing to do in many situations The optical components that do this "trick" are Called birefringe wave plates or retardication plates.

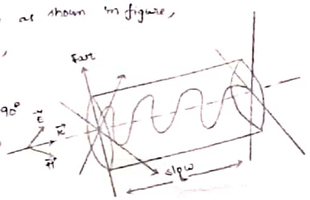
Wave plates :-

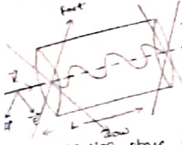
By taking just the right slice of a crystal with respects to the Crystalline axis, it Can be arranged so that the minimum index of refraction is exhibited for one polarization, of the electric vector of a linearly polarised value as shown in figure,

i) The wave is polarised among the fast axis, since its phase velocity will be a Maximum.

A linearly polarised wave with its plane rotated 90° will propagate with the maximum index of refraction and minimum phase velocity as shown in figure 2.

ii) The wave is polarised along the slow axis.



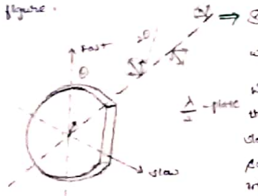


The difference in the Number of wavelength 1 & 2 (2⅔ and 4 respectively) would imply a ratio of the two indices of refraction $n_{fast}:n_{slow} = 2:3$ a much larger difference than in typical natural Crystals the ratio has been exaggerated for clarity.

The propagation phase Constant k Can be written as $2\pi f n/c$ radians. The difference between these two phase shifts is termed the retardation $r = 2\pi f (n_{slow} - n_{fast}) L/c$ The value of r in this formula is in radians but is more Common to express in wavelength or waves with a full wave meaning $r = \pi$, a quarter meaning $r = \pi/2$ and so forth. for a plate that had only ¼ The retardation would change at a rate faster than it would wave retardation. This difference can be noted by calling it a multiple order quarter wave plate.

Half wave plates :-

The Most commonly used waveplates are the half-wave plate ($r=\pi$) and the quarter waveplate ($r = \pi/2$) can be used to rotate the plane of linearity polarity light as shown in figure.

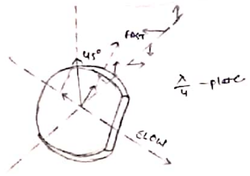


⇒ Suppose a linearly polarised wave is normally incide on a waveplate and its plane of polarisation is at an angle θ with respect to the fast axis to see what happens resolve the incident field into components polarised along the fast and slow access as shown after passing through a maximum splits the same component passes through a maximum 180° out of a point describes a linearly polarised ing along the negative slow axis this wave but making an angle θ on the opposite side of the fast as the original polarisation axis, had been rotated, through an angle 2θ. The same result will be found. If the incident where makes an angle θ w.r.to the slow axis.

The retardation try both ways and use linear polariser to check for improvement in the extinction area.

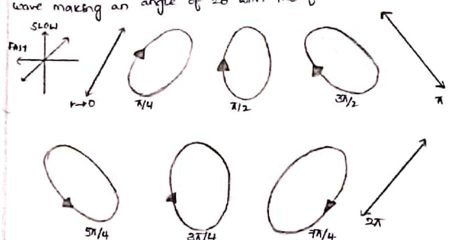
Quarter - Waveplates :-

Quarter - Waveplates are used to turn linearly polarised light into circularly polarised light and vice versa to do this the waveplate must be oriented so that equal amounts of fast and slow waves are excited. This is achieved by using an incident linearly polarised wave at a point where the fast - polarised component is at retarted by a quarter - wave or 90° in phase moving an eight wavelength further we will not that the two are the same magnitude but the first Component It will also be a maximum and the fast Component, is zero. Since it has been retarted by a quarter wave on 90° in phase. Moving an 8th wave length further we will further we will note that the two of the same magnitude but the fast Component its decreases and this slow component is increasing moving another 8th wave we find the is tip of the total electrical vector is traced.



What effect do retardations other than a half-wave or a quarter wave have a linearly polarised light?

The result is elliptically polarised light where the amount of ellipticity is a function of the retardation of the incident plane wave the exception is a half wave retardation, in which case the ellipse degenerates, into a plane wave making an angle of 2θ with the fast axis.



The effect of λ/4 retardation on intensity on linearity polarised light with the plane of polarisation making an arbitary angle with respect to the fast axis.

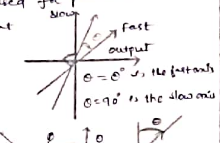
Wave plate Applications :-

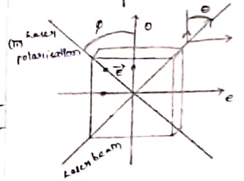
→ Varying the light Intensity

→ Examples of special optical

→ used to prevent the special reflection

→ used for polarization measurement





Input	Output
Quarter wave.	
linear, θ=45°	Right Circular
linear, θ=-45°	left circular
Right circular	linear, θ=-45°
Left circular	linear, θ=45°
linear of 45°	elliptical.
Half wave	
linear, angle θ	linear, angle -θ
left circular	right circular
right circular	left circular
Any wave -plate.	
linear θ = 0° or 90°	Unchanged.

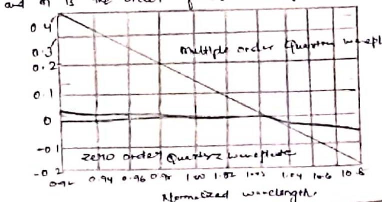
Optical Isolation :- A quarter-waveplate can be used in an optical isolator, that is, a device that eliminates undesired reflections such a device uses a quarter wave plate and a linear polariser or polarising beam splitter Cube.

polarization Cleanup :- Often an optical system will require Several reflections from metal or dielectricmirrors.

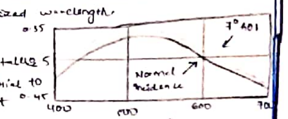
Multiple order waveplates :- Retardation of multiple order plates is only slightly more temperature dependent Comparing with the zero order ones

$$r = (2m+1)\pi \left(\frac{df}{f_0}\right) \approx -(2m+1)\pi \left(\frac{d\lambda}{\lambda_0}\right)$$

where f_0 and λ_0 are the design frequency and wavelength and m is the order of the wavelength.



Achromatic waveplates :- It use two birefringent crystalline materials or polymer material to provide a constant phase shift independent of wavelength.



Berek's variable wavelength :- It have a variable birefrigence or thickness that can be tuned to certain wavelength or shift the retardation value for a single wavelength.

L. Dilleswar Rao
IIIrd MPE

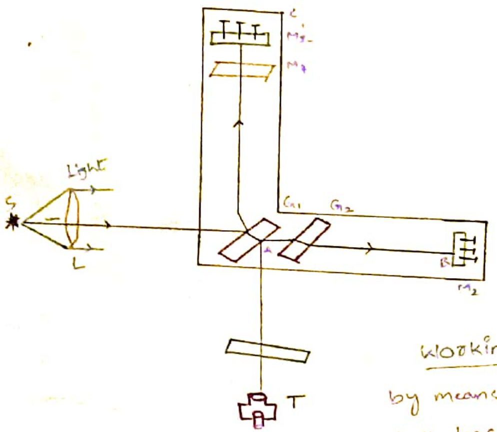
MICHELSON INTERFEROMETER

MICHELSON INTERFEROMETER: Michelson Interferometer is an instrument in which the phenomenon of interferometer is used to make precise measurements of wavelengths, refractive index and distance.

principle: In michelson interferometer, a beam of light from an extended source is divided into two parts of equal intensities by parts of reflection and refraction.

→ These beams travel in two mutually perpendicular directions and together often reflection from plane mirrors.

→ The beams overlap on each other and produce interference figures.



construction: It consists of a beam splitter G_1, a compensating plate G_2 and two plane mirrors M_1 and M_2. The beam splitter G_1 is a partially silvered plane parallel glass plate

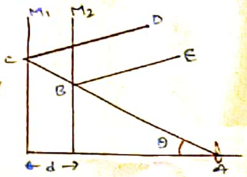
→ The compensating plate G_2 is a simple plane parallel glass plate having the same thickness as G_1

→ The two plates G_1 and G_2 are held parallel to each other and are inclined at an angle of 45° with respect to the mirror M_2.

→ The mirror M_1 is mounted on a carriage and can be moved with the help of a micrometer screw.

→ The plane mirrors M_1 and M_2 can be made perfectly perpendicular with the help of fine screws attached to them

→ The interference bands are observed in the field of view of the Telescope T.



Working: Monochromatic light from an extended source S is rendered parallel by means of a lens L and is made incident on the beam splitter G_1. It is partly reflected at the back surface of G_1, along AC and partly transmitted along AB.

→ The beam AC travels normally towards the plane mirror M_1 and is reflected back along the same path and comes out along AT

→ The transmitted beam travels toward the mirror M_2 and is reflected along the same path. It is reflected at the back surface of G_1 and produce along AT

→ The two beams received along AT are produced from a single source through division of amplitude and are hence coherent.

→ The superposition of these beams leads to interference and produces interference figures.

→ The total path difference between the two beams is given by $\Delta_a = 2d\cos\theta$.

→ For constructive interference (maxima) Bright fringes $2d\cos\theta = (2m+1)\lambda/2$ [m=0,1,2,3...]

For Destructive Interference $2d\cos\theta = m\lambda$ [m=0,1,2,3...]

Apparatus:

* plane mirrors (M_1, M_2)
* plane Glass plates (G_1, G_2)
* Telescope (T)
* Convex lens (L)
* virtual image of M_2 (M_2')
* Monochromatic extended Source (S)

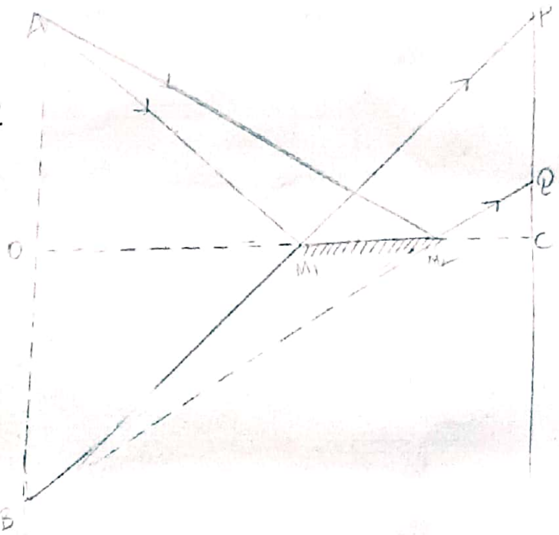
NAME: KANCHARAPU BHAVANI PRAS...
GROUP: IIIrd BSc (MPE)
HL NO: 2122001053027

LLOYD'S SINGLE MIRROR.

Q) How does the Wavelength of Monochromatic light is a Measured with the help of the Lloyd's Single Mirror. Deduce the Formula Used (V.U 1994, 1997, 2000, 2003)

⟹ Formation of Interference Fring :-

In Lloyd's Single Mirror Arrangement a Small Metallic Mirror is Filed where reflecting Surface is plane and highly polished. The light wave from a narrow source (A) of Mono-chromatic light when Incident on the Mirror M_1M_2, the reflected lights, incident on the Screen which give rise to a Virtual Source B. the real source A and Virtual source B, Virtues like Coherent source. Direct waves from source A and the reflected waves from B on the Superposition at the region PQ will give interference Frings



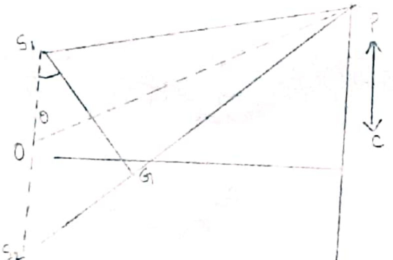
⟹ characteristics of Fringes in Lloyd's Mirror :-

i) Here the Central Fring is dark
ii) Here the Fringes are onesided
iii) A phase change of π of Created due to reflection of light from denser to rarer. Medium
iv) wave front is devided by the Method of diti division of wavefrom.

Theory :-

let the distance between to Coherent source $S_1S_2 = d$

Distance between source and Screen $OC = D$



let nth order fring is produced at P at a distance x_n from the Central fring C path difference at P between two Interfering beam $= S_2G$

From Similar traingle S_1S_2G and OPC

$$S_2G / S_1G = \frac{PC}{OC}$$

$$\Rightarrow S_2G = \frac{PC}{OC} \times S_1G$$

$$= \frac{PC}{OC} \times S_1S_2 \quad (\text{Since G is a very small})$$

$$= \frac{x_n d}{D}$$

total path difference = path difference due to differen path + path difference due to reflection $= \frac{x_n d}{D} \mp \lambda/2$

2) For nth order bright fring at P

path diff $= 2n \times \lambda/2$

$$\therefore \frac{x_n d}{D} \pm \lambda/2 = 2n\lambda/2$$

$$\Rightarrow x_n = \frac{(2n+1)\lambda D}{2d}$$

For the next Bright Frings $x_{n+1} = \frac{(2n+3)\lambda D}{2d}$

$\therefore$ Fringe width $\beta = x_{n+1} - x_n = \frac{\lambda D}{d}$

iii) For nth order dark Fringe at P

$$\frac{x_n d}{D} + \lambda/2 = (2n+1)\lambda/2$$

$$\therefore x_n = \frac{n\lambda D}{d}$$

Fringe width $\beta = \frac{\lambda D}{d}$

Mequring β, d and D we Can Compute λ,

Experiment arrangement –

As like biprism experiment

(*) what is the different between biprism and Lloyd's Fringes ? (V.U 1994 1997 2000)

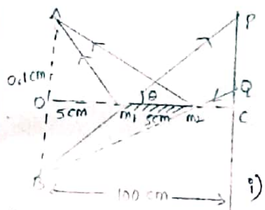
i) in biprism experiment Fringes are formed on both sides of the Central Fringe, whereas Lloyd's mirror arrangment the fringe are formed on one side of the Centeral line.

ii) in biprism the Central Fringe is bright where in Lloyd's mirror Central Fring is dark

iii) In biprism the separation between every pair of corresponding point (d) of the Coherent source is same hence fringth with is same for all Parts of the source

iv) In biprism, distance of nth bright fring from c in Lloyd's mirror that is $x_n = \frac{n\lambda D}{d}$, $x_n = \frac{(2n+1)}{2}\frac{\lambda D}{d}$

Problem ① V.U 1997 ⟹ A Lloyd's mirror of length 5 cm is . .



Given

$M_1M_2 = 5cm$

$\lambda = 6000 \times 10^{-8}$ cm

$OA = \frac{d}{2} = 0.1$ cm

$\therefore d = 0.2$ cm

$Om_1 = 5cm$

$D = 100cm$

i) Fringe width $\beta = \frac{\lambda D}{d} = \frac{6000 \times 10^{-8} \times 100}{0.2}$ cm $= 0.03$ cm

ii) width of the fringe system – $PQ = CP - CQ$ from Similar Δm_1CP and Δm_1OA

$$\tan\theta_1 = \frac{CP}{m_1C} = \frac{OA}{Om_1}$$

$$\Rightarrow CP = \frac{OA}{Om_1} \times m_1C = \frac{0.1 \times 95}{5} = 1.9cm$$

Since $m_1C = 100 - 5$ cm $= 95$ cm

From similar triange ΔAOm_2 and Δm_2QC $\tan\theta_2 = QC/m_2C = OA/Om_2$

$\Rightarrow CQ = OA/Om_2 \times m_2C = 0.1 \times 90 = 0.9cm$

Since $m_2C = 100 - (5+5)$ cm $= 90$ cm

(iii) let the amplitude of incident ray = a and amplitude of reflected ray = b

Then $\frac{\text{intensity of incident ray}}{\text{intensity of reflected ray}} = a^2/b^2$

$$\Rightarrow \frac{100}{a^2} = \frac{a^2}{b^2} \quad b/a = 9/10 \quad \therefore b = 9/10\, a$$

$$\frac{I_{max}}{I_{min}} = \frac{(a+b)^2}{(a-b)^2} = \frac{(a+\frac{9}{10}a)^2}{(a-\frac{9}{10}a)^2} = \frac{(19/10)^2}{(1/10)^2} = 19 \times 19 = 361$$

Problem ② V.U 2000 :- Lloyd's mirror expiriment is Performed with a mirror wave source emiting waves of wavelength 40 cm Using a plane metal sheet on a table top on the reflactor, if the source is placed 6 cm above the table Find the height of the 1st Maximum above This surface of a distance of 400 cm From the source

Sollution :- in Lloyd's mirror

condition of the nth ~~above~~ ader bright Fringe.

path difference $= 2n\frac{\lambda}{2} = \frac{\lambda}{2}$

$$\frac{x_n d}{D} = (2n-1)\frac{\lambda}{2}$$

$$\Rightarrow x_n = (2n-1)\frac{\lambda D}{2d}$$

For 1st maximum $x_1 = \frac{\lambda D}{2d}$

Given that $\lambda = 40$ cm

$\frac{D}{2} = 6cm \quad \therefore d = 12$ cm

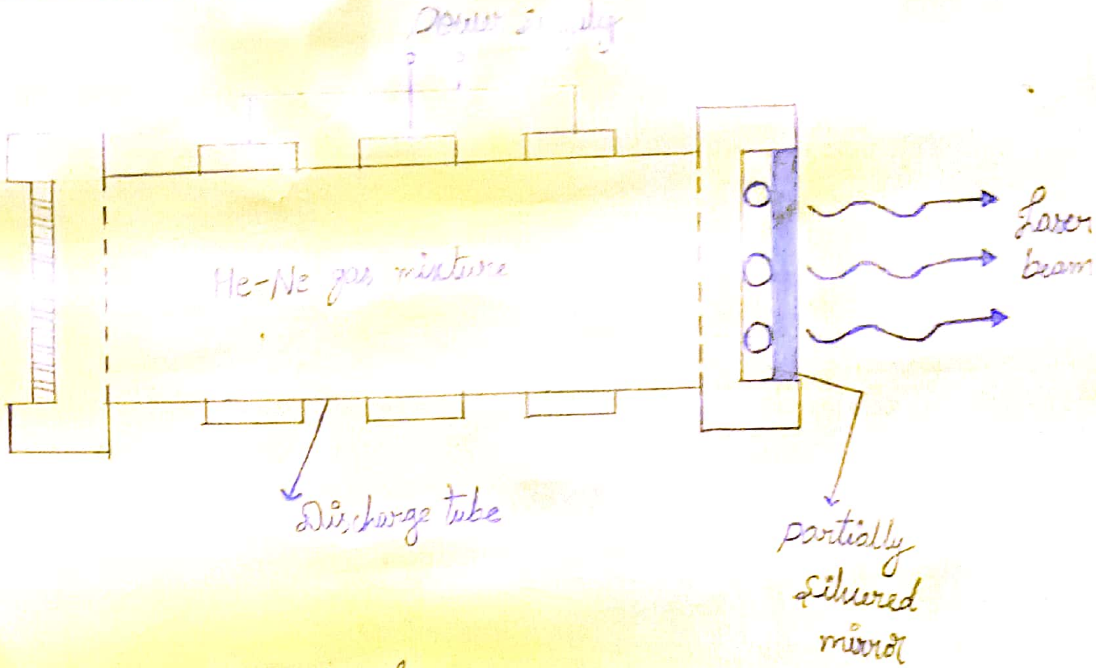
$D = 400$ cm

$$x_1 = \frac{40 \times 400}{2 \times 12} = \frac{2000}{3}\text{ cm} = 666.67\text{ cm}$$

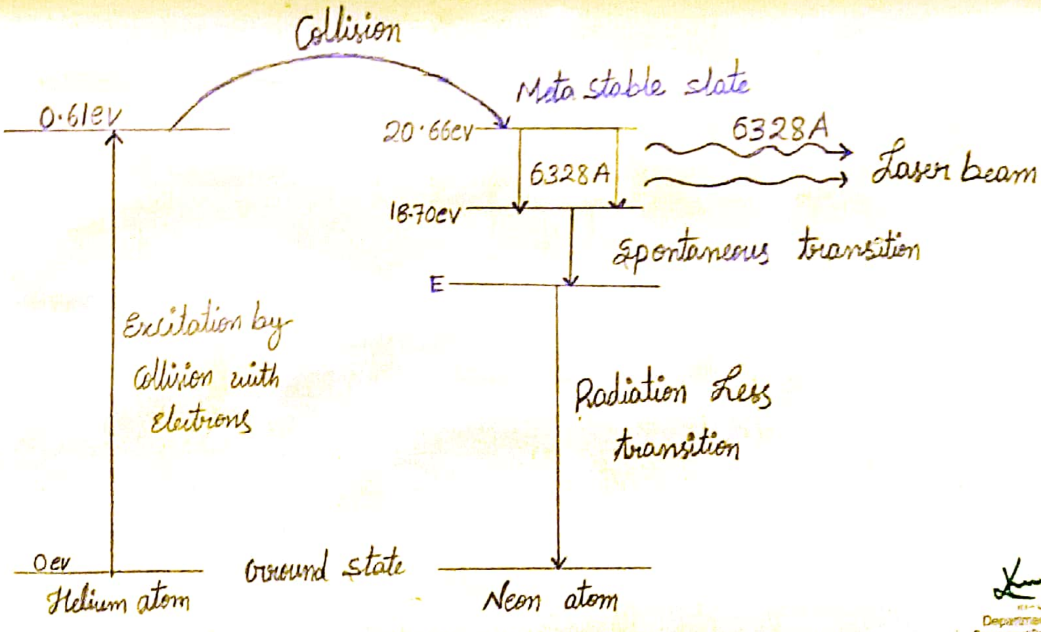
Name : Goudo. Vamshi
Group : (M.P.E)
Hall ticket no : 2122001053020

NAME: Y.THARUN
H.T.NO: 2122001053048
GROUP: MPE [BSC 3rd YE

He - Ne Laser



He - Ne Laser



Energy Level diagram for He- Ne Laser system

A continuous and intense laser beam can be produced with the help of gas laser. A simplified diagram showing basic features of a He-Ne gas laser is shown in fig He-Ne laser system consists of a quartz discharge tube containing helium and neon in the ratio of 1:4 at a total pressure of about 1 mm of Hg. One end of the tube is fitted with a perfectly mirror and the other end with partially reflecting mirror. A powerful radio frequency generator is used to produce a discharge in the gas so that the helium atoms are excited to a higher energy level. The energy level diagram for He and Ne atoms. When an electric discharge passes through the gas the electron in the discharge tube collide with the He and Ne atoms.

WEDGE SHAPED FILMS

*** Interference due to a thin wedge-shaped film :**

Let us consider a thin wedge-shaped film of refractive index μ bounded by two plane surfaces inclined at an angle [fig 3.28]. Let the film be illuminated by a parallel beam of monochromatic light the incident ray surface of the film so interference occurs between the incident ray reflected at the upper and lower surface of the film so that equidistant alternate dark and bright fringes become visible. The interfering rays in reflected light are AR_1 and AR_2 CR_2 both originating from the same incident ray SA. To evaluate the path difference between these two rays the perpendicular CD and CG are drawn from C on AR_1 and AB respectively. If θ is an angle of wedge-shaped film is very small AR_1 and CR_2 will be almost parallel and after the perpendicular CD. the paths will be equal. path difference

Between AR_1 and CR_2 will then be

Δ_1 = path ABC in medium - path AD in air

$= \mu(AB + BC) - AD$ ...... (1)

As ΔACD and ΔACG

$i + \angle DAC = \angle DAC + \angle ACD = 90^\circ$

$\angle ACD = i$

$r + \angle CAG = \angle CAG + \angle ACG = 90^\circ$

$\angle ACG = r$

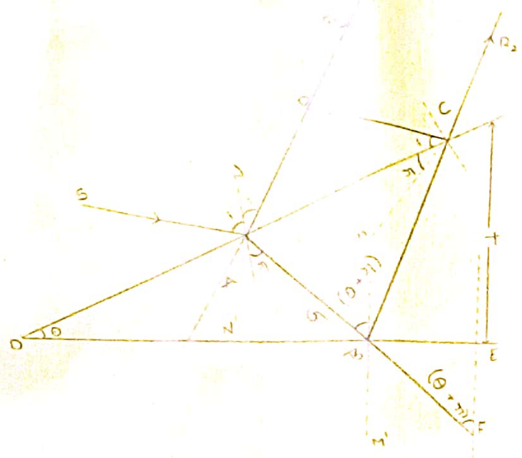


Fig : 3.28

$\therefore$ Refractive index μ of the film μ

$$\mu = \frac{\sin i}{\sin r} = \frac{AD/AC}{AG/AC} = \frac{AD}{AG}$$

$AG = \mu\ AG$ .... (2)

To find the length of the path of light ray BC and Now draw perpendicular CE to from C on OE and produces AB. These meets at F.

Further exterior angle = sum of the interior angle

Hence $\angle ABE = \angle MBA + 90^\circ$

$= \theta + 90 + r$

$\therefore \angle MBA = \theta + r$

$\therefore (\theta + r) = \angle MBA = \angle M'BF = \angle BFC$

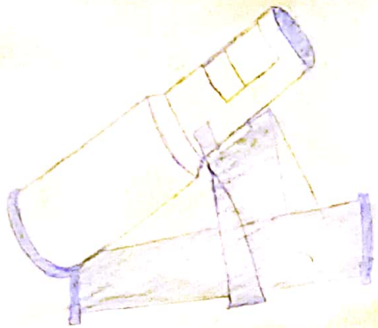
$= \angle MBC = \angle BCF$

Hence ΔBCF is the isoscales triangles

Department Of Physics
Government Degree College (MEN)
SRIKAKULAM

Name : Gunmidi. Mohana Rao
Hall No: 2122001053022 group: B.Sc (M.P.
G.D.C (MEN), Srikakulam

NICOL PRISM



Schematic representation of the Propagation of li
in a Nicol Prism showing the splitting of unpolarized ligh
into ordinary and extraordinary polarized rays

A Nicol prism is a type of polarizer. It is an optical device made from calcite crystal used to convert ordinary light into plane polarized light. It is made in such a way that it eliminates one of the rays by total internal reflection, i.e the ordinary ray is eleminated and only the extraordinary ray is transmitted through the prism. It was the first type of polarizing prism, invented in 1828 by William Nicol (1770-1851) of Edi

Uses:- Nicol prism were once widely used in mineralogical microscopy and polarimety, and the term "using crossed Nicols" is still used to refer the observing of a sample placed between orthogonally oriented polarizers. In most instruments, however Nicol prism have been replaced by othe types of polarizers such as polaroid sheets and Glan-Thompson prisms.

mechanism:- The Nicol prism consists of a rhombohedral crystal of Iceland spar that has been cut at an angle of 68° with respect to th crystal axis, cut again diagonally, and then rejoined, using a layer of transparent Canada balsam as a glue. unpolarized light ray enters through the side face of the crystal, and is split into two orthogonally polarized, differently directed rays the Birefringence property of calcite.

Department Of Physics
Government Degree College
SRIKAKULAM

Name:- Lenka Santosh
Group:- B.Sc (M.P.E) IIIrd
RollNo:- 212200105303 4

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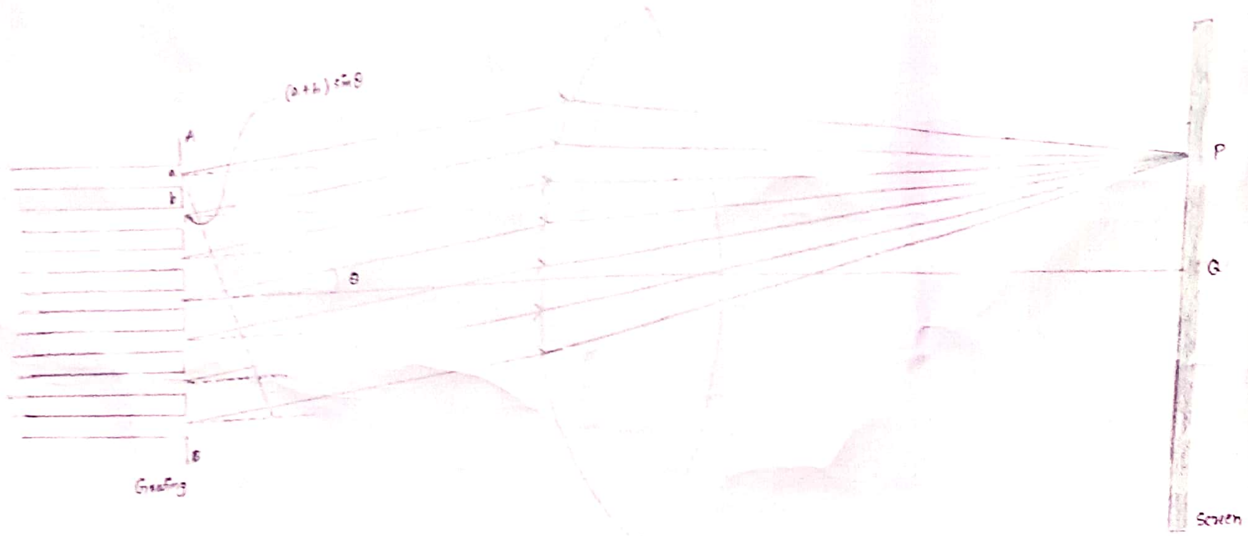
Plane diffraction grating



* A large number of parallel slits of equal width separated by opaque spaces, constructed equidistant line on a plane glass plate with help of a diamond point. generally there are 10,000 to 15,000 lines per inch in a plane transmission grating

* Huygens principle state that waves spread out after they pass through slit

* Bending of light at the corner of an obstacle

* There are two types of diffraction

Fresnel diffraction: Distance of of screen from aperture is finite

Fraunhofer diffraction: Distance of screen from the aperture is infinite

* The source and AB is the slit, un deviated rays are focused at O while diffracted rays through θ are focused at P. path beyond AN is same.

Therefore path difference $BN = AB \sin\theta = e \sin\theta$

Department of Physics

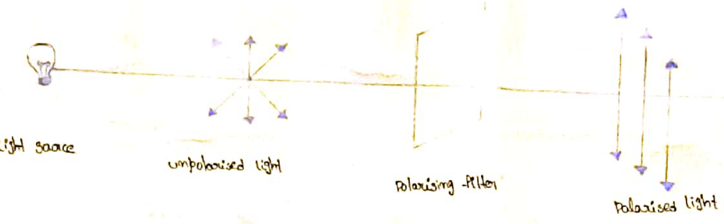
K. Phalguna

: POLARIZED LIGHT :

Polarization :-

* A light wave that is vibrating in more than one plane is referred to as unpolarized light. Polarised light waves are in which the vibrations occur in a single plane. The process of transforming unpolarized light into polarized light is known as polarisation
* Polarisation, also called wave polarizations, is an expression of the orientation of the lines of electric flux in an Electromagnetic field (Em field)

Construction :-

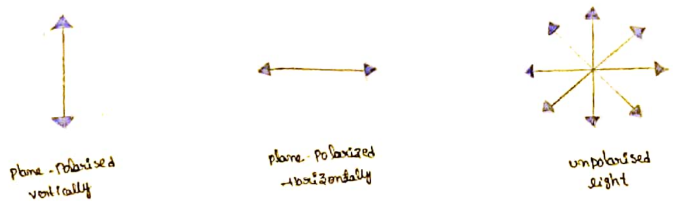


* Polarised light is made up of waves that vibrate in a single plane. There are three types of polarized lights. In linearly, circularly and elliptically polarised lights. In linearly polarised light, the electric vector of light moves in a single plane along the direction of propagation

Polarized light :- Polarised light has electric fields oscillating in one direction, whereas unpolarised

unpolarised light :- unpolarised light has electric fields oscillating in all directions.
Example the sun, incandescent and fluorescent lights and flames produce unpolarized light

* The three types of polarisation based on transverse and longitudinal wave motion are as follows:
  - ⇒ Linear Polarisation
  - → Elliptical Polarisation
  - ⇒ Circular Polarisation

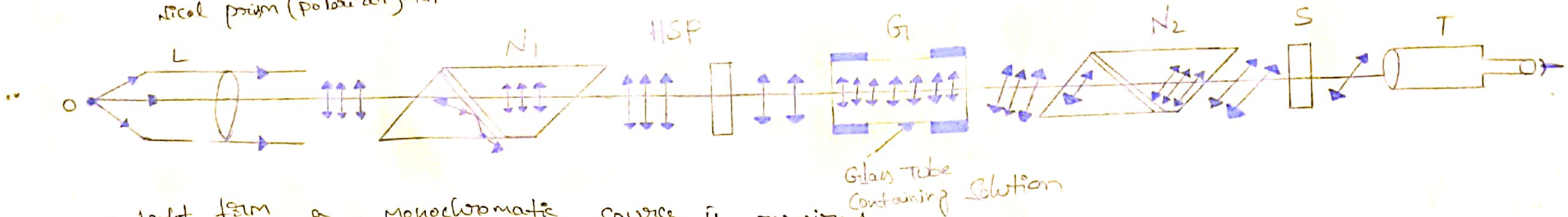


Department Of Physics
Government Degree College (MEN)
SRIKAKULAM

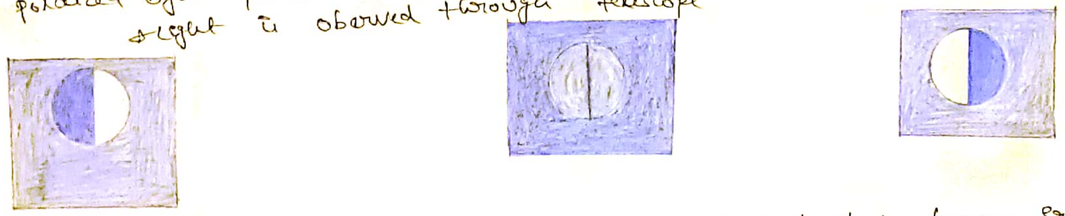
Name :- K. Hemalatha
Group :- BSc [M.P.C]
HT NO :- 2122001053035
Year :- III rd year

LAURENT'S HALF SHADE POLARIMETER

- Polarimeter – Instrument used for determining optical rotation of a solution
- Saccharimeter – for determining optical rotation of a sugar solution
- Construction
  - Convex lens (L)
  - Nicol prism (polarizer) – N_1
  - Half shade plate (HSP)
  - Glass tube (G)
  - Nicol prism (Analyzer) – N_2
  - Eye piece (T)



- Light from a monochromatic source is rendered parallel by lens (L)
- Light transmitted by the polarizer (N_1) is plane polarized
- polarized light passes through half shade plate & glass tube 'G' containing solution
- light is observed through telescope



- The analyzer is rotated until both halves of half shade become equally dark
- Glass tube is filled with the solution.
- The field of view become illuminated.

Name :- N. Sowjya
Group :- B.Sc (MPE)
H.T.No :- 2122001053039
Year :- III^rd Year

Department Of Physics
Government Degree College (MEN)
SRIKAKULAM

Ruby Laser

Definition: A ruby laser is a solid-state laser. This is successful laser developed by Maimane in 1960 the active material in the Ru[by] laser chromium ion and so energy level of chromium ions takes part in the lasing action. Ruby laser produces visible light of deep red colour wavelength 694.3nm.

Working Principal: A Ruby laser emitts lights by accumulating the emitted radiation when electrons drop from a higher energy state to release it through the side of the partially silvered ~~on~~ end.

Construction of ruby laser: A ruby laser consists of three important elements i) laser medium ii) the pumping source and iii) the optical resonator.

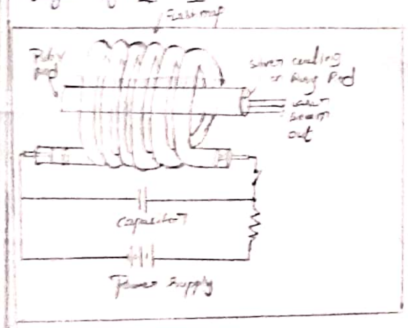
i) **laser medium in Ruby Laser:** In a Ruby laser, a single crystal of Ruby (Al_2O_3) doped with small (0.05%) of Cr_2O_3 acts as host material.

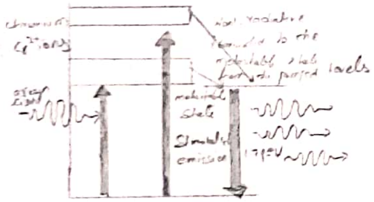
ii) **Pump source in Ruby laser:** the pump source in a Ruby laser provides energy to the laser medium.

iii) **optical resonator:** The two ends of the cylindrical ruby rod are flat and parellel. The ruby rod is placed in between two mirrors having optical coating at one end of the rod the mirror is fully silvered whereas at another end the mirror is partially silvered.

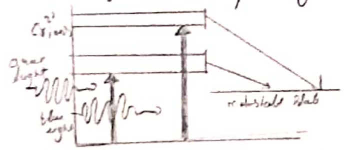
Working of Ruby Laser: Ruby laser is based on three energy levels. The upper energy level E_3 is short lived, E_1 is ground state, E_2 is metastable state with lifetime of 0.003 sec.

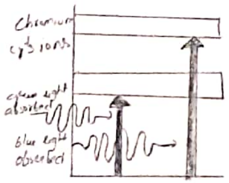
Diagram of Ruby Laser:





The ions after giving a part of their energy to crystal lattice decay to E_2 state undergoing radiation less transition





When a flash of light falls on Ruby rod radiations of wavelength 5500 are absorbed by Cr^{3+} which are pumped to E_3

Uses of Ruby laser

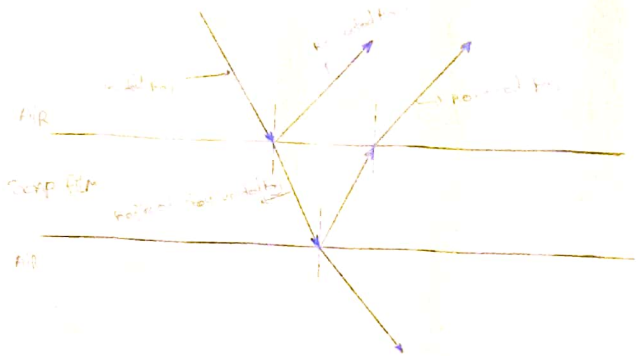
1. Ruby laser has very high output power of the order of 10^4–10^6 watts it has wavelength of 6943 Xmstrongs
2. Ruby laser are used for holography industrial cutting, and welding

Drawbacks (or) Limitations:

1. The Ruby laser requires a high power pumping source
2. The laser output is not continuous but occurs in the form of pulses of microsecond duration
3. The defects due to crystaline imperfection are also present in ruby laser

Department Of Physics
Government Degree College (M)
SRIKAKULAM

Colours in thin film.



Colours of thin films

Every one is familiar with the brilliant colour exhibited by a thin oil spread on the surface of water and also by a soap bubble these colours are due to interference between light waves reflected from the top and the bottom surfaces of thin films. when white light is incident on a thin film, the film appears coloured and the colour depends upon the the thickness of the film and also the angle of incidence of the light.

Interference in thin films

consider a transparent thin film of uniform thickness t and it's refractive index μ bounded by two plane surface K and K as shown in figure

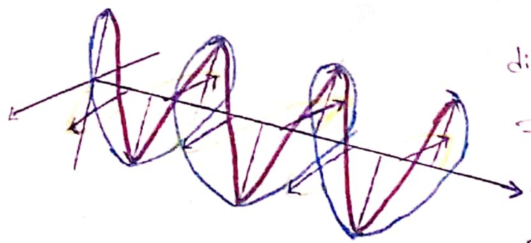
A ray of monochromatic light AB incident on the surface K of the film is partly reflected along BC and partly refracted into the film along BD. At the point D on the surface K the ray of light is partly reflected along DE and partly transmitted out of the film along DG. the ray EH after refraction at H, finally emerges along HJ.

NAME :- G. Eswaran
H.No :- 212201053023

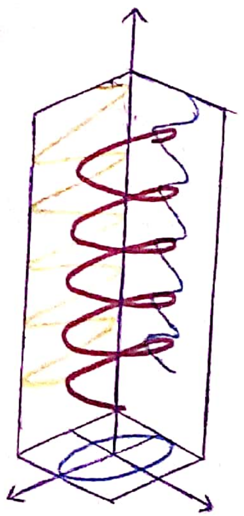
CIRCULARLY & ELLIPTICALLY POLARIZED LIGHT

Circularly polarized light:- In circularly polarized light, the electric vector of light is made of two linear components perpendicular to each other, having equal amplitudes but with a phase difference of $\pi/2$. In

Elliptically polarized light:- Elliptically polarized light consist of two light waves that are linearly polarized, but unlike circularly polarized light, they have unequal amplitudes but the same frequency. This results in a light wave with electric vectors that both rotates and changes its magnitude.



If light is composed of two plane waves of equal amplitude by differing in phase by 90°. then the light is said to be circularly polarized. If two plane waves of differing amplitude are related in phase by 90° or if the relative phase is other than 90° then the light is said to be elliptically polarized



In circular polarisation, there are two linear planes in the light's electric field that are strictly perpendicular to each other. In elliptical polarisation, the light's electric field is at an elliptical propagation.

Expression for elliptical polarized light:- $E_x = E_{0x}\exp(i(kz-\omega t))$, $E_y = E_{0y}\exp(i(kz-\omega t+\phi))$

Expression for circularly polarized light: $E_{0x} = E_{0y}$, $\phi = \frac{n\pi}{2}$, $n = 1, 3, 5 \ldots$

NAME:- M. YOGESWARARAO

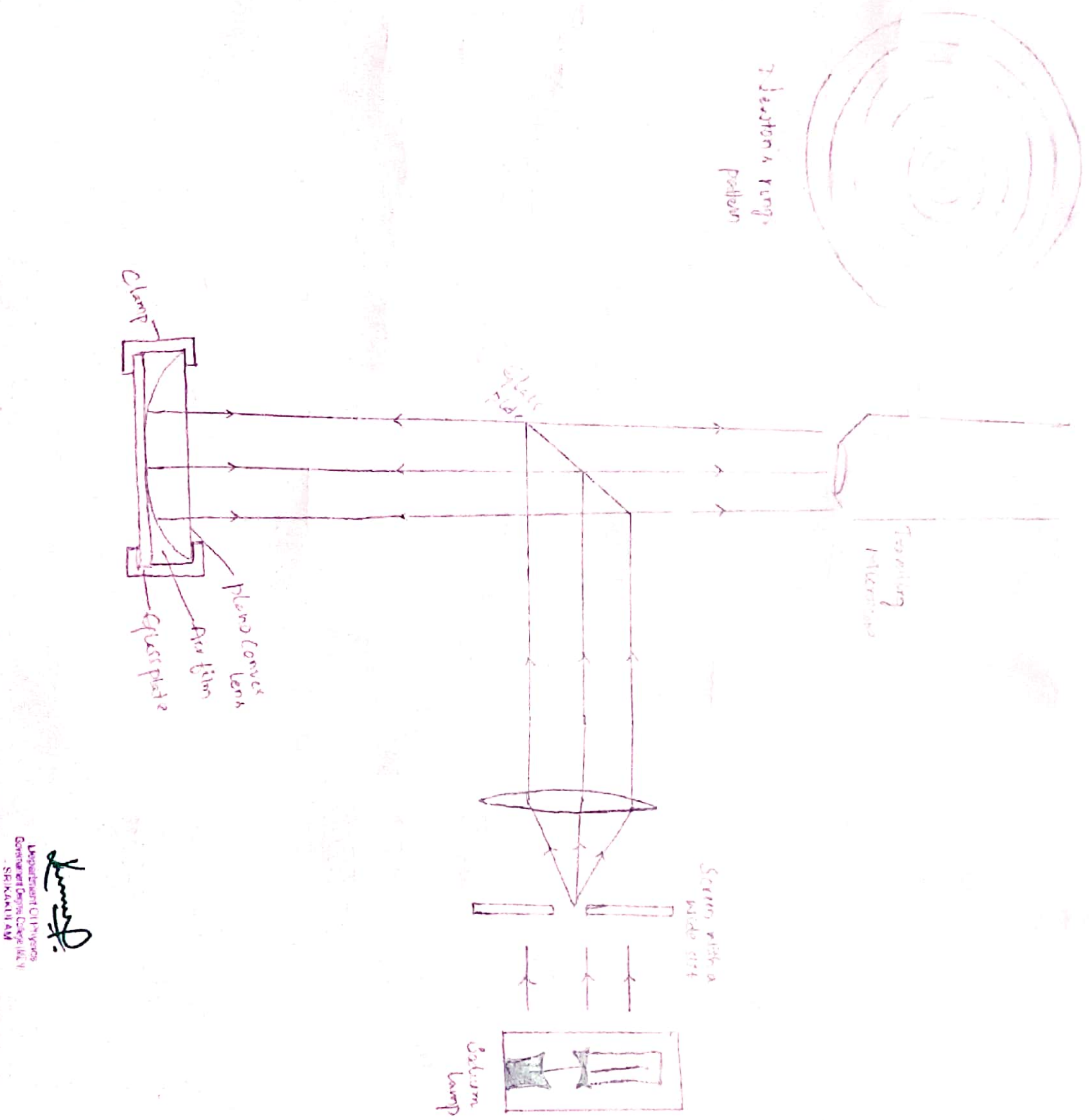
GROUP:- BSc (MPE)

HTNO :- 21220010 53077

YEAR :- III[rd] year

G. Praveen
HTNo: 2112010153024
Roll No: 24
Group: B.Sc [MPC]

NEWTON'S RINGS



The apparatus for Newton's ring and the aim of the experiment are to study the formation of Newton's rings in the air film in between a lens which is a plano-convex and glass plate by using a nearly mono chromatic light from a sodium - source and here it is to determine the radius of curvature of the plano - convex. The optical set up consists of a convex lens usually with a very large radius of curvature placed on a flat glass. the glass and lens only touch the centre. the gap between the lens and glass gradually increases towards the end and is filled with any fluid or air film.

The interference technique of Newton's Rings is widely used for the quality control of optical surfaces because the precision obtained with this method proves to be very satisfactory.

CLASSIFICATION OF REFRIGERATOR :-

Refrigerator :- A refrigerator is a commercial home appliance consisting of a thermally insulated compartment and heat pump (mechanical, electronic or chemical) that transfers heat from its inside to its external environment so that its inside is cooled to a temperature below the room temperature.

=> In simple language, A refrigerator is a machine used for keeping things cold. People put items, to keep items cold or good (unspoiled) for a longer time.

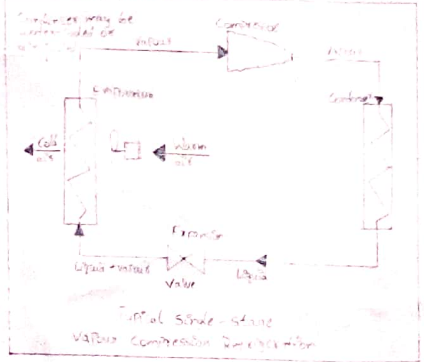
Classification :- Refrigerators can be classified in various ways based on different criteria such as size, configuration, features, energy efficiency and cooling technology. Here's a detailed breakdown:

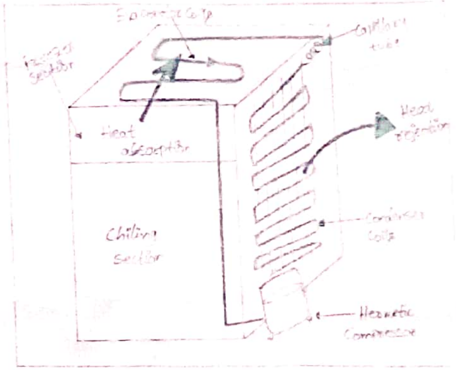
1. Features :

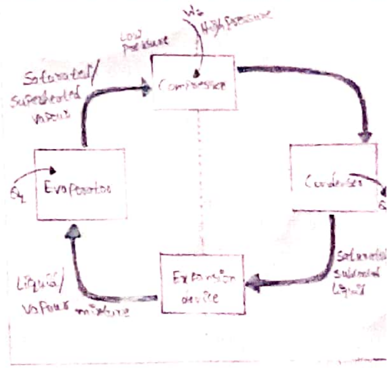
- Ice Makers : Automatic ice makers that produce ice cubes, crushed ice, or ice nuggets.
- Water Dispensers : Dispense filtered water and sometimes ice through the door
- Smart Refrigerators : Equipped with features like Wi-Fi connectivity, touchscreens, and compatibility with smart home systems for remote monitoring and control
- Adjustable Shelves and Bins : Allow for flexible storage arrangements to accommodate varying item sizes
- Temperature - Controlled Draws : Provide separate temperature settings for storing specific items like produce, meats, or beverages
- Convertible Refrigerators : offer flexibility by allowing users to switch btw fridge and freezer compartments depending on their needs
- Energy Efficiency : Refrigerators with Energy Star Certification are more energy-efficient, saving on electricity costs over time.

2. Cooling Technology :

- Compression Refrigeration : Most common cooling method, using a compressor to circulate refrigerant through coils to cool the interior
- Absorption Refrigeration : Utilizes heat energy, often from a gas flame, to drive the cooling process, commonly found in RV refrigerators and some specialty models
- Thermoelectric Refrigeration : Relies on the peltier effect to create a temperature difference, often used in small, portable refrigerators.







3. Size and Configuration

- Compact/Mini Fridges : Typically small in size, suitable for dorm rooms, offices, or as a secondary fridge
- Top - Freezer Refrigerators : Have the freezer compartment on the top and the refrigerator compartment below.
- Bottom - Freezer Refrigerators : Feature the freezer at the bottom and the refrigerator on top for easier access
- Side - by - Side Refrigerators : Divide the fridge and freezer compartments vertically, with each occupying one side of the appliance
- French Door Refrigerators : Similar to side-by-side refrigerators, but with two doors for the refrigerator compartment and a freezer drawer below
- Built-in Refrigerators : Designed to be installed flush with cabinetry, offering a seamless look and typically customizable panels.

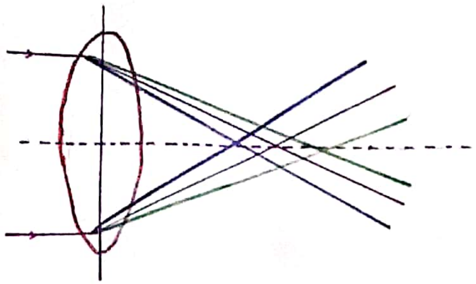
4. Specialized Refrigerators :

- Wine Refrigerators : Designed to store wine bottles at optimal temperatures and humidity levels to preserve flavor
- Commercial Refrigerators : Heavy-duty refrigeration units designed for use in commercial settings such as restaurants, supermarkets and laboratories
- Medical / Pharmaceutical Refrigerators : Specifically designed to store vaccines, medications, or biological samples at precise temperatures to maintain efficiency and safety.

=> When selecting a refrigerator, consider factors such as available space, storage needs, energy efficiency, and budget to choose the most suitable option to your requirements.

* CHROMATIC ABERRATION *

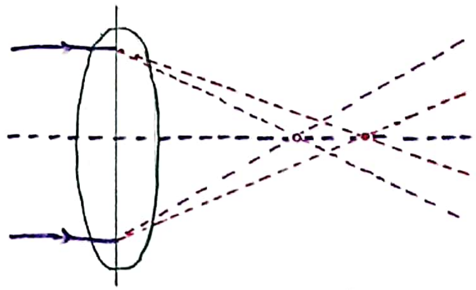
* In optics, chromatic aberration, also called chromatic distortion and spherochromatism, is a failure of a lens to focus all colours to the same point. It is caused by dispersion



Chromatic aberration.

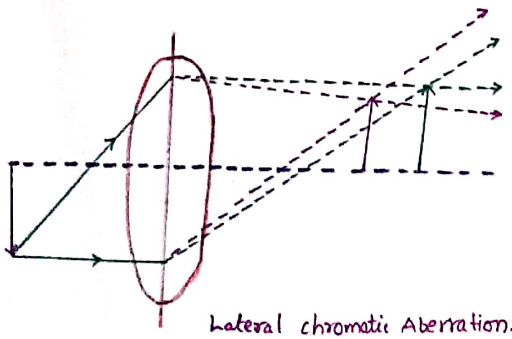
* The refractive index of the lens elements varies with the wavelength of light
* The refractive index of most transparent materials decreases with increasing wave length.
* Since the focal length of a lens depends on the refractive index, this variation in refractive manifests itself as 'fringes' of colour along boundaries that separate dark and bright parts of the image.

* There are two types of chromatic aberrations
  1. Axial (longitudial) chromatic aberration
  2. Lateral (transverse) chromatic aberration



Axial chromatic aberration.

* Axial aberration occurs when different distances from the wavelengths of lights are focused at different distances from the lens.
* Longitudinal aberration is typical at long focal lengths. Transverse aberration occurs when different wavelengths are focused at different positions in the focal plane, because
* magnification and distortion of the lens also varies with wavelengths.
* Transverse aberration is typical at short focal lengths.



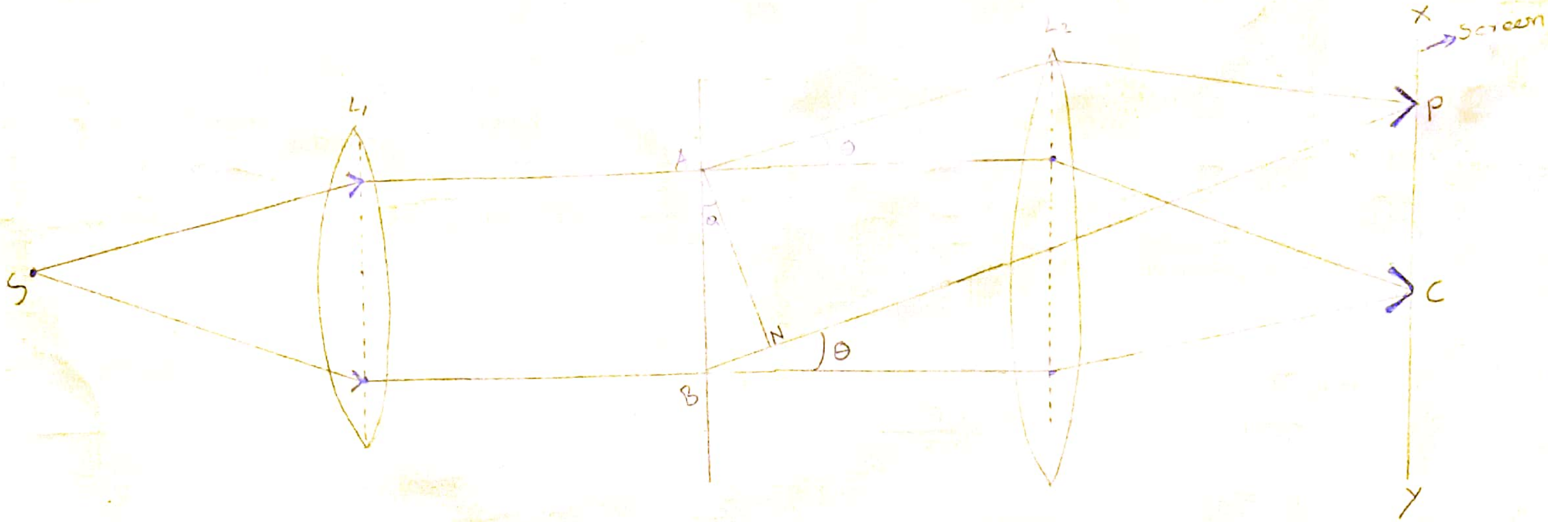
Lateral chromatic Aberration.

* The ambigous acronym LCA is sometimes used for either longitudinal or lateral chromatic abberation
* The two types of chromatic aberration have different characteristics and may occur together
* Axial CA occur throughout the image and is specified by optical engineers, optometrists, and vision scientists in diopters. It can be reduced by stopping down, which increase depth of field
* Transverse CA does not occur in the center of the image and increases towards the edge. It is not effected by stopping down.
* The chromatic aberration may also be measured by using the phenomenon of crystal diffraction.

Department Of Physics

Presented by,
N.SRINIVASARAO
BSC MPE

Fraunhofer diffraction due to a single slit



→ In Fraunhofer diffraction the source and the screen are a infinite distance from the obstacle and the wave front is plane.

→ Let a parallel beam of monochromatic light of wavelength be incident normally upon a narrow slit AB of width 'e' where it gets diffraction in above fig.

→ When light travels in air, it encounters various phenomena like interference, refraction reflection and diffraction.

→ When the light comes in contact with an obstacle, diffraction of light takes place.

→ We can observe single slit diffraction when light passes through a single slit whose width is on the order of the wavelength of the light.

→ The diffraction pattern on the screen will be at a distance $L >> w$ away from the slit. The intensity is a function of angle.

Department Of Physics
Government Degree College (MEN)
SRIKAKULAM

Kikkara Madhu
21220010530 28
BSc (MPE)