Experimental Physics - II
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Lecture - 50
Expt. For brewester

In last class we have demonstrated Malus law, means if unpolarized light is polarized using the polarizer, now if you use another polarizer and the analyzer and rotate that polarizer analyzer with respect to that polarizer. polarizer, analyzer both are same just the name is different because of the use. they have optic axis.

this electric field that vibration it is fast among the optic axis, ok s so it gives the plane polarized light. it has electric field component, it is vibrating in a particular direction. Now if you have if you use another polarizer as a analyzer. keeping the optic axis parallel to the optic axis of polarizer so; that means, this light; this polarized light this electric component it will pass through it

we will get the intensity of the light that is square of the altitude. that is if it is e 0; e 0 square will be the intensity of light. that intensity of light we detected using the detectors auto detector, now, when we rotate the analyzer it will make angle of this optic axis of the analyzer will make angle with the optic axis of the polarizer. it is theta so then component e 0 cos theta that is the component will pass through the analyzer,

it is an intensity will be e 0 square cos square theta e 0 square is i 0. intensity i will be equal to the i 0 cos square theta. that experiment this is the Malus law and that we have verified in last class we have demonstrated the experiment. when you are using polarizer, analyzer we are telling that we are getting polarized light.

Now what is the mechanizing for polarization of light, how we can produce polarized light? Ok that is what I will discuss today, and we will demonstrate one experiment that is Brewster's law. let me tell about the about the theory of that experiment and then we will demonstrate the experiment.

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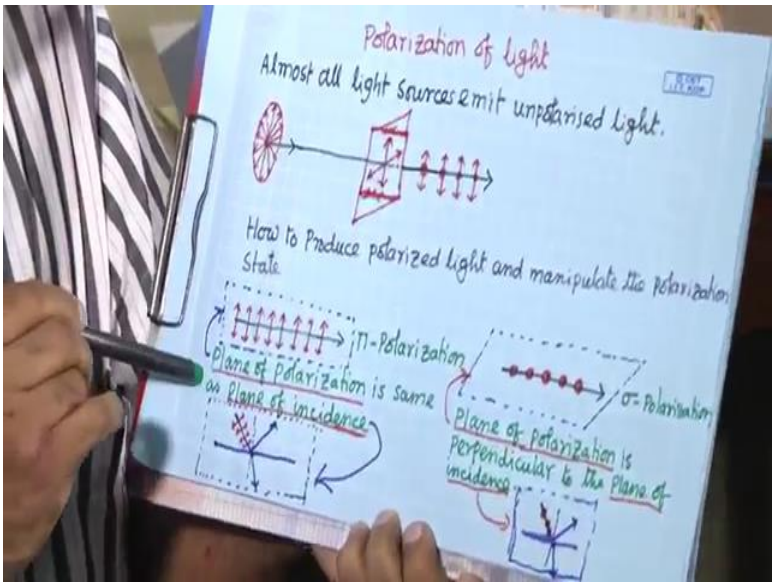

polarization of light, so either polarizer or analyzer it works on some principle ok, to polarize the light. here that is what in general I am discussing how we can polarize the light or how polarizer polarize the light, what is there what we will use as a polarizer? almost all sources emit unpolarized light, unpolarized light we it is the electric component in it is vibrate in all directions.

we have spaced this with two mutually perpendicular component, that is this plane is perpendicular to the direction of the light, and that also we will represent like this. one component is this, another component is this perpendicular to the paper. So how to produce polarized light and how to manipulate the polarization state? Ok, polarization state this light is this is this the propagation direction.

if this is the direction of the electric component then tell it is a polarized light and this type of polarized light when plane of polarization. Plane of polarization means this the plane contain the electric component direction of the electric component and the direction of the light propagation. they are on this plane.

this is the plane of this we tell the plane of polarization if plane of polarization this plane is same as the plane of incidence, light is falling and then it is a refracted or reflected normal is there so that the plane of incidence, If plane of incidence and plane of polarization is same then we tell there is a pi polarization, that we tell the pi polarization. If plane of polarization is perpendicular to the plane of incidence,

in this case if this is the plane of incidence, ok and then plane of polarization actually this it is contain the direction of the electric field as well as the direction of the propagation of light. they are on this plane; they are on this plane if this is the plane of incident, then plane of polarization is this ok; if they are perpendicular to each other then we tell there is the sigma polarization, this plane of the paper if we considered is the plane of incidence, then pi polarization we represent like this and sigma polarization we represent like this,

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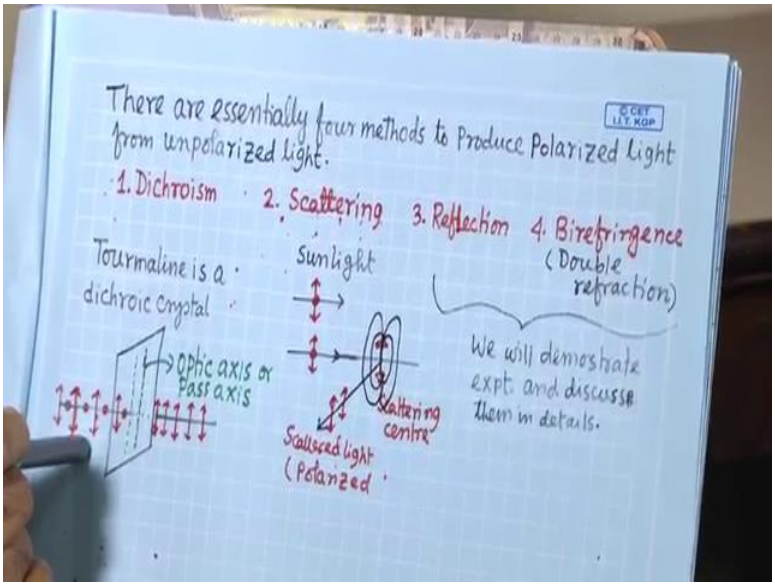

now, there are essentially four methods to produce polarized light from unpolarized, light. dichroism, scattering, reflection and birefringence or birefringence people tell different way, or it is called also double refraction this there are four methods, tourmaline is a dichroic crystal these are natural crystal is call tourmaline,

this crystal actually it can this crystal have optic axis or pass axis. means it depends on the which axis which direction will be optic axis or pass axis that depends on the structure of this; of the crystal one direction is the optic success or pass axis means the electric field; electric field parallel to this electric field the component parallel to the optic axis will pass through.

And electric field perpendicular to the optic axis that will be obstacle will not be pass through, if this is the optic axis for this tourmaline crystal. unpolarized light is falling on this then we will get only this electric component other one this will be discarded. other

side of this is done we will get polarized light; this is one way this called dichroic crystal. it is a natural crystal and one has to cut the crystal in proper way identifying the optic axis and one can use as a for polarizing the light.

this as a; this mechanism is called the dichroism ok; that mean this sheets actually one can used as a polarizer or analyzer, another method is scattering sunlight is coming there are a lot of dust particles of molecules in here, this sunlight scattered hole on the air particle ok, and then that your particle your molecule that acts as a scattering centre.

any particle any molecule they have electrons. there is a there will be dipole oscillation if this is the direction of dipole oscillation along this there is no radiation; along these there is no radiation. radiation is maximum perpendicular to this direction, when this unpolarized light is falling so actually one component so because of the directional oscillation of the dipole of air molecule,

one of the component will be scattered and other of the component will not be scattered, what would be the scattered light will get then it will be polarized; it may partially polarized but after scattering with many particles. finally, one can get the polarize light scattering also another reason to polarize the light, third is reflection and fourth is birefringence or double crystal double refraction,

these two are very important method generally most of the device based on this polarize device based on this two method, we will demonstrate experiment and discuss them in detail, when we will plan to demonstrate experiment based on them and for that we will we will discuss about it. these are general discussion I made.

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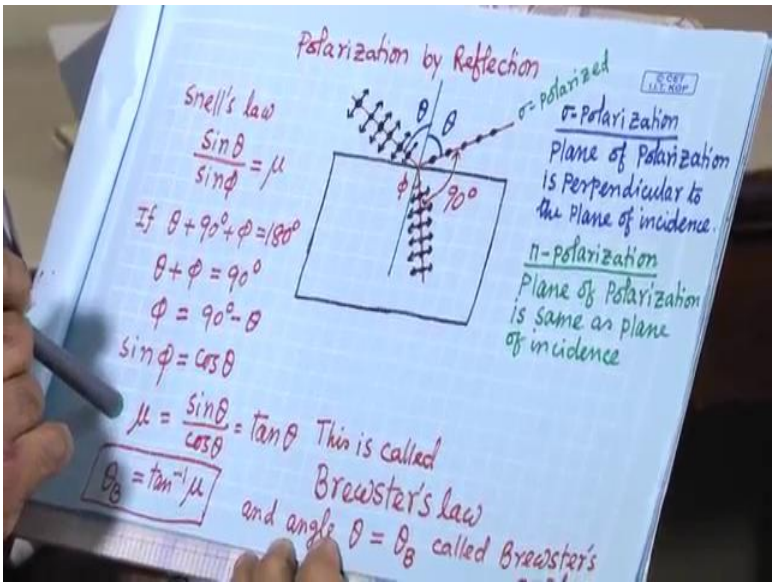

Now, let us; let us see this polarization by the reflection and we will do one experiment based on this. polarization by reflection this is a glass slab, unpolarized light is falling on it this is the normal. Now, one part is reflected another part is refracted; if you change the incidence angle, if you change the incidence angle actually both reflected light and refracted light both are unpolarized light.

If you change the incident angle and for a particular incident angle; for a particular incident angle this reflected light it becomes polarized. Is reflected light becomes polarized although this refracted one is unpolarized or partially polarized. this and this, this is sigma polarize light we get, when we get? We get for a particular incident angle. that incident angle is called Brewster's angle,

he discovered this method; he found this method and he also found that this at Brewster's angle incident angle we will get reflected polarized reflected light. And at that condition at that position the angle between the reflected light and refracted line is 90 degree,

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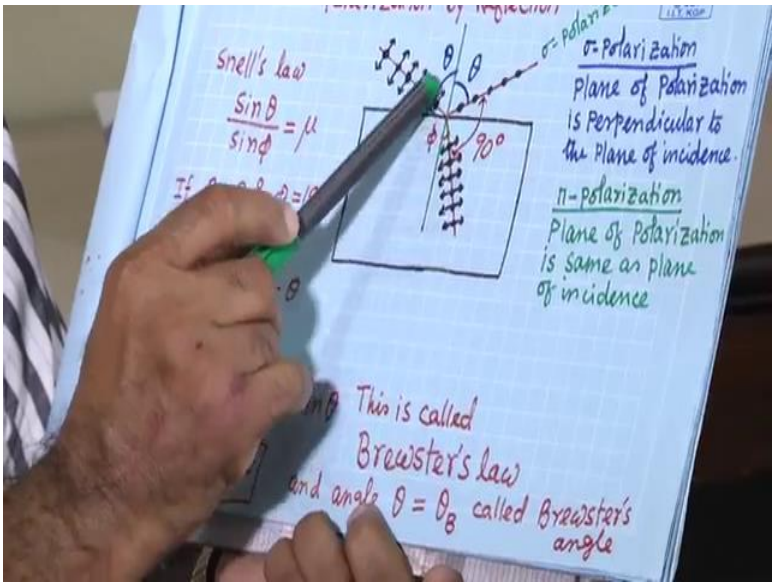

from Snell's law actually sin theta by sin phi this is the refracted angle equal to mu refractive index of this glass, Now, in this condition; under this condition at Brewster's angle we can write this theta plus 90 degree plus phi equal to 180 degree; equal to 180 degree theta plus phi theta plus phi is 90 degree phi equal to 90 degree minus theta. sin phi equal to cos theta, here sin phi we can replace with the cos phi cos theta. mean equal to sin theta by cos theta equal to tan theta.

this angle theta we tell this Brewster's angle; this angle theta B equal to tan inverse, if you know the refractive index of this glass. We can find out the Brewster's angle or if you can measure the Brewster's angle; if you can measure the Brewster's single you can find out the refractive index of this glass, this experiment we will demonstrate this experiment in the lab.

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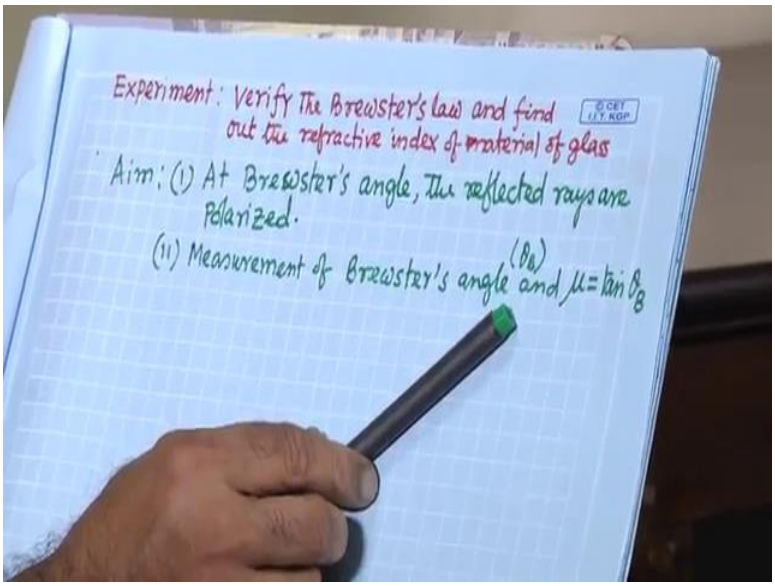

experiment is the verify the Brewster's law; what is Brewster's law? At a particular angle, at a particular incident angle the reflected light will be polarized, ok and find out the refractive index of the material of glass. In that condition if we can measure the Brewster's angle then we will be able to find out the refractive index of the material of glass,

aim of the experiment is at Brewster's angle the reflected ways are polarized that we have to show how to show that I will discuss measurement of booster angle and calculate the mean equal to tan theta B, this is the experiment we will perform in the lab.

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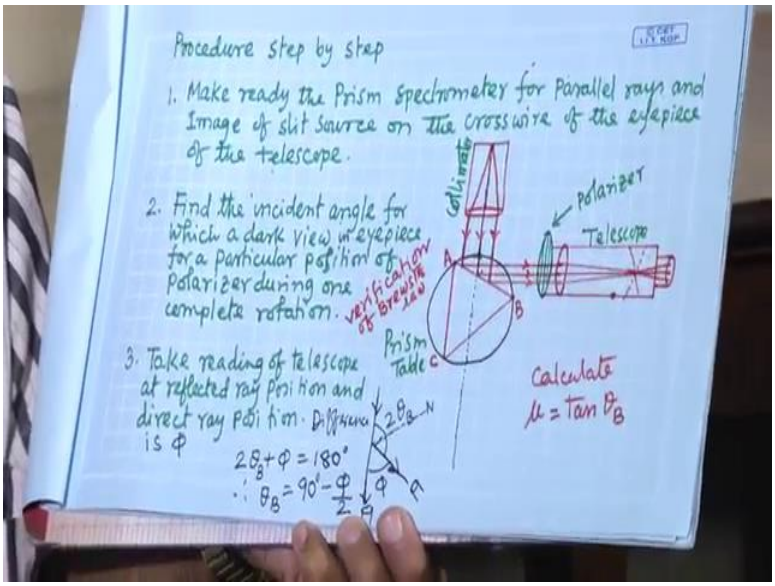

let us how to do this experiment let us follow the procedure step by step. we will use Prism table and will you Prism or glass lab one also can use glass lab, but we will use Prism on surface refracting surface of the Prism we will use because we look at the reflected light; we look at the reflected light. first, we have to make ready the Prism spectrometer for parallel ways and image of slit source on the crosswire of the eyepiece of the telescope.

you know we have demonstrated many experiments using the spectrometer. initially we have to make ready the spectrometer; labeling the spectrometer. Then using the split level then we will use the optical leveling, then we will use the Schuster's method for getting the parallel rays and focusing the eye piece to the crosswire,

when the spectrometer is ready for doing experiment then we will then find the incident angle for which a dark view eye piece for a particular position of polarizer light one complete. what we will do? on Prism table will put this Prism. this refracting surface; reflecting surface we will use, from collimator parallel rays will follow on it and then this is the reflected ok, we will put the telescope here,

Now, which one is incident angle? this is a ray and if you this is the perpendicular to this phase this will be incident angle. Now if I rotate the prism, I can change the incident angle. initially I will if this is the normal. initially I will rotate the Prism to keep this

angle is almost 0, Now I will increase the angle; I will increase the angle; I will increase the angle. almost 0 means my telescope will be here.

now, you know this if I rotate the mirror by angle theta. I have to rotate this telescope to see the reflected 1 by 2 theta. So; that means, this whatever incident angle remain change incident angle remain changed that to get the polarized light in telescope. you have to rotate the telescope by 2 theta again,

actually, for each incident angle we will catch the reflected one; we will catch the reflected one and then that reflected one is whether it is polarized or not for to check that one, what we have to do? We have to we will use one analyzer or polarizer in front of this telescope. Now we will; we will rotate this polarizers with a complete one rotation.

if you see that intensity are not changing so; that means, this is the unpolarized; if intensity is changing with rotational the polarizer, we can say that is the partially polarized. when it will be, we will change the incident angle and we will change the, we will catch the refracted rays and we will continue this procedure this for a complete rotation of the polarizer what we have to get, if it is completely polarized.

one position of the polarizer will get this there will be no light passing through this telescope. this view will be dark. So; that means, this polarizer has optic axis when it is completely polarized, when optic axis is perpendicular to the direction of the electric component then there will not be any electric component means light, we will pass through it,

we have to change the incident angle and for each incident angle, we have to catch the reflected rays in the telescope and for each reflected rays we have to do this one complete rotation of the polarizer. And you have to see whether we have seen the that field of view is dark whether getting during the rotation whether we are getting one complete for a particular position we are getting complete dark field of view, When we will get complete dark of view; that means, this reflected light is completely polarized.

And now we have to measure the; now we have to measure then at that position we will take the reading of the telescope. Now we will take out this Prism and then we will take the reading of the direct light, we will note down that one. this will be so then what is happening.

this sitting and this sitting we are taking this is the angle, we are measuring we are getting from the reading of the telescope. Now here this is the incident at the diffracted so; that means, this normal is here; normal is here so; that means, this angle if it is incident angle then this will be reflected. these two total angle is 2 theta or 2 theta B we can say 2 theta B.

2 theta B plus this angle phi whatever we are measured. that will be 180 degree. then theta B is 90 degree minus phi by 2, experimentally we are measuring phi; we are measuring phi see if you put phi here, we will get theta B. Now, when we will get theta B, we can calculate the B,

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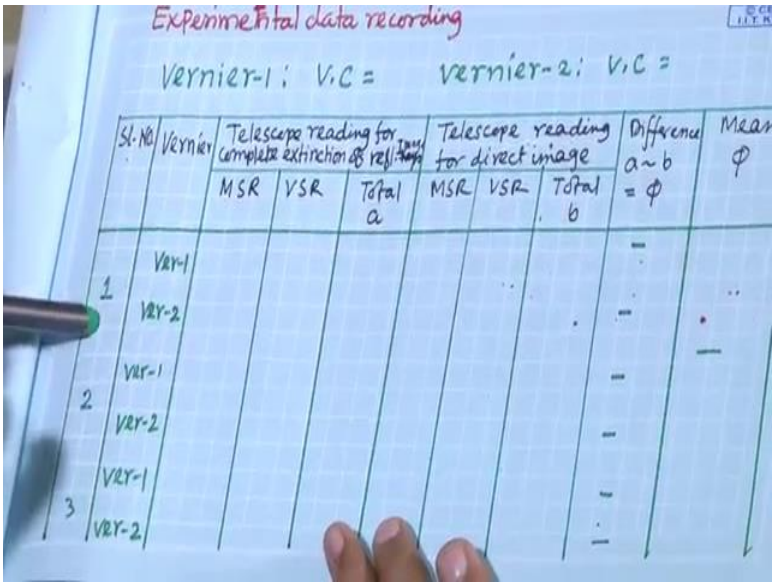

for that we will use table; we will use table find; we have to find out Vernier constant to Vernier's are there in spectrometer you know. Vernier 1 and Vernier 2; we have to note down generally both are having the same vernier constant note down the vernier constant. Then your serial number means number of observation 1, 2, 3,

So; that means, for each incident angle you are checking, telescope reading for complete extinction of reflection. we will do this process we will do this process for each change of incident angle, we will catch the reflected one. And we will rotate the polarizer and if it is not completely dark means complete extinction of the reflected light. that reading you are not noting down.

when we will get complete extinction of reflected light that reading, we will note down for Vernier 1 and Vernier 2, similarly two more observation we will do repeat the experiment you know this we take more data more observation it will be more accurate. for each then for each time we will take one set data and then we will remove the Prism and then we will take direct reading; we will take direct reading and then again, we will put Prism take the second data.

that way thetas if we take then that will be really sometimes people what they do that first this theta is they are taking this one and then next theta is they are taking this one. that is not the good way to do any way. then we find out the difference of a and b. that will be phi, so mean phi you can find out. theta b can find out. that is what the experiment verification of Brewster's law and find out the refractive index of the material of the Prism or the glass slab. this that is what one has to do. And I think in next class I will demonstrate the experiment in our lab.

Thank you for your attention.