Experimental Physics - II
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Lecture - 39
Michelson Interferometer (Experiment)

we will demonstrate now the Michelson Interferometer Experiment.

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this is the experimental setup it is looks very simply but is very sensitive experiment. If I task the table then it is it will get disturbed. in this setup as I showed you in theory class that there is a source laser source we will use.

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light is coming from this laser source generally it is a it is very the source is it is almost point source it is laser almost parallel to make it extended because for this experiment we need extended source, this is the convex lens the convex lens we put here. it is distance is almost 35 centimetre, although these yeah focal length is 20 centimetre focal length is 20 centimetre if we put that 20 so you will get you will get a point

either so we have to keep because otherwise real source real if it is less than half then you will not get a real image. to get the real image so we will we have kept this distance greater than focal length then after focusing it will again diverge, so we will get extended source this as if here it is a working as the extended source. Now this light from this extended source where it will fall, it will fall on the beam splitters or we are telling these half silver glass pipe. this is the half silver glass plate it is set that 45 degree it is set at 45 degree with this incident laser light

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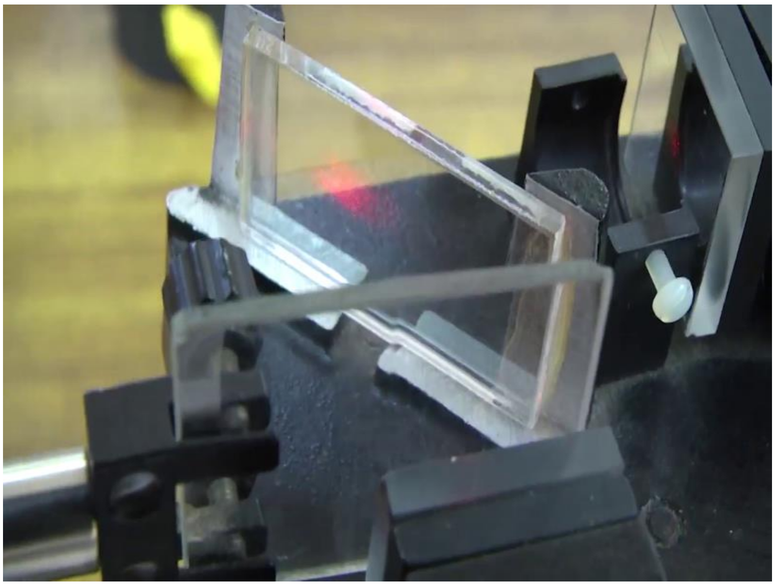

if it is 45 so one will be reflected along this direction at 90 degree and another one will transmit that is what I showed in figure.

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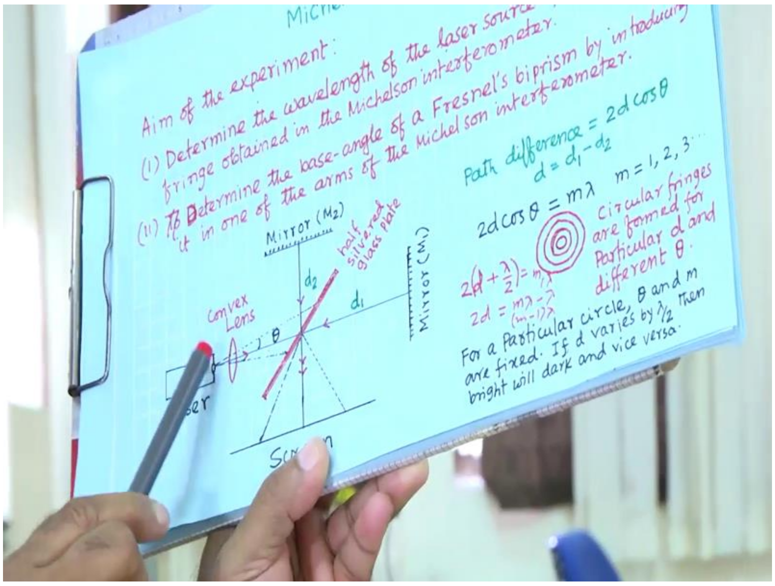

One will just transmit and go towards the mirror M1 and another will reflect and go towards the mirror 2. here which one is mirror 1 and mirror 2, which one is mirror 1 and mirror 2.

so, this is a reflected is the reflected from the surface here. this is we are telling mirror 2 and this is light is going directly here this is a mirror this is mirror 1 where light is going directly. that is the mirror 1 and this one is mirror 2 and this is the beam splitter or glass plate where this reflection is occurring as well as transmission is occurring

So now, now these again after coming to mirror 2 it will reflect back and go this in this direction and from mirror 1 so it is reflected from mirror 1 and come and then it is a reflected from this glass plate and go this way. these two reflect reflected or whatever this two ray is coming from the mirror 1 and mirror 2. they will interfere and will get interference pattern on the screen. here we have put this white screen here we have put the white screen and on white screen you can see the fringe concentric circle fringe

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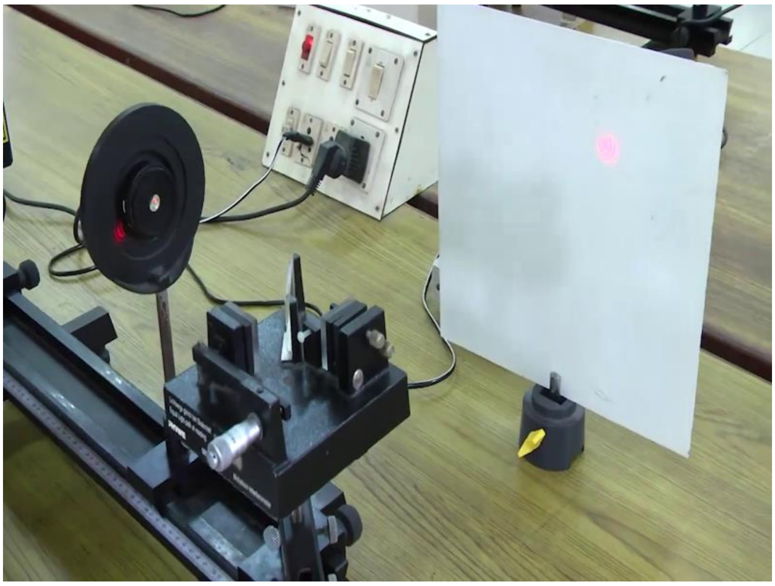

the centre one is b one and it is it can be b it can be dark it can be b it can be dark as I told this order of the centre one is the maximum is the maximum. Now if I change the distance of the one of the mirror by the and then we will see when I am changing the distance of mirror there will be appearing or collapsing of the fringe at the centre or from the centre that we have to count.

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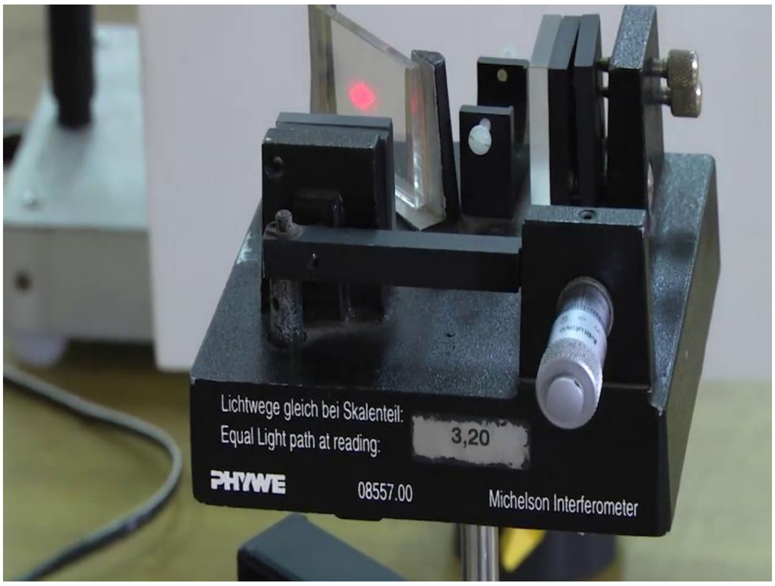

this is the micrometre this is the micrometre is like it is like screw gauge this micrometres so initial reading we have to take initial reading is here, I can see this is a initial reading this circular scale that linear scale reading, I can see these 6 6 5.5 it is a 5.5 millimetre and this circular scale reading is it is a almost is 0; almost it is 0 least count we have to find out.

if I so there are 50 division see if I rotate twice, so it shifted in linear is shifted by 1 millimetre. least count of this micrometre is 0.01 millimetre or 0.001 centimetre that since you have to note down that since you have to note down you know yes.

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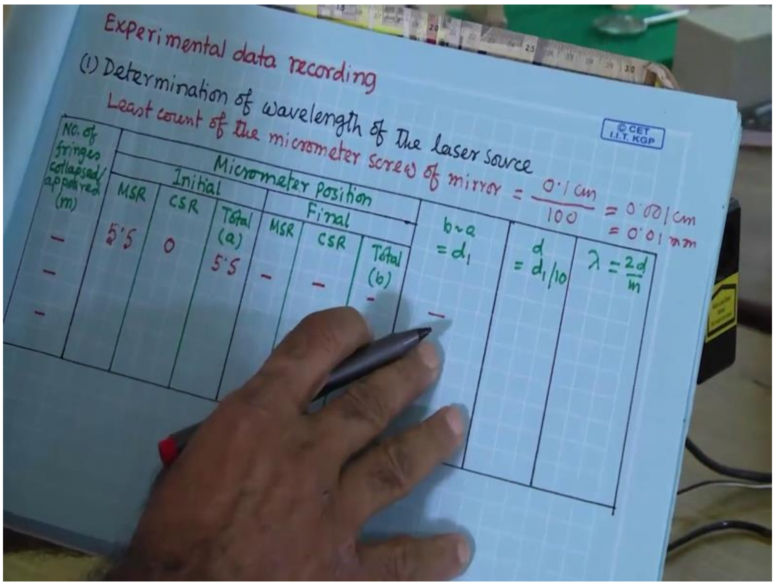

least count from the micrometre on linear in linear scale that is 0.1 centimetre for movement of the rotation of the it is hundred division twice least count will be 0.001 centimetres that you have to note down Now I will note down this main scale reading what I told that is 5.5, so better I will write this 0.01 millimetre this I can write in millimetre main scale reading it is the millimetre, so circular scale it is a 0 total 5.5 that the initial now I will I will change the distance of the mirror and take the final reading.

when I will change so what I will see, I will see this either appearing or collapsing the fringes at the centre. it depends on both way I will show you. So now, if I rotate in this direction what you will see. I have done first. it is a collapsing and appearing like this ok, so I am changing it is one earlier one was there so 2, 3 it is done more 4, 5, 6. going out is it is a appearing ok, so 7, 8, 9, 10 I think we generally take 20.

I am changing and I have to count that one I have to count that one, so I am not counting but one has to count one has to count ok, so then it is a 20 Now I have to take reading so whatever the reading from here you can take, but I am not taking because I have not counted properly their reading you have to note down that reading you have to note down in this. your final reading you should note down so this

this whatever the difference of these two you will get you will get difference of this you will get and here as I told these reading actually it is this shifting of the surface of the lever action, here you can see I am changing here. lever action due to this lever action. it is shifting so this one is to 10 ok, so if this change by 10; it is a shifting by 1.

that is a whatever reading will get so divided by 10, so that will be the change of the distance of the mirror, so we will you will get the d. when you will get the d and m we have counted m we have conquered say 20 or 25, so you can calculate lambda So you do this experiment 2, 3, 4 times ok, I will rotate it the other way then you will have fillings there that it is collapsing you know, I rotate it is now you see earlier it was appearing now collapsing Means collapsing means the order of the centre fringing increasing is increasing, that means I am increasing the distance I am increasing the distance between 2 mirror, so you see so collapsing

if I start from here collapsing 1 collapsing, 2 collapsing, 3 collapsing 4 collapsing, 5 collapsing, 6 collapsing, 7 collapsing, 8 ok, so initial reading and then you have to take final reading. you will get the get the d value as well as m value and calculate lambda. Now these so I have not shown you how to how to adjust it is very sensitive.

before starting this recording, we have set it and very sensitive you know. if I change, you see angle of the glass plate, then you see this how sensitive it is it is changing just see changing I am changing rotating no. I am rotating you see I am rotating, because slowly I have to do otherwise I cannot come back again yes; yes, you see it will be changing because of change of angle so we try to keep it when it is very distinct, so that we take as a we take as a 45 angle is 45 angle is 45.

this is very sensitive with a change of the angle of the yeah. angle of the glass flips ok, so I am getting you see 0 is shifted that side. we are trying to adjust 45 when we will get the symmetrically this one ok, so this the position we keep this approximate 45 degree. Now this exchange of the is the tilting of the you see these two mirror has to be completely it is a vertical ok, if I change the tilt of the Mirror 1 mirror so here there are option.

you see this how sensitive it is I am just changing the tilting you know so it is tilting it is it is going 0 zeroth this central order is going out you see I now I lost I lost centre again appear again appear, so very slowly I have to change yeah I got back other one is there so if I rotate this one also same ways is you see it is the. this one is changing this way other one is changing this way the tilt angle, so it done

I have to come back so other way it has then other way yeah, I have to come back see it is a so sensitive yes, this way you have to adjust the tilting we have to adjust the tilting of this mirror. when we will get it is not it is not very perfect fringe, we have got that is because it is the adjustment is not so fine here. it is really difficult to really difficult to get more change only we are getting few still it is not yes, it is shifted you know

so these are tilting and then we are changing the distance effect you are seeing effect you are seeing setting this experiment is handling this experiment is quite it is not difficult, but one need skill to do that and do the measurement just taking reading is very easy So now, what so what we will do, so here you are seeing this here you are seeing that this is one mirror and this is another mirror .

this light is falling here so this is one arm, and this is another arm if I put biprism in this arm if I put biprism in this arm. here this optical path will be introduced in this arm, but this arm will remain same So now, I will put biprism in one of this arm in this arm, so let me put and then start again for biprism will just do the experiment let me just first put the biprism So now, now I have inserted the biprism in one arm of the Michelson interferometer. this is the biprism I can show you I have another piece.

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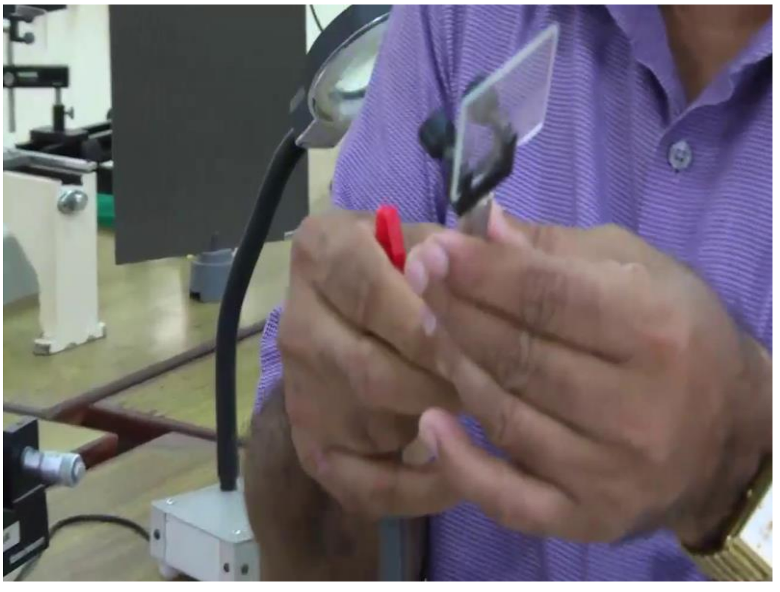

these we have inserted this you can see this in middle so there is a line. that is the age of this biprism these biprism we have inserted we have inserted in one of them, so this is one mirror this is another mirror so light is coming from this glass plate so in this direction in this arm I have put this biprism and these biprism is on a translational stage, this translational stage it has linear scale as well as Vernier scale.

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Vernier scale have these 50 division and linear scale it has smallest division is 0.5 millimetre, so you have to note down the least count you have to note down the least count for so these the table.

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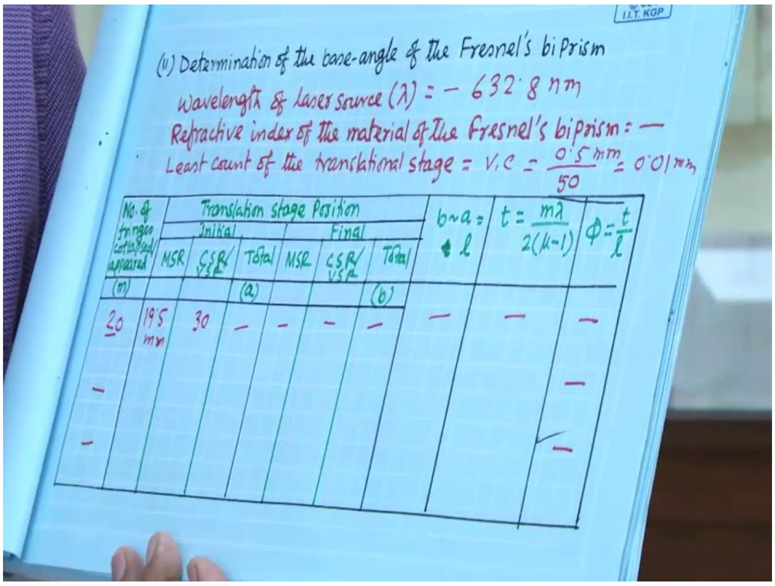

Determination of the base angle of the of the biprism. wavelength of the laser here this whatever in earlier experiment we have found that you can take our standard value of this laser. I think exactly I do not know this what is the, so it is a written here 632.8 nanometres 632.8 nanometre refractive index of this material, so from manual one has to note down which the meta refractive index of the material.

Now least count it is the I found that or this in this case better it is the Vernier constant least count is the Vernier constant, it is a 0.5 divided by this is the millimetre smallest deviation of the linear scale divide by total Vernier division is 50, so this is 0.01millimetre or 0.001 centimetre So now so earlier what we have done so we have changed the distance d between the mirror one mirror we are translating in this case we will change will translate the biprism in and out in one arm. and then we will count the number of fringes collapse or appeared

that reading we have to take, so here so here this is the as I told this least count of this one this, I think this we can show the scale. these the Vernier scale these is the Vernier scale, and this is the linear scale, so 50 divisions on Vernier and here the smallest division is 0.5 millimetre. Now you see if I rotate this one, so before so this is the now you see at this position this is the fringe this is the fringe.

there is the order of the of the centre fringe we do not know what the order is say it is M1 Now I am changing the tank I am just translating the just translating these biprism either in or out that means, the light will pass through the different thickness. this reading I have to I am not noting down, so this reading I have to note down it is a approximately 1.95 centimetre and Vernier one has to find out.

But anyway, Vernier is about 30 ok, so this you should note down this initial position of the translational stage what I told 1.595 1.95 or 19.5 millimetre 19.5 millimetres ok, circular is Vernier that is 30 into Vernier constant 0.01 so total you write. Now I will come the number of fringe collapse or appeared when I am translating and after that final position, I have to take reading ok, so for that let us move.

you see now you see this fringe ok, now I am moving you see if I go this way, so I have to count ha. it is one has to be very careful it is I could not do properly yes, I can do now Anyway now again I if I start from here, I have to take reading ok, so earlier whatever reading I have noted down so that disturbed. at present again I have to take so I am not noting down so just example I gave you. Now I have to I have to very carefully rotate. this one collapsing you see 2, 3, 4, 5, 6 it is the order is increasing of the central fringe So now, it is M plus 6 kind M1 plus 6, so M1 that if it is M2 say M1 minus M2 will be 6 So for this translational motion if we take this final reading, so for 6 this number of orders collapsing that is 6 for that reading you will get but this reading will be very small, so we take more we take more we take more just do it and count do it and count do it and count and say after 20 you take reading.

this reading difference of these two reading will give you l value l value and here there is no factor because this is the normal translational stage says so far twenty it is a collapsing. for that after that what is the reading one has to take and then this one. you will get this minus this you will get l you will get t then you will get phi now you go do more 3, 4 experiment

others other way I will I will rotate other way then you see this appearing still collapsing I am going in same direction. you have to take reading when you are starting when you are satisfied take reading initial and then I am going other way you see now appearing as if from centre one order is going out so decreasing you know decreasing

count 1, 2, 3, 4, 5, 6, 7 so continue up to 20, 25, 30 and again you initial reading final reading and then calculate the phi. few times few observation you should do a few observation issue you should do and take the average of them you will get phi and least count of this translation stage you know and earlier. these for micrometre also you know. you can calculate the error as I mentioned you can calculate all say that

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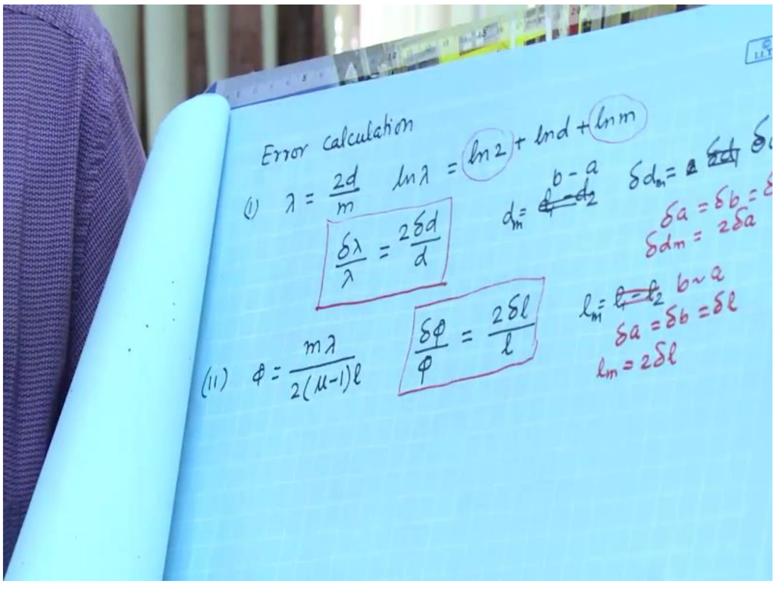

this very sensitive experiment, but it is very nice experiment and very accurately one can get the result wavelength as well as this angle of the biprism this angle here we are telling base angle one can calculate. if base angle is supplied so in this formula actually what happens in this formula you see you have lambda you have mu and you have yes and also this you have lambda mu and phi

if on if two is known then third one you can calculate, see in this method mu also one can find out. If this angle is given this angle is given then mu can calculate or mu is supplied, so one can calculate this angle experiment is same but just calculation will be different.

I think I demonstrated Michelson infer meter how to measure the wavelength and how to measure the angle of the biprism or refractive index of the biprism And how this fillings also we got how these fringe are collapsing or appearing depending on the distance of the mirror or thickness of the biprism thickness of anything any. if you change the vary the thickness, so biprism it is a nice there is a variation of thickness just if you translate you can get the variation of thickness change of the optical path with that how fringe appearing and collapsing that feelings we are getting that also nicely we could see I will stop here.

Thank you for your attention.