Experimental Physics - II
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Lecture – 35
Bi – Prism (contd.)

we are in second year lab Optics Lab of Department of Physics IIT Kharagpur. today I will demonstrate this Bi-Prism experiment for measuring the wavelength of a monochromatic light.

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this is the setup for Bi-Prism experiment. here this is the source

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in front of source this is the pin hole light is coming through a hole and that light is falling on a slit.

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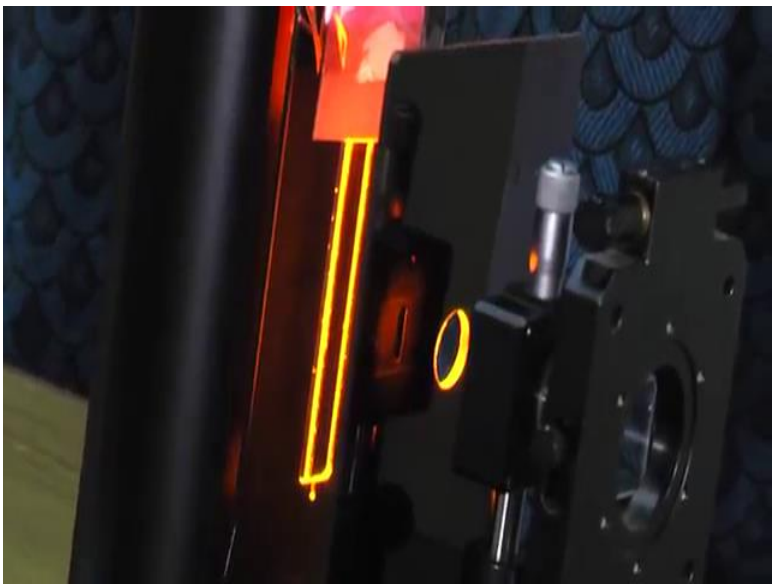

actually, for our experiment the source is the slit source. we will take this one as our source position we have it is fixed; it is fixed on the optical table.

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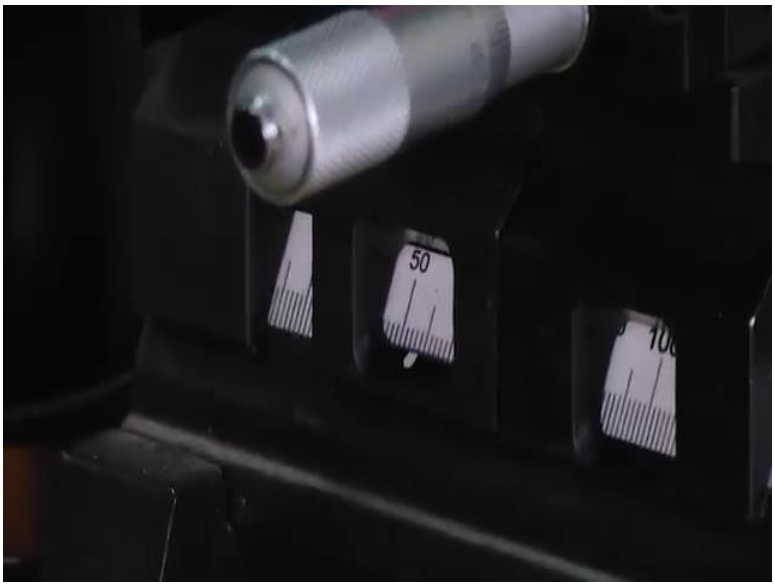

there is a marker here. you can one can note down the position of the slit source. I can see the reading it is 55 millimeter, 5.5 centimeter. one can note down this reading.

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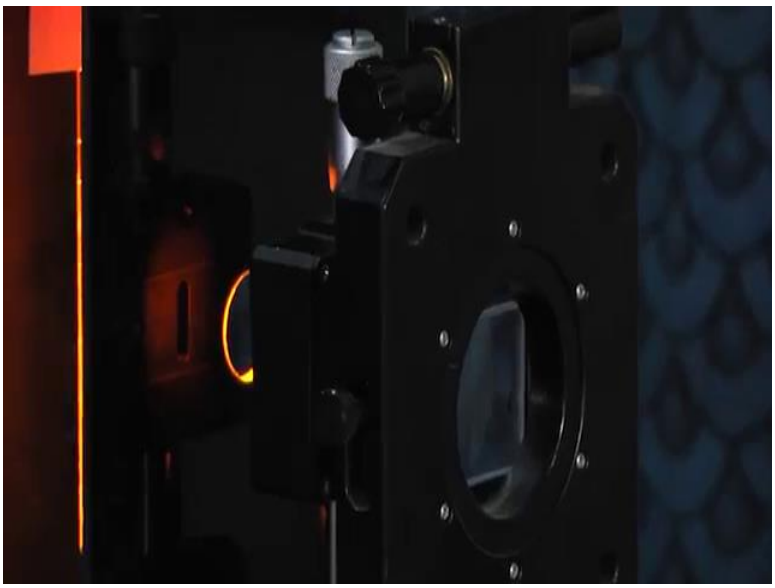

Now, this is bi-prism, you can see this bi-prism here this edge it is there is a edge of bi-prism, as I showed you there is a edge of the bi-prism.

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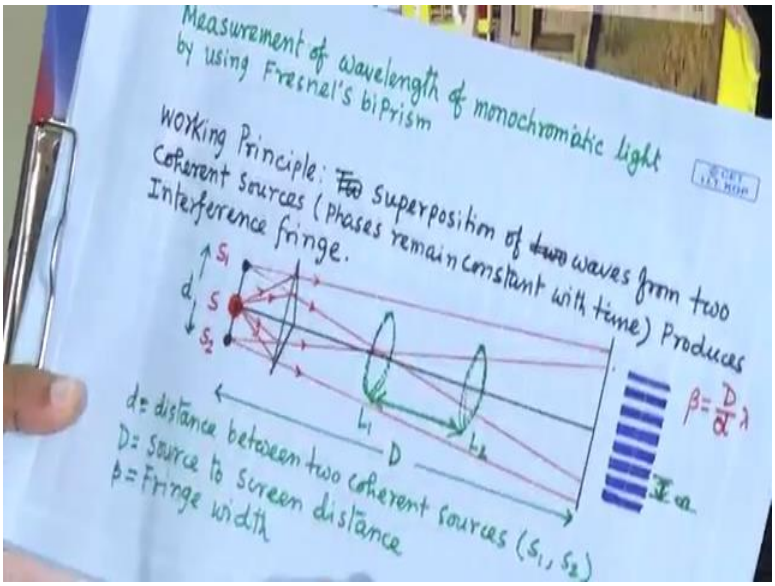

this edge you can see here; this edge you can see here. it is like this; it is like this. this is the bi-prism we have placed in front of the slit source. This also is what is the position of this bi prism, that one can note down from here. I can see the reading it is around 100 103 of a millimeter, 103 millimeter.

So; that means, this bi-prism and the slit this position if you note down. you will know the what is the distance between bi-prism and the slit. now theory is telling that this light source one source is one source is light from the source is falling on the bi-prism. Now, there will be 2 virtual image at this position that we cannot see virtual image I cannot see. So now, say suppose this I will show you, I will show you later on.

suppose this I have fixed this two position and virtual image are formed 2 image are formed. Now, light is coming and there will be interference, there will be interference, actually you can see here. from this source light is coming in this region and from this source light is coming in this region.

overlapping region is this overlapping region is this part. I will see the fringe, I will see the fringe this type of fringe for due to the interference. this is the screen. Now, we have source now you have bi-prism I have showed you, now this is the screen this screen is eye piece this screen is eye piece.

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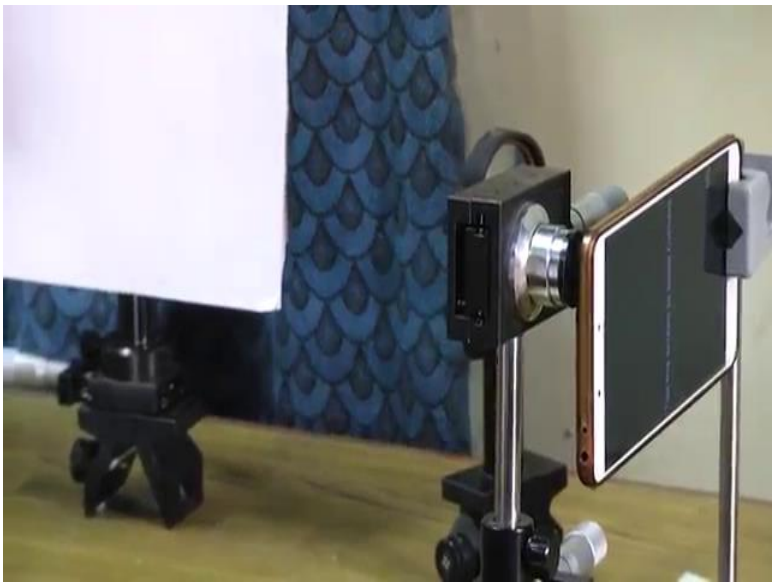

this is the eye piece, this is the eye piece ok, this is the eye piece. Now, on the plane of the of the cross wire this image fringe is formed.

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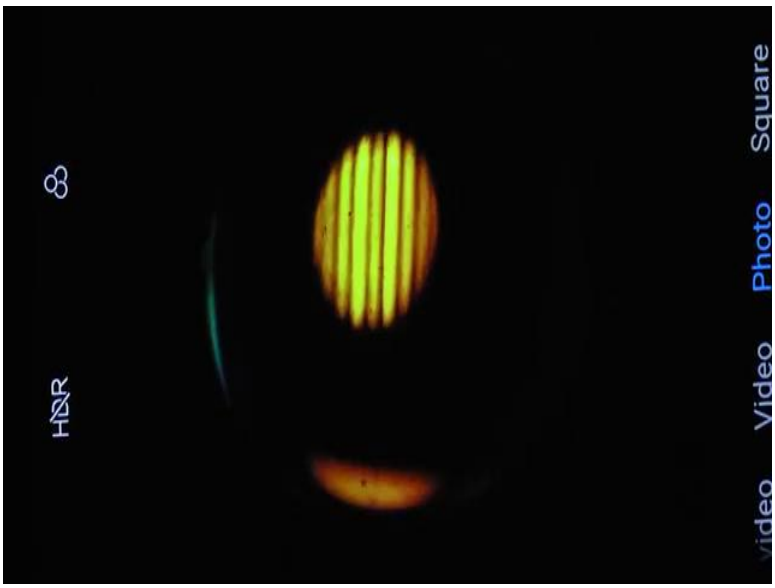

This fringe you can see this, you can see this is the fringe ok, dark b, dark b, dark b, this is the fringe here you can see. fringe is formed.

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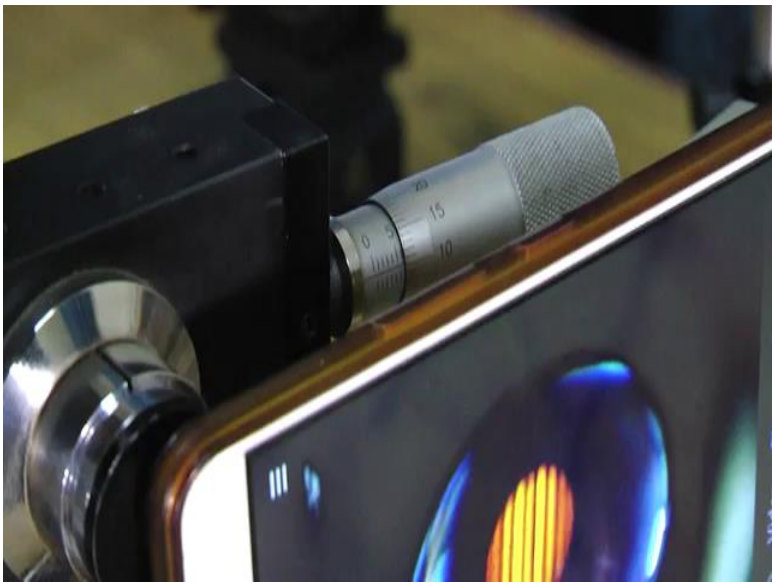

Now, using this micrometer here, there is a micrometer scale. we should you can say this is the screw gauge principle; we have linear scale and circular scale. You know in experiment physics 1 I have showed you that how to calculate the least count and how to take reading.

this is the micrometers scale it is a screw gauge principle. we tell the micrometer. from here this cross wire if you can shift the position of the cross wire just changing the rotating this micrometer. And you cross wire I will fixed at the fringe number 1 and then I will take reading and then I will shift 2 3 4 5 or as I told sixth-one, eleventh-one, sixteenth one.

you can take reading of the fringe. Now, how to calculate the fringe width, that I told you this I showed you a readymade I have done it just to show you this fringe is formed means on eye piece, that micrometer is attached with that one and we can measure the fringe width principle is simple just we have slit source bi-prism is placed and then we are getting fringe that we put this fringe on the eye piece, eye piece, eye piece.

while we put on eye piece, I could put this. I could put this screen here; I could put this screen here, but I will not be able to see the fringe width, fringe separately, because theirs of separation is small with bear eye it is difficult to see ok, on the screen it is difficult to see. eye piece it is magnify the image and we can see that is what happened, it is a magnified image we are seeing here.

now I will disturb the set up. And, step by step I will show, how to do this, how to set this experiment, in this hall. that time I will not use camera just I will show the procedure. here there is a cross wire I can move this here this black one is cross wire. If, I yeah, I am moving the cross wire this cross wire is moving, but I think it is difficult to see yes cross wire is moving anyway.

I think it is a disturbed now I think crosswire is this position. that position of the cross wire one can move using this micrometer And, set up different b one and take the reading and shift to the other some from left to and to left as I mentioned in previous class. let me disturb the set up ok, because I before disturbing, I showed you, because this optical arrangement it takes time to get this fringe. of I will not spend that much time to get the fringe again, but I will show you the procedure step by step.

we can see this is the just here we have use sodium source. here this one pin hole this is the spin reason is that I want to obstacle other light to come and fall on this, only light will come from this hole and fall on the slit.

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here you can see this is the slit I can increase and decrease the slit width now I am opening. slit width you can control; slit width you can control generally we keep slit width it is very small yes at this edge.

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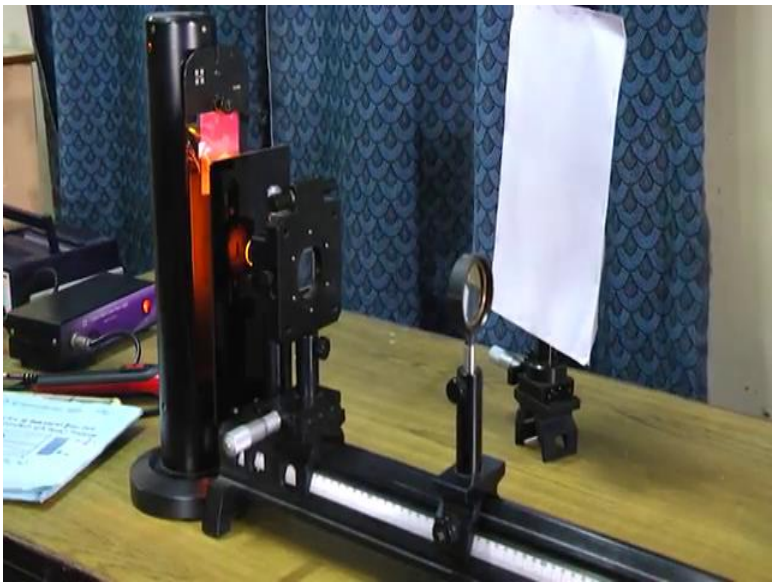

then I have put this slit mercury is this side. I put this slit at as close to the hole at close to the hole. it was at yeah I think I will keep at the same position, it was at 55 millimeter I will fixed it there is a screw here I fixed it then I will see the yes light is coming and I can adjust the width of this line is closed; now reasonable light is coming fine. now this is my slit source.

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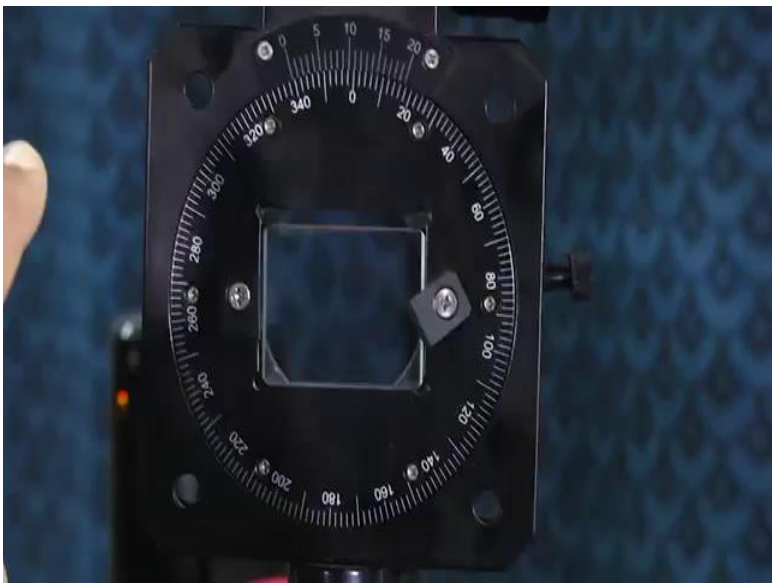

This is the now I place bi-prism. I will place bi-prism, as a bi-prism we can let us whether you can see the edge of this bi-prism this is the edge of the bi prism. this bi

prism fixed on a holder. in this holder you can rotate the bi-prism on it is plane as well as also you can rotate this bi-prism you can rotate bi prism this way also.

and also you can shift x this translational motion it has this and on the on this you can change the position now this bi-prism now, whether this which phase should be towards the towards the slit, it is the plane phase, it is the plane surface and this is one. anyone it can be you can put any one towards the source. generally we put this plane surface towards the source, but it can be in opposite way also there should not be any problem.

now, I will put here ok, now I will put here [FL]. it was at this place you know, it was at this place I think I will marker is this other side. marker is other side yes. it is position was 103 as I told you it is position was 103 and I kept at the same position. Now, this also we have to note that and here you can see this for this position of this, for this position of this, bi-prism. this virtual image is formed. Now, using the convex lens as I told that you can get the real image, now that get getting the real image whether let me see whether I can show you on the screen.

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this is the convex lens; its focal length is around 10. I will put this one. for this position of the lens of this bi-prism and the source; virtual image is formed supposed to form this virtual image. Now, if I use the lens if I use the lens then we will get we will get this real image on the screen that screen can be your micrometer. that eye piece or I will use here this screen here is this white screen.

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if I keep this one, more than this distance between the source and the screen, if it is greater than 4 greater than 4 f, then we will get the image real image of on the on the on the screen for 2 position of the lens. let us try whether we can see the I think yes, it is a I think I will take this mercury is this side, I will take yes. let us let me see whether we can yes.

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You can check you are getting the image; real image is that equal intensity. to get the equal intensities generally we have to move, we have to move this other way move this yes, it is a more or less equal intensity of this 2 image

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slightly you can make it sharper. this is the real image, two image you are getting ok, because there are two virtual source, there are two virtual source this is for one position you note this position from this from this position of the lens you note down. this will be u, and this will be v and this also I have to note down the position of the screen.

now you try to find out the second position of the lens. see if a very small image you will get, but yes, it is there, but it is difficult to see you know difficult to see thus two, but it is there I can see it is there I can see here two are there.

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Now, difficulties is that this when image was bigger for first position, we are able to see on the screen, but for the second position it is small it is difficult to see But, we can see that is why we use the eye piece this instead of the screen we use the eye piece. it will magnify, it will magnify the image and we can see there from the eye piece.

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actually, I will take away this screen I will put eye piece, I will put eye piece ok, I will put eye piece Now, through eye piece, through eye piece, I will see I will try to see. lens

is there for two position for two position yes. for two position ok, I will see the image on the eye piece eye piece slightly I think it is I have to make it this way

through eye piece I will see the image and I have to get the image on the eye piece, but that light I think it is a creating problem to see this yes. actually, you have to find out two position, actually one position is near about this and that screen I can see without bear eye I can see fixed the eye piece position it is a greater than this distance should be greater than 4 d 4 f.

for this position you find out that 2 2 2 position of the lens, 2 position of the lens, 2 position of the lens and for each position note down this position of the lens. And, then as I told you that this for measuring d 1 d 2 for measuring d 1 d 2 you have to for measuring d 1 d 2

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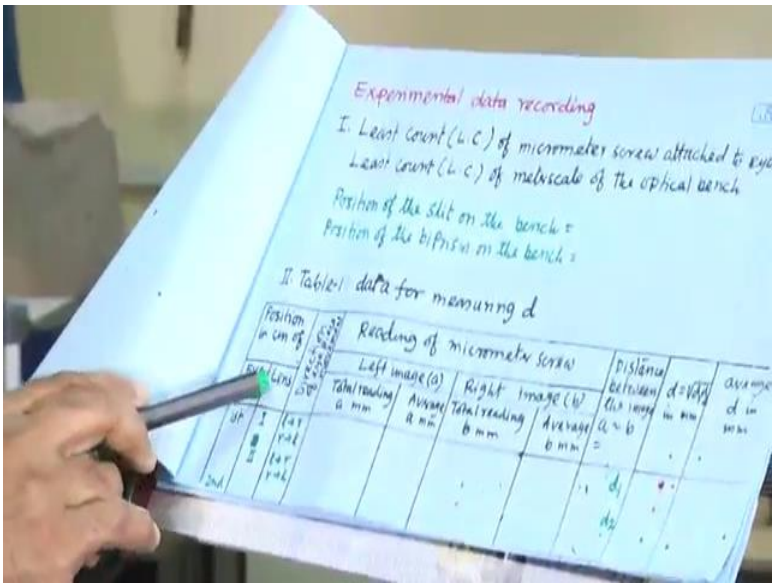

eye piece first position this is the first position say and this lens for position one notes down for lens for these 2 For lens position or lens position we do not need to note down, because here image we will see on the on the on the eye piece. just for lens 1 and for lens 2 left to and to left. image 2 image you will see as I showed to you on the screen. here also you will see these two image.

Now, it is in you will see in magnified way. cross wire easily you can save a one image and then or left one and then crosswire take the reading of from micrometer. move to the

towards take the reading again and again go further and come back from to left, take the second one and then come back to the first one takes again reading. that is what meaning of left to and to left.

you will get the value of d 1 and d 2. it is difficult to show, it is difficult to show through the micrometer. that is why I showed you from here. again, I will show you, again I will show you from the screen I think it is the just take position s anyway keep it and take s. this is the 2 image for second position.

this is for a particulars position of eye piece means this screen it will be replaced by eye piece. when we are doing taking the reading first here just to show you, I am showing. I will take the second position of the screen or eye piece, then again repeat the experiment, again repeat the experiment yes nicely I am getting nicely I am getting image. I can make it equally yes equally b.

For second position also you will get for second position also you will get, but as I told this is very difficult to resolve them. Now, here we can resolve you know for higher distance we can resolve, but the intensity is not equal. I try to make it equal. from the using this eye piece, we can find out the d 1 and D 2 for 2 3 position of the screen.

Now, you now, distance of the virtual image s 1 and s 2 is measured. no way you can disturb this position of the slit and the position of the bi-prism Because, source distance is defined 2 coherent source distance is defined. Now, I will remove the lens I will remove the lens I will remove the lens this interference fringe is formed.

that interference fringe I should will be able to see on the screen I should be able to see on the screen, but problem is the fringe width are fringe width are small it is even very small than the source distance ok, two virtual source distance is very small. that fringe I cannot resolve on the on the screen ok, I have to use the micrometer, because it shows the magnified fringe.

in micrometer I have to use micrometer on this screen I cannot show I cannot show I cannot show. I have to use micrometer basically. I will use micrometer. again just through micrometer you have to you have to find out the fringe.

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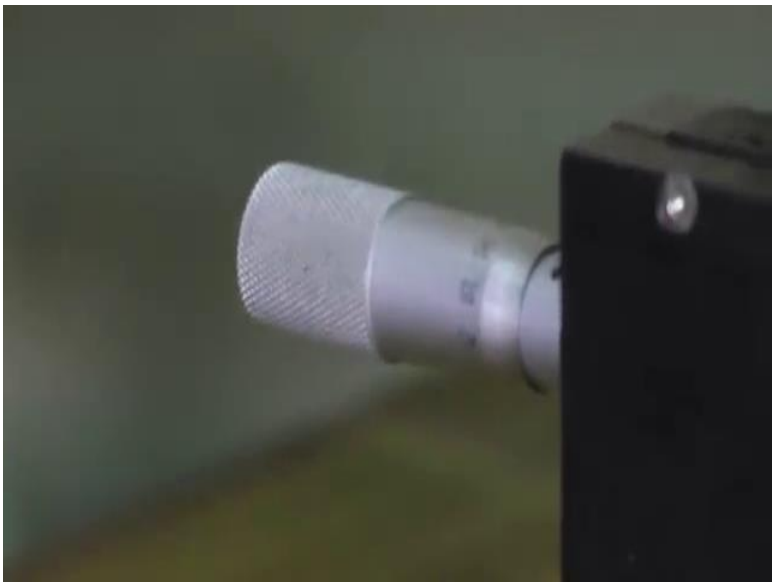

as I showed you already through camera that how fringe is formed and this just here this screw gauge this circular and linear scales are there, and I am rotating this one means crosswire is moving. fringe is formed. this cross wire is set say on this fringe. Now, I will take reading of the micrometer. Now, I will shift I will put on the 2nd one or 3rd one, 4th one, for each time you take reading or as I mentioned. First one I will take and then I will take the 6th one ok, 6th one, then I will take the 11th one.

it will depend on that, how many fringe you are getting. in this case I saw we are getting very few fringes not much in this case we will take reading of fringe 1 2 3 4 5. all will take and then we will take the difference of one to 1 to say 5, 2 to 1 to 6, 2 to 7, 3 to 8. this way also one can calculate. for fringe interesting things is that fringe width fringe width it will depend on it is a D by b lambda. these d is fixed now ok, this source distance is fixed now.

Now, fringe width you can increase or decrease just changing this capital D means, slit position is fixed now changing the screen position Means the eye piece position, you can change this distance if for a higher distance beta that fringe width will be higher, for smaller distance this will be lower. Also, you can also you can change; you can change this d to change the fringe width. if d is smaller fringe width will be higher, if D is higher small d if it is higher. fringe will width will be lower.

that is why one has to one has to think one has to think that one has to think that this fringe to get the fringe alone has to think this fill the view of the micrometer, how big it is? And, there is fringe width is very high then you will get very few fringe only, but measurement accuracy will be, but you will get few fringe.

If, fringe width is not in medium fringe width are medium, then you will get few number a greater number of finger on the field of view, then you can take more of on larger number of the of the fringe. that one has to adjust. just take reading as I mentioned here for on the table from the table for D 1, D 2, D 3 position.

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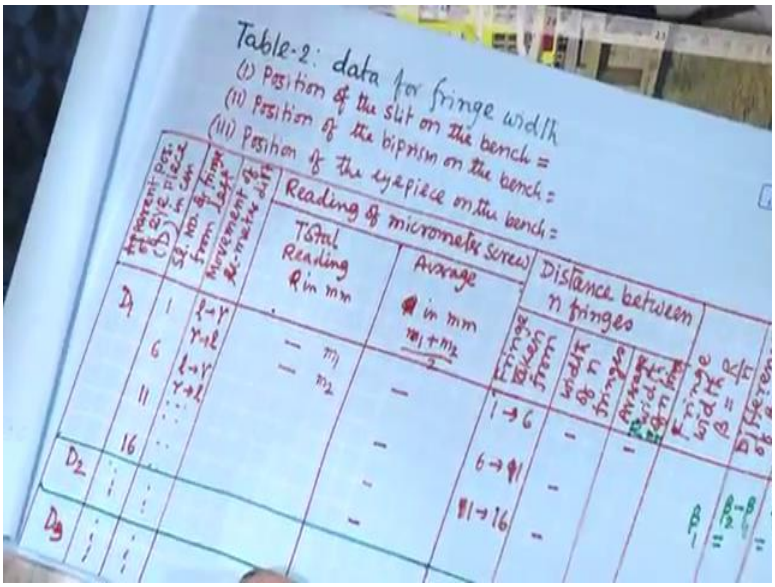

this changing this three position, for each one you take the reading from the micrometer ok, setting this fringe one from the left. You see nothing to just your reference you are taking one this fringe from the left this one. Then next one will be 2 3 4 5, because all are equidistance there is no problem which is which one you are taking as a one

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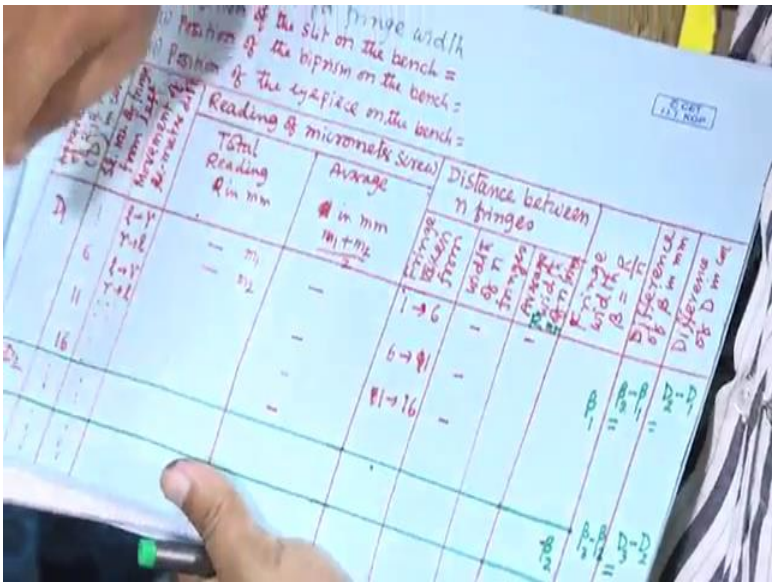

for a particular position of this one you do this measurement, when you are moving left and again go back from to left take reading take average and you have final one. For second position again fringe width will change then, D 2 position D 2 repeat for D 3 repeat the experiments And, find out from calculation how to find out that already I have told you and you can then calculate the wavelength of this.

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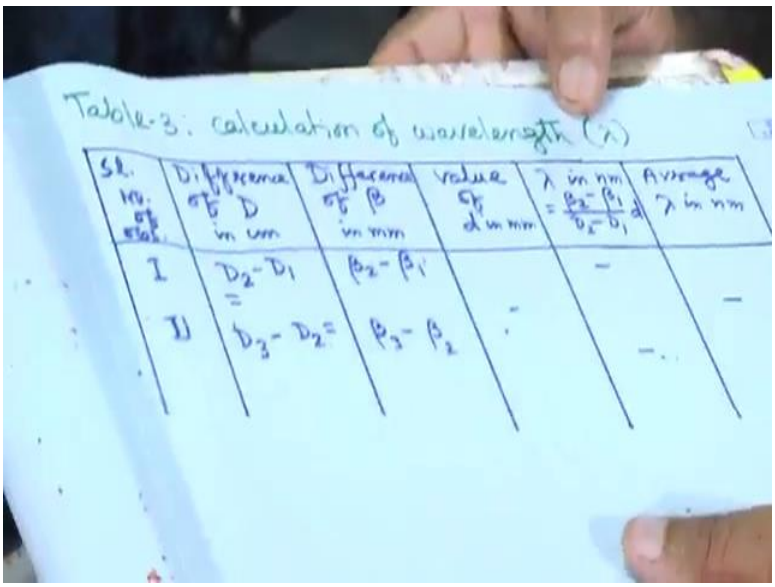

here one thing I just would like to tell you that, I want to demonstrate you see this.

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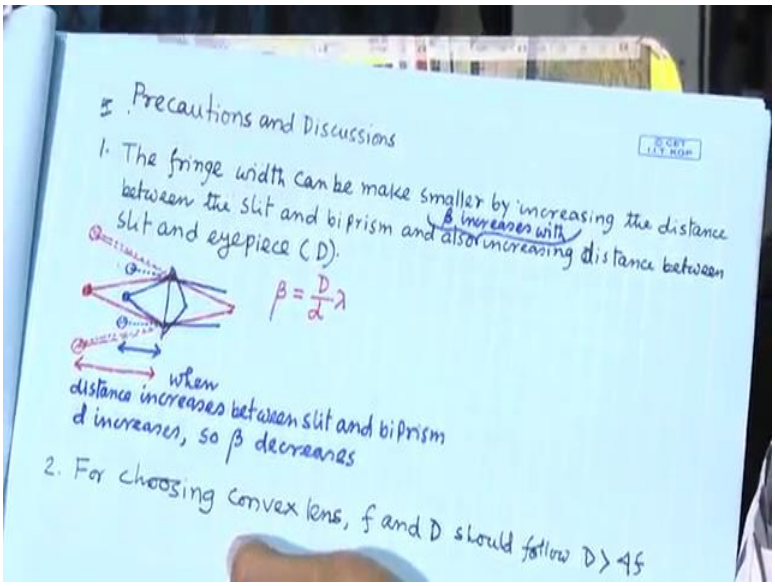

This d as I told these d source distance it depends why we should keep, why we should we should not disturb the position between the slit and the bi-prism. Once, we fixed and measure the small d we should not disturb it why because these small d it depends on the on the distance of the distance between the slit and bi prism If, distance of the slit and bi prism if it increase that d value will be the red one you can see that d value will increase d value that separation will increase.

If this distance is smaller ok, then separation this d will be smaller; let me demonstrate it whether this phenomena we can see on the screen or not let us let me try I do not know I have not seen earlier. see for seeing the image actually I have to use this one for this. Now, this whatever the separation we are seen for first position of lens. if I increase the distance. as I told distance between the slit and this one.

this virtual image that it should increase distance in a small d, that should increase. I am expecting here also the separation will increase separation will increase. let me change increase the distance of the of the bi prism from the bi prism from the ok, you see it is a increasing separation is increasing, you see separation is increasing ok, separation is increasing I am increasing the distance of the bi prism from the yes from for this one. I have to find out suitable to make it sharper yes to sharper yes.

separation I am decreasing now the separation yes, the separation is decreasing. Now, increasing the separation between the slit and bi prism virtual image that distance s 1 s 2

will increase. here also this whatever image I have image of that virtual image is found real image. their separation also should increase, and it is happening it is increasing it is increasing. that is why in this figure in this figure I have shown when source this is the bi prism when source is here.

virtual image this is the separation when source is here ok, or source is here, but I change the bi prism distance. whatever now distance between the source and bi prism is this. in virtual source will be here you know. now, this d value is higher. that is what is happened here. that distance this is defined distance between the virtual image a virtual image ok, which are the coherent source formed by the bi prism. their separation it depends on the distance between the source and the bi prism.

And, you have to you have to find out suitable that that source distance, means this distance between the virtual source. Because, fringe width also depends on d if the d is if it is very small if it is very small then beta will be very high. in the eye piece you may not see the greater number of fringes. one has to be optimize. fringe width is controlled by d small d and capital D. small d and is controlled by the separation of these two and capital D of course, this position of the screen you can see. I think that is what the bi prism experiment and it is a very nice experiment, and one can calculate the wavelength of this wavelength of this of the light.

In this case we have used sodium light it is the monochromatic light it is not strictly monochromatic, but there are very close two lines are there D 1 D 2 lines, but we take ordinarily we cannot resolve them we can consider earlier one light of 5 9 5 8 5 8 9 3 on the average 9 3 Armstrong. one can find this using very accurately. I think I will stop here we will continue next class for other experiment.

Thank you for your attention.