Experimental Physics – III
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Lecture – 43
Sodium Yellow Doublet (Contd.)

(Refer Slide Time: 00:35)

I will demonstrate sodium d 1 d 2 line, how to without using the grating spectrometer. this is our experimental setup, I have shown many time this spectrometer prism spectrometer in Experimental Physics II. In addition, I have discussed details about the spectrometer, about the components in the spectrometer, how to level the spectrometer, how to get the parallel rays using the Schuster's wave.

Student: Yes sir.

Anyway again I will tell you; this is our sodium source, sodium source. Now, there is a slit and without the slit, we have selected; now this is the collimator, here there is a collimator lens.

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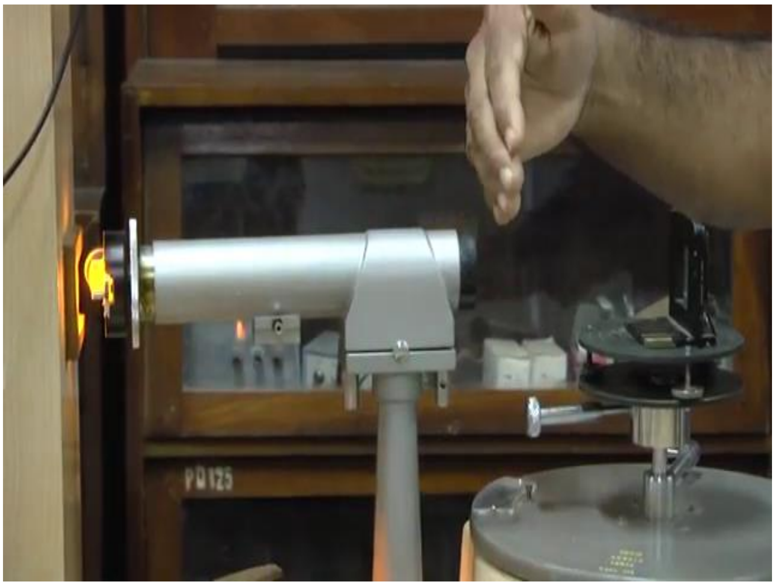

This slit is source, now that is collimator lens; it is a light coming from the collimator lens. that will be parallel if the slit is at the focal point of the collimator lens.

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Now, here I have put grating. This grating specification is 600 lines per millimeter, 600 lines per millimeter means 6000 lines per centimeter means 50000 lines per 50000 lines per inch ok. now my parallel light is falling on the grating and it is falling perpendicularly on the grating surface. That is the condition as I mentioned.

Now, this lights through the refraction is the through the grating is refracted in different angles and we will see different order. From the direct light from that position from left side and side, we see the different order. I have set it as I mentioned in the discussion of the theory. Now I have two at the second order diffraction peak.

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Here one can see that you can see that two lines, two lines.

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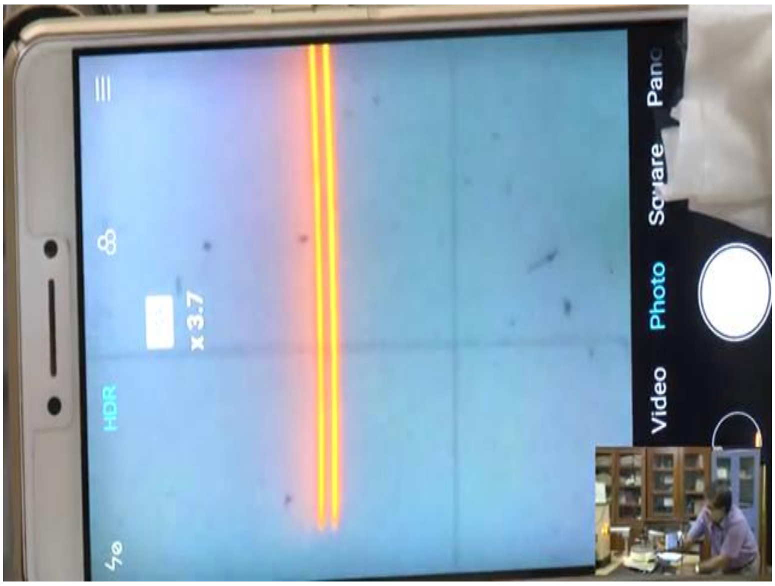

This one is sodium d 1 and another is sodium d 2 lines. If I just spot no (Refer Time: 03:40) also you have not seen light. See it is a live demonstration, so I have to close just this collimator face.

Student: Yes sir.

If the second order diffraction all of it is the interference, it is the maximum for sodium d 1 and for sodium d 2. actually what you have to do? This is the; you can see this is the crosswire. you have to put crosswire at sodium d 1 line and at sodium d 2 line.

I can just rotate it slightly. and it is seems (Refer Time: 04:43) anyway ok. Other side I restart, so I left. I am trying to take towards the anyway. I think the camera feeling difficultly actually you can have to adjust (Refer Time: 05:20) so as well as rotate it. this crosswire you have to set at the dual light and then take reading; then take reading from the Vernier 1 and Vernier 2 for sodium d 2 line, again we have to take reading ok.

This is for second order; from left side, you are taking say this is the left side and for second one you are taking reading and then I will go to first orders. I will go to first order.

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I will just remove this one and then I will use for the (Refer Time: 06:06). Where is this? At the second order. This is the end of first order end of first order (Refer Time: 06:40) get back here, I have to set slightly (Refer Time: 06:50) gets the (Refer Time: 06:52).

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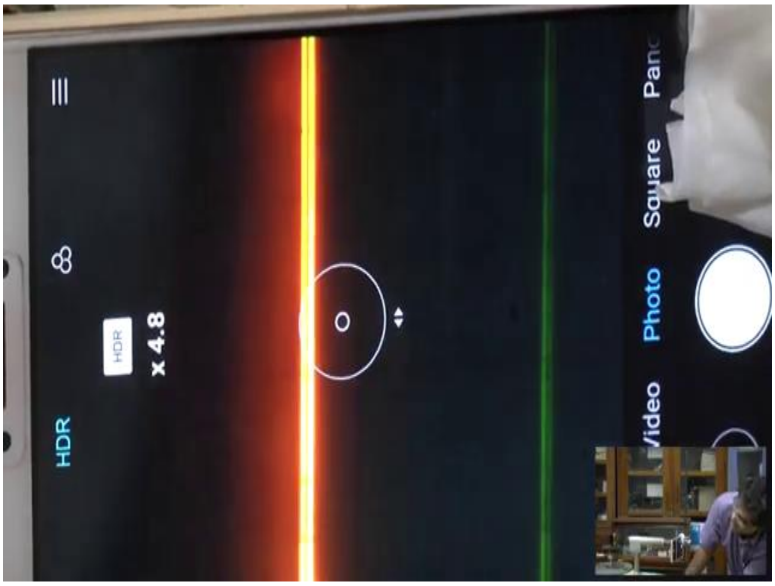

Yes, I got it but do not know (Refer Time: 07:50) this is the first order, see you can see separation. However, it is very first order as I told this resultant path will be smaller than the second order. Here clearly you can see this separation is smaller than the second order. However, one can distinguish, one can see distinguish this, our getting the lines per centimeter its 600 6000 lines per centimeter. One can easily resolve in first order also. See, in first order again you just set the crosswire at d 1 line and d 2 line and take the reading of the Vernier 1 and 2. This is the left side, and similarly side you will get first order and second order, see rotate it.

I will not going to show because setting parallel all these are slightly time consuming. you can see this side also first order, second order take the reading of the take the reading of the Vernier 1 and Vernier 2 of first order and second order and for each order, for sodium d 1 and d 2 ok. And, then after doing that you have to take the direct reading ok; you have to take the direct reading of the.

You can remove this since your grating at the direct reading of the source of the slit source ok. So now, if I show the just I think centre wall, centre wall is not developing. Can you see easily? (Refer Time: 10:01) centre wall yes. If the centre wall is getting light, (Refer Time: 11:14) slightly sharper, here.

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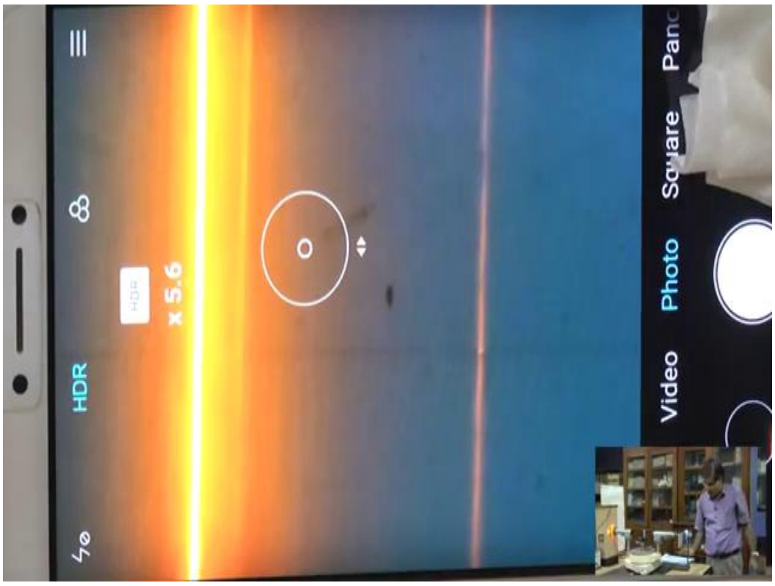

Yeah, this is the centre finish ok, centre order, zero-th order ok. You can clearly see that it is your laser ok. if I see higher ramifications, you can see this is the figure, it is the figure (Refer Time: 11:43) small line was slightly I know (Refer Time: 11:48). I am touching this focus if you know but one should not touch; one should not touch because one has to do Schuster method for getting parallel rays under (Refer Time: 12:09), but since I have not done Schuster method (Refer Time: 12:18). this is the central one ok.

That is you side also you will get first order, second order take the reading. what I will do? I will just I and I told you what data you have to take, what data you have to take other side also I have mention, I have mention. x will be parallel to the Vernier constant of spectrometer Vernier 1 and Vernier 2. Vernier 1 and Vernier 2 spectrometer. You just check the Vernier constant, in our case it is a 20 second; Vernier constant is 20 second in our spectrometer 20 second means it is not time.

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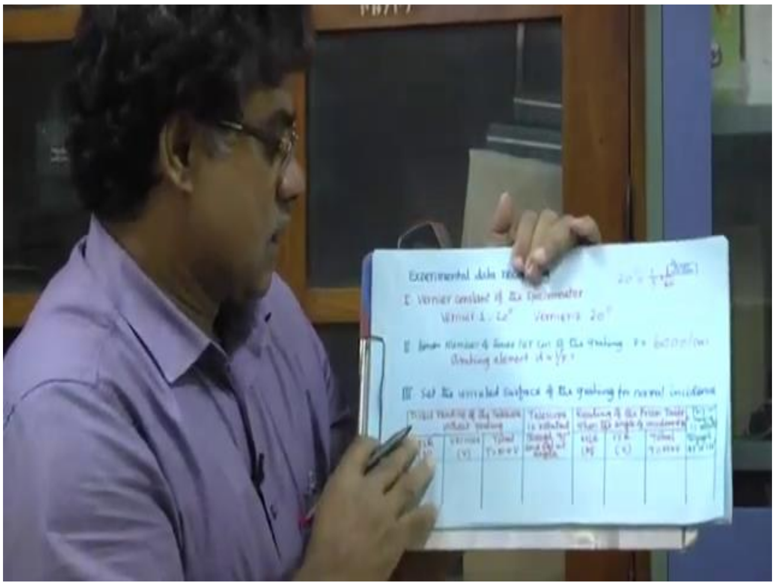

60 second means 1 minute, 60 minutes means 1 degree. its 1 by 3 into 1 by 60 degree; 20 second means 20 second means 20 second means it is a one-third. I think it is one-third minute and 1 minute is 1 by 60 degree ok.

1 by 180 degree; this is the Vernier constant and for both case, this is the same, this is same, you have to note down. Now, number of lines per centimeter of the grating ok. Here I can show you I will just take it.

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I will show you this detail, this picture this is the grating and this is the grating holder. Here you can see it is written 600 lines per millimeter, 600 lines per millimeter, 600 lines per millimeter ok. means 6000 lines per centimeter, then it is approximately its 15000 lines per inch ok. That you have to note down; that we have to note down. I think we should note, in the holder, put in holder we will note down; total number per centimeter this is an it is a 6000 per centimeter line per centimeter.

Grating element d it will be 1 by p means 1 by 6000 ok. you can calculate (Refer Time: 15:27). Now, set the unruled surface of the grating for normal incidence as I told this you have to set for normal incidence, but before that you have do Schuster’s method. That I have explained in Experimental Physics II. you have to we have to put the grating, you have to put the grating ok, you have to put the grating and then find out the minimum deviation position.

From minimum deviation position you just put the telescope, you just put the telescope of minimum deviation position; from there just you deviate 6-7 degree further. Now, you rotate the prism table, this prism I think this is the prism.

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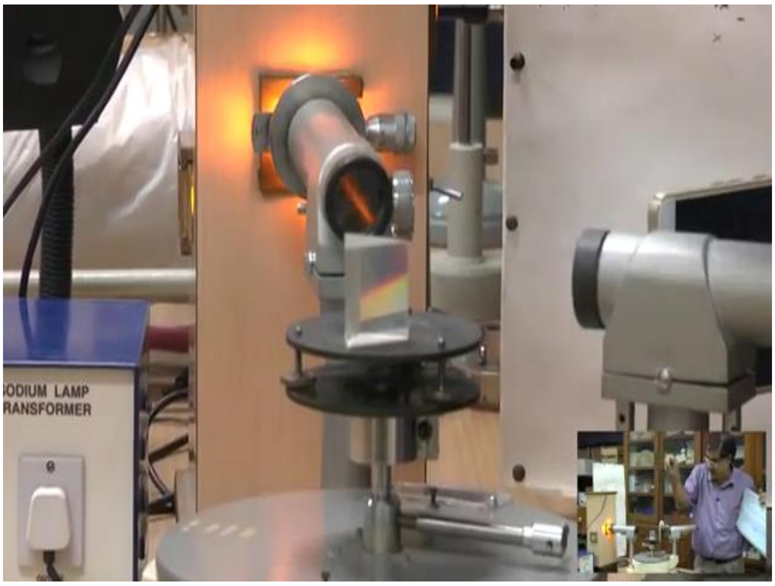

Which one? Yes, this is the base and this is the prism angle. this if you this if you rotate towards the collimator, then if you adjust the collimator ok; make it sharp then you rotate. Because, that is the incident angle for minimum deviation position; now I have shifted this telescope from that position to the 6 degree from that position that means I will not see that spectral line. When I rotate this one, I will change the incident angle, I will increase or decrease the incident angle; for both cases, the deviation will increase.

I will get the spectral lines and I will be able to see in the telescope ok. Now, Schuster's method itself is telling that when you rotate this prism the gauge angle, or prism angle, the gauge towards the collimator towards the collimator, then you should open this collimator and when you rotate towards the telescope, towards the telescope ok. You should (Refer Time: 17:51) times and make it what make it sharp, this image spectral lights you should make it sharp.

Then you take that is the and these both lenses are set at the set for the parallel ok. that we have to do and then after that next condition is you have put this one, it is a normal (Refer Time: 18:16) the rays ok.

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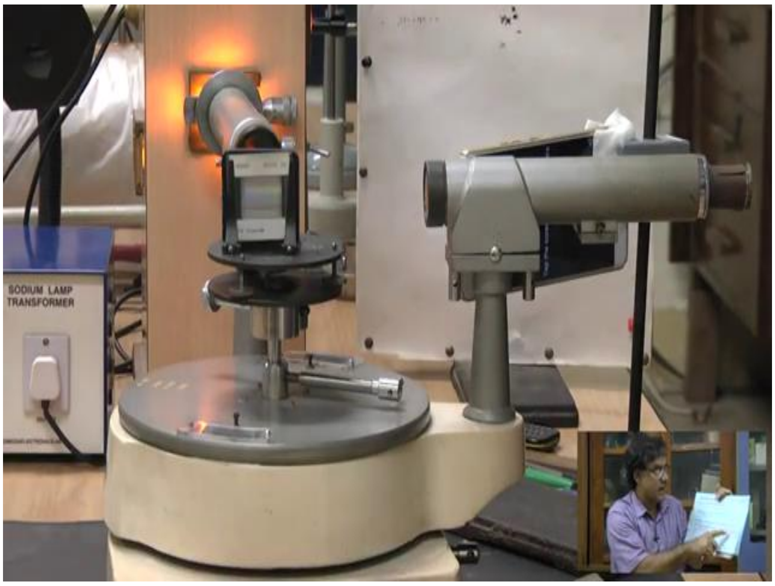

This parallel ray should form perpendicularly on that on this.

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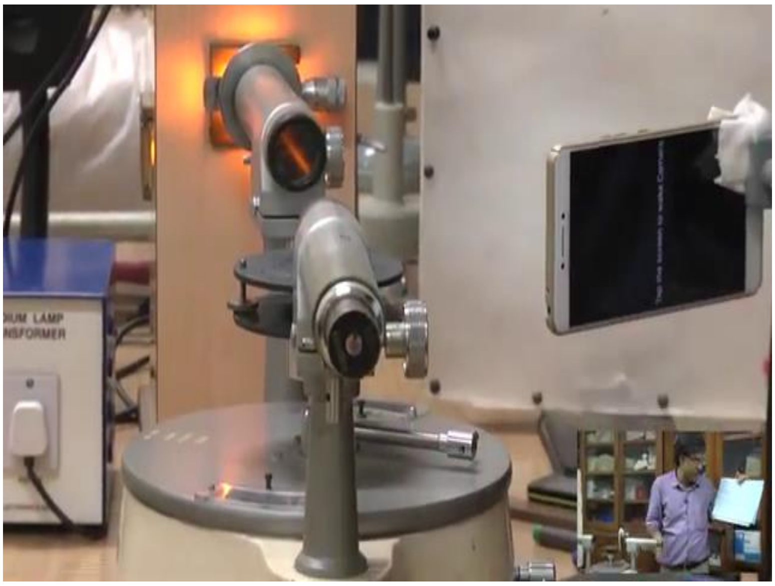

For setting this up, what we will do? First, you should take direct reading of the telescope without grating; without grating you should take reading direct reading for the telescope ok. Take reading from a and b, note down and then use from that I am getting you just shifted by 90 degrees so on ok. And, then we put grating, we put grating or all grating should do; we put grating then whatever the reading of this that reading direct reading you got from there prism table will rotate by 45 degree ok.

Prism table let us see that is better way, better way I think if we put this one at 90 degree and then this one set for reflection you set in such a way for reflection set in such a way that. When it will be at 45 degree then you will get, you will see the reflected image at this 90 degree position, then you are sure that it is at 90 degree. It is at 45 degree; further, you rotate by 45 degree so.

either 45 or 135 degree, then it will be 90 degree with this collimator ok, surface will be surface will be at 90 degree with the axis of the collimator ok. That had your condition what theoretical condition will be satisfied and then now see the as I told that. this is for setting the grating at normal incidence. Reading of the prism table when the angle of the incident at 45 degree; that means, as I told you, take the reading. you better you fix the this grating at 90 degree, grating surface at 90 degree with the real with the angle of with the axis of the collimator.

then angle of diffraction for the d 1 and d 2 lines ok; there are this ordered numbers: first order, second order, third order, ok. For d 1, for d 2 first order second order, third order, but here see this grating; this number of lines is very high. Other I am not able to see, up to first order and second order we are seen other order we will not see. take reading for first order and second order, if you take more number of lines per centimeter then you will get first order, second order, third order but, in that case problem is this first order, in first try, it will not be well resolved or not in that spectrometer.

In that case, for second order and third order the other value we take. then value from Vernier 1 and Vernier 2 you have to take data. Reading for the refracted image with the telescope ok. This is for left side and this is for side of different order that from (Refer Time: 22:19) d 1 and d 2 lines, you are taking d 2 from there we can find out. Here we take difference of first order from left side and side for d 1; that will be 2 theta. divide by 2 it will give you the angle of difference.

You calculate as I shown you and then you can we can calculate the wavelength of d 1 d 2 ok. data you have taken, these now wavelength will be lambda equal to e sin theta by m; e sin theta by m ok.

For first order, second order we have taken data, so and d as 1 by phi it is 1 by 6000 again from that you find out d. theta you have to measure. we find out lambda for d 1 and lambda for d 2 and also you can calculate this one's power very easily, also you can calculate the resolute power for this from this data ok. Therefore, say m calculate (Refer Time: 23:37), either in the measurement of lambda which is very simple (let us say and then. here main thing is that you have in spectrometer you have used the grating spectrometer for measuring the spectral lines, wavelength of unknown light etcetera.

However, here main aim of this experiment is to demonstrate the speed of the coupling, speed of the coupling in the atomic system, in the atoms ok. That obviously, we have seen the doublet structures of the sodium. Now, it is a challenging job what leads to the job then to see them separately in a spectrometer. One has to take special care; one has to take very good grating and its number of lines per centimeter. it is very costly also because number of lines per centimeter is higher, higher. It is a difficult job to segregate also (Refer Time: 24:24) that is a bad source of ion.

That special care one has to take and one could see that in different order resolving it is a separation of different that I will show you and one can as I mentioned. here I think this exposed area in our case it is that I try to check it, exposed area it is around, but let me just approximately set at normal. In addition, if I see the second order, let me just check whether I can show you. It is the first order then it is the second order. I think it is the; I think (Refer Time: 25:55). See approximately I am trying to show you, let me check in the (Refer Time: 26:08) it is there, I try to show you, what I want to show you (Refer Time: 26:49).

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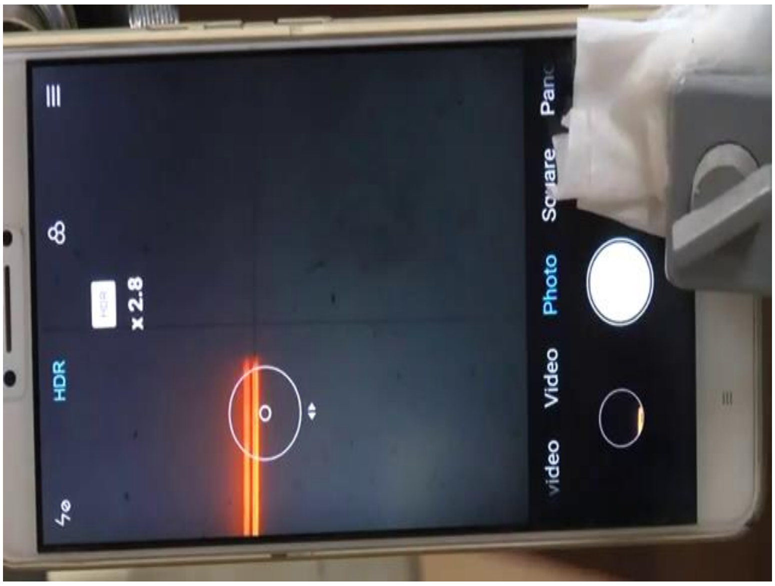

Anyway. What I was trying to; if exposed area is lower then what will happen? we were just I am closing the grating that area with an obstacle. Yes, it is you see. It is so heavier if light (Refer Time: 27:25) even the power is going there completely, it is completely closed.

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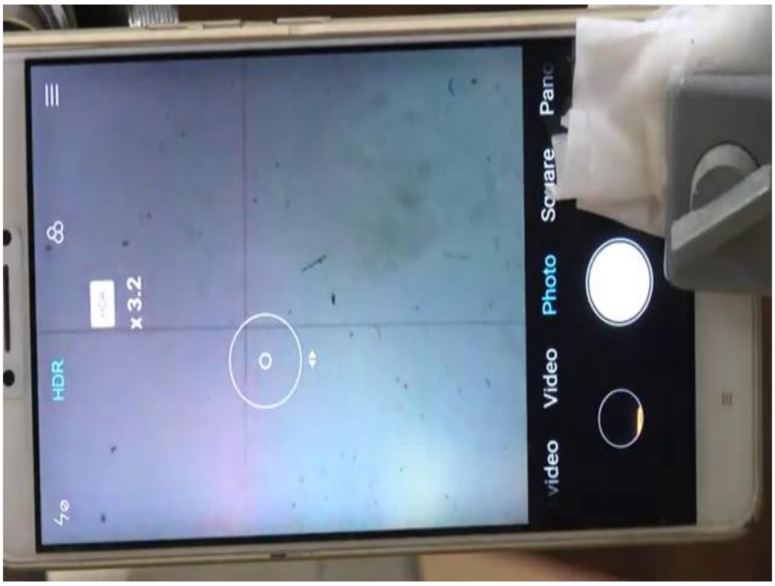

From here, here I can see that I can see that this exposed area not more than 1 to 2 millimeter you know. because the slit size we have taken is it is a micron size, it is very small slit size we have to take. If I increase slit size then it will be broader. It is run out of there is.

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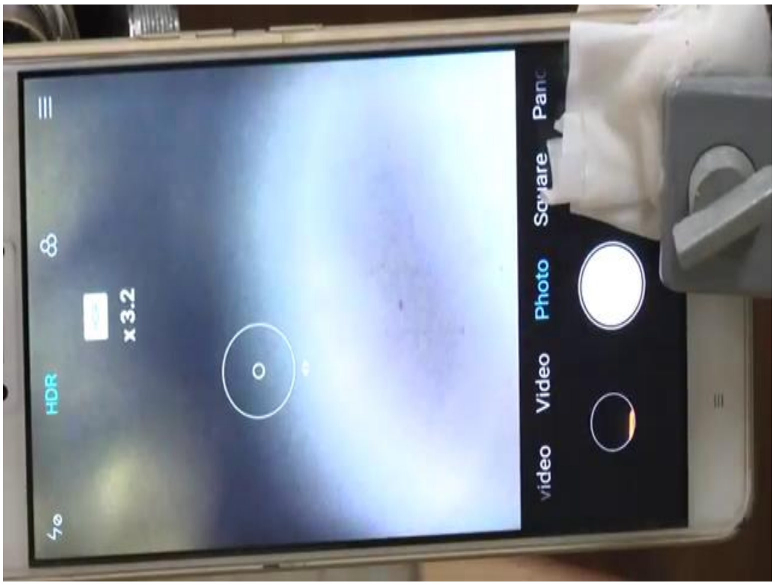

See, if I increase the slit width but then it will be I have increased the slit width, so exposed area will be higher. However, then this image will be also it is a, it will be slit image whatever we have seen this (Refer Time: 28:46) image the slit width is having the image which also higher. That way it is a (Refer Time: 28:54), but here whatever I will see this exposed area it is there is. If I (Refer Time: 29:03) try to make it is this obstacle, see it is a. total number of exposed that I will try to; see total number of exposed area is smaller (Refer Time: 29:17) looking (Refer Time: 29:19) has gone; it is gone, is gone yes.

When I am just decreasing the exposed area ok; then its regulation is going there you know.

That is you can shake it, yes.

See exposed area is smaller ok. That one can check it with the fine movement arrangement of the then you can obstacle with the some multimeter oscillator and you can see this, it is I think its regulation will be there. this small end and that capital end, this is very important ok; capital m is not lines or centimeter. Generally, we take for calculation or we think it is dimensionless and it is total number of lines exposed to the light on the grating ok.

if that exposed area, I was trying to reduce just manually, roughly so and then showing that its regulation is going back; we could not see them separately that one can arrange this experiment just with translator, micrometer translator and can see that attenuation, resolving power depends on the exposed area of light. I think I will stop here.

Thank you for your attention.