Experimental Physics - II

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Lecture – 29

Determination of the calibration plot of deviation versus wavelength for a given prism and hence determination of the wavelength of the unknown light source using calibration plot

today we will demonstrate experiment for minimum deviation verses wavelength a for a particular prism. yesterday in last class in have discuss about the deviation as a function of incretin angle and of from theirs how to find out the minimum deviation and if you know the angle of prism then, you can find out the refractive index.

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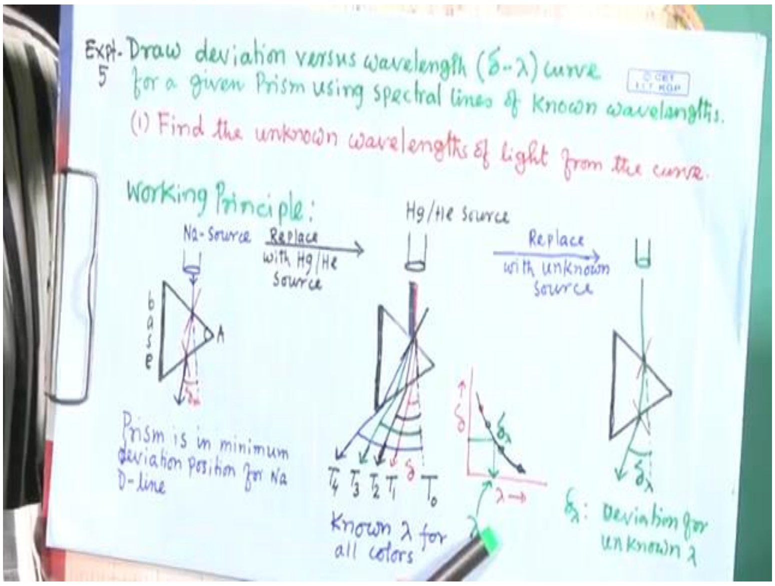

today I will discuss I will demonstrate draw deviation actually minimum deviation angle of minimum deviation versus wavelength of light curve delta lambda curve this call also dispersive curve for a given prism using spectral lines of known wavelength then, find the unknown wavelength of light from the curve.

this is the experiments. how to find out the wavelength, how to find out the wavelength of a spectral lines or of light using the prism. this is the experiment. this is not dispersive curve. Dispersive curve is refractive index verses the wavelength. this curve is called calibration curve. initially for known wavelength we find out the minimum deviation for each wavelength and then we will plot it Now, for same prism if you use unknown light having unknown wavelength then, we will measure the deviation. Now, that deviation will put in the plot in the curve that is calculation curve and then corresponding wavelength we can find out from the curve.

working principle for this experiment is take a sodium source and put the prism on the table. I assume that the spectrometer is initially level optically mechanical levelling, optical levelling, as well as the this for parallel range these (Refer Time: 03:39) method that everything is done. spectrometer is ready for the experiment. from coli meter the parallel range we will fall on the prism and from the prism the refractive rays we will get.

image of the source we will get on through telescope that initial this adjustment is ready. Now, we will do experiment. we will use the fast sodium source and then we will put the prism on the table prism table and then find out the minimum deviation for this for this sodium light after keeping the in prism minimum deviation position for sodium D lines and also taking reading for this, we will replace the source, we will replace the source with another source either mercury or helium source

just this one will be replace with mercury or helium source Here we assume that now we will see the spectral lines of different colours and the wave length of those spectral lines are known actually from chart one can find out what are the wave length for these for the spectral of helium source or mercury source.

these source, we will take as a known source means known wavelength for the spectral lines. this light will fall on the prism Now, you will get this this dispersion. deviation it depends on the wavelength different colour you will get separately. Now, we will measure we will measure the deviation, we will measure the deviation for different colours for different colours putting telescope at different position.

we will measure the that deviation. I again I did one mistake. here I told this a minimum deviation, it is not minimum deviation it is deviation It is just deviation as if function of wave length, it is not minimum deviation here actually the for a particular position of the prism for a particular position of the prism ok, we are measuring the deviation for different wave length without disturbing this position of the prism, we will just again we will replace with another source of unknown wave length

Then again, we will measure the deviation that deviation we will plot in the calibration curve and from their corresponding wavelength we can find out for as I told this all measurements we are going to do for a particular position of the wavelength what is that particular position. that particular position is fixed at the minimum deviation of the for the sodium light

that is why this first this setup is required. we know this is the; this is the position of the prism, what is that position minimum deviation position for sodium the lines Now, just we will replace the source of known wave length and measure the deviation of different colours and then replace with unknown with source of unknown wave length and measure the deviation for that for [for different colours here for unknown source.

Now, I know the deviation now, I had the deviation verses wavelength calibration curve. from that curve, if I know the if I plot the deviation for unknown source then, corresponding wavelength I will get this is the experiment. let us do first this part already I have said it already I have said it.

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here this from coli meters parallel rays are coming and this falling on the prism falling on the prism you can see that this the base of the prism and this one is the reflected phase and another reflected phase is this side and this is the affix of the prism all already I have said already I have said this prism at the minimum deviation position for this source sodium source yellow light is coming this is already at the minimum deviation position.

now just I want to show you that as I told that what is the minimum deviation position no, if you for a particular incident angle. you will get minimum deviation. if you increase the incident angle. deviation will increase, if you decrease the incident angle from the minimum deviation angle. also, this deviation will increase. that just I would like to show you in my camera. here I set camera I think I have to no

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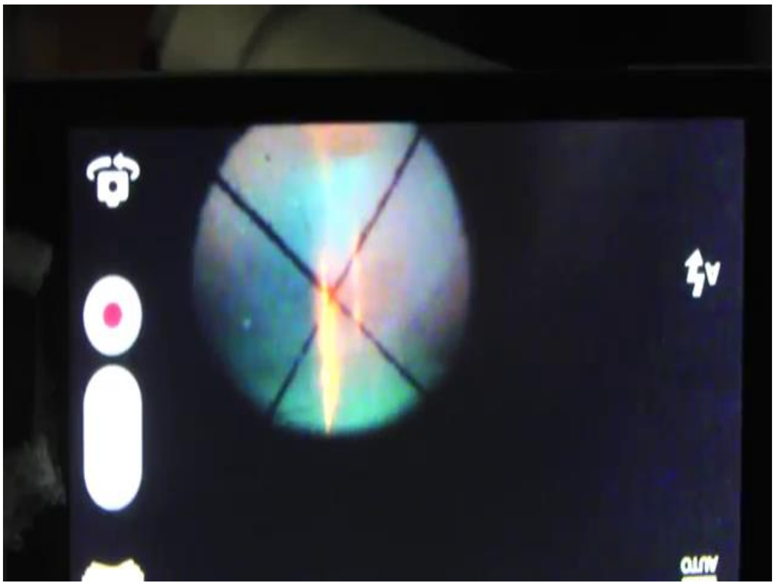

I think this fine. here in front of IP's I have just put my camera you can see this filled of view. this corsair and that is the corsair here this spectral lines for sodium as I told this I set almost that is at the minimum deviation position. for now, I am just changing the; I am just changing the angle of the incident angle. I am rotating the prism; I am rotating the prism; you can see this it is moving towards this other side

now I am rotating the prism in opposite side. it is a coming back coming back and then yes you see. Now, I am continuing the rotation. again, it is going back ok; that means, this is the minimum deviation position, this is the minimum deviation position ok, this is the minimum deviation position at the cross at the. minimum deviation positions this spectral line is at the cross point, spectral line is at the cross point. this is the minimum deviation position

if I increase from this position if I increase the incident angle rotating the prism table say, if it is a clockwise or anticlockwise whatever in both ways it is going; it is going back from this position. that is why it is a minimum deviation position. now my prism is at minimum deviation position for the sodium light. I will take reading for this; I will take reading for this here. I have to take reading experimental data recoding.

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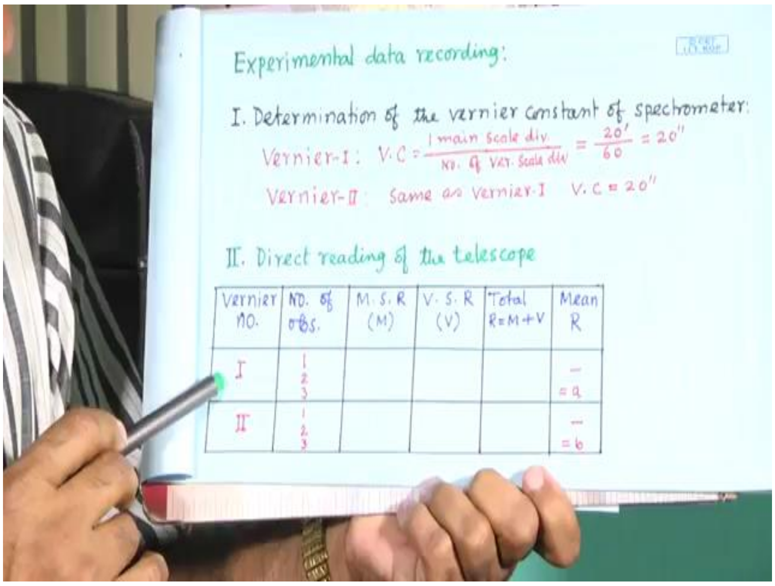

first as the you know this determination of the Vernier constant of spectrometer all we have discuss many times. in our case is a 20 second. that you have to note down, then direct reading of the telescope. that reading we can take at the end of the experiment, it is not necessary that we have to take it at the beginning. either you can take at the beginning or you can take at the end of the experiment this direct reading of the telescope rights. that also we have discuss for other experiment. for Vernier I and Vernier II say this reading is this reading is a for Vernier I a Vernier I it is a and this for Vernier II it is b, this is the direct reading

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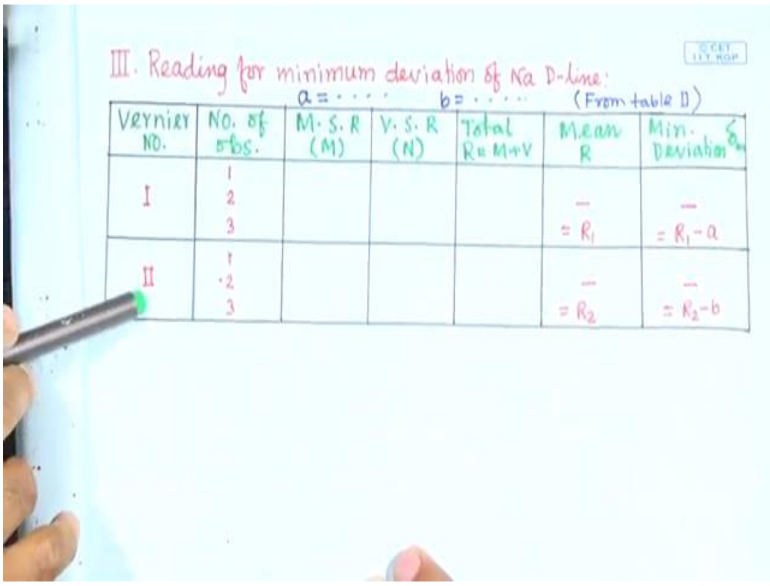

Now, now level is reading for minimum deviation of sodium D lines, reading for minimum deviation of sodium D lines from table 2 we you know the direct reading for the direct position of the telescope is a for Vernier I and b for Vernier II. that you should note down on the top of the table and then this for Vernier I and Vernier II, you take the main scale reading, Vernier scale reading, the total of these main scale plus Vernier scale reading.

for Vernier I find out the mean, if say this is R 1 and mean reading for Vernier II this R 2. minimum deviation delta m will be R 1 minus the reading for direct ways that is a. R 1 minus a that will be the minimum deviation and R 2 minus b that will be the minimum deviation from this seeing from Vernier II and this seeing from Vernier I these just I do not need that one, I do not need this on, but, this we are fixing or prism at a particular position

in which position it cannot be arbitrary it cannot be arbitrary ok, why we have chosen this one. that when we replace the another source without disturbing the prism, we can get; we can get the spectrum for all colours after this we should not disturb the prism; prism will be at the same position same ways ok, we will not change the position of the Vernier only, we will rotate the telescope then reading we will change. direct reading and there is reading for this one. only this one after doing this one we will not touch the prism at all, we will just replace the source sodium source with another source.

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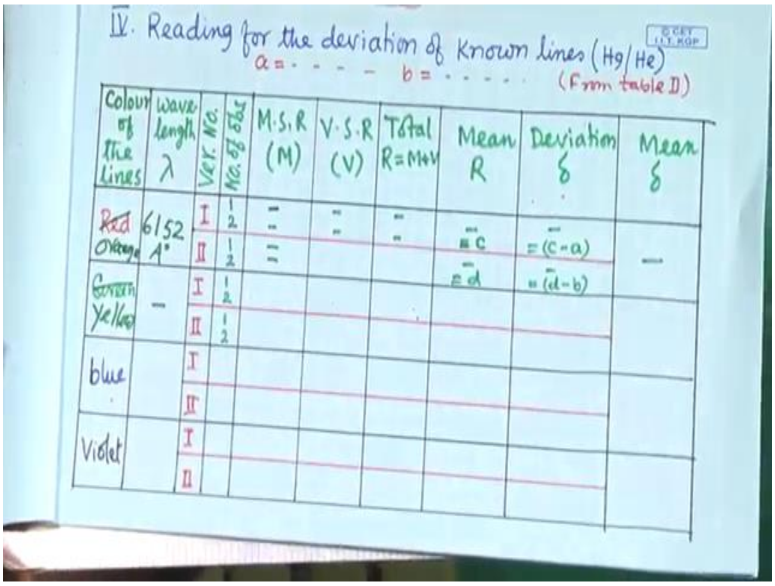

in this case we will use the mercury source as a known source. now, we will replace this sodium source with mercury source and take reading for the deviation of the spectral lines of the spectral lines and that spectral lines wavelengths are known from higher we know.

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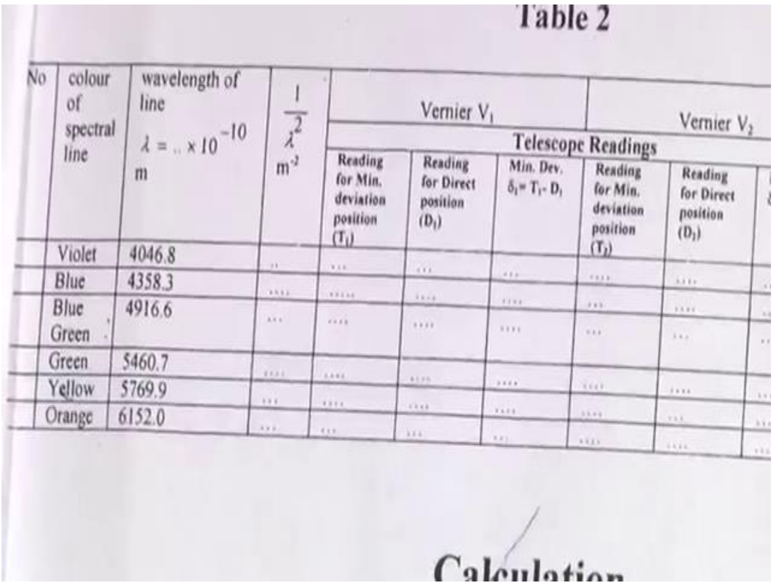

Table 2

No	colour of spectral line	wavelength of line $\lambda = .. \times 10^{-10}$ m	$\frac{1}{\lambda^2}$ m^{-2}	Vernier V_1 Telescope Readings: Reading for Min. deviation position (T_1)	Vernier V_1: Reading for Direct position (D_1)	Vernier V_1: Min. Dev. $\delta_1 = T_1 - D_1$	Vernier V_2: Reading for Min. deviation position (T_2)	Vernier V_2: Reading for Direct position (D_2)
	Violet	4046.8	..	...	...	...	....	....
	Blue	4358.3	....	.....	....	....	...	....
	Blue Green	4916.6	...	....	....	....	...	...
	Green	5460.7	....	....	....	....	....	
	Yellow	5769.9	...	....	....	....	....	....
	Orange	6152.0	...	...	...	...	....	....

Calculation

that I can show you we have a chart we have a chart basically; we have a chart you can see here. this for mercury source, spectral line of mercury source we will get spectrum of different colour. colour of spectrum is violet, blue, another blue, then green, then another green. intensity will be different and this then yellow then orange. their wavelength is given here. this wavelength we will use let us first replace the source and see whether we get this spectral lines of this colours and then we have to identify the colours at corresponding wavelength and then for different wavelength we have to take the reading of deviation just rotating the telescope

now, we will replace the sodium source without disturbing the system without disturbing the system please take it out and then put the mercury 1.

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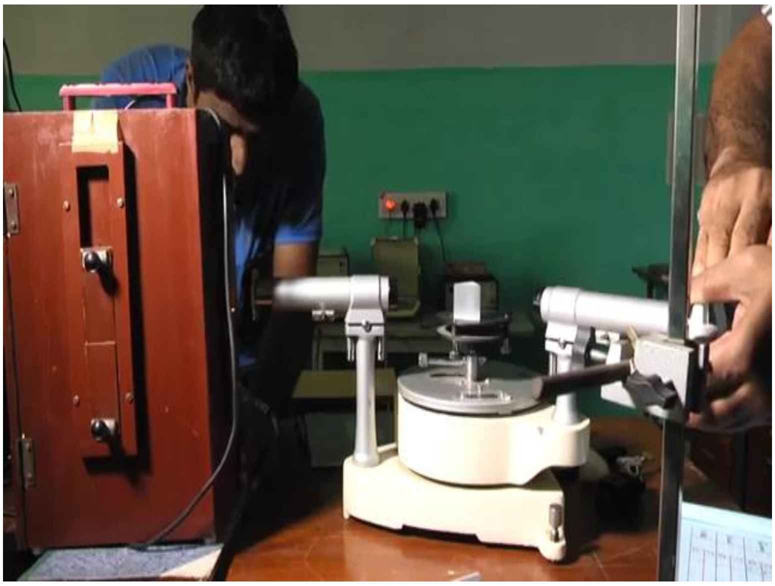

Yes, we have just this is the mercury source, this is the mercury source and you should not disturb the spectrometer just we will set.

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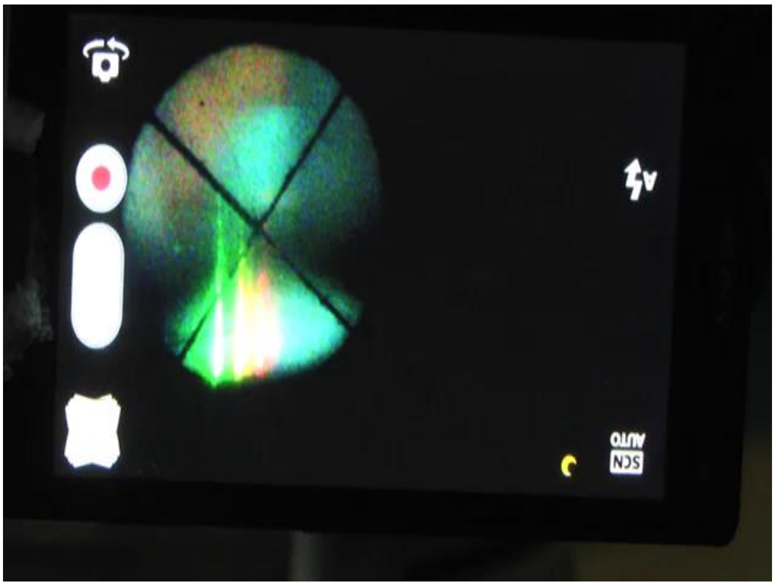

We will set and let me check whether we are getting yes, I think we have to set it once more, nicely if it has come you can see just I have replace the; I have replace the source earlier just yellow colour sodium D lines came for sodium source. Now, this mercury source and this for mercury source that is lighter coming falling on the prism and then we are getting separation of the; separation of the different colours.

what are the colours I told that is there should be prominence there are many spectral lines but, you may not see all? prominent colours one that should be red colours, I think violet, blue, then green, yellow, orange; how many I can see here, this is I think this violet this is violet and this orange, yellow, green I can see green I can see

green, blue, orange I think this the orange basically, it is not red looks red but, it is the orange then after that we are getting yellow; after that we are getting yellow. corresponding wave length is given for orange 6152 and then this for yellow is the 5769 and then you will get green you will get green this green you will gets this the 5460 and this other colour here violet is here you see but, it is the it is not very intense also here we cannot see.

But I think through the telescope I will be able to see all colours but, here just I am showing you the spectrum of the mercury lights. it is a for now I will just remove this camera my mobile and just do the experiment what I have to do, I just move I just move the telescope you know. and set for a you see I will set for this corsair; I have to set this corsair; I have to set. I think I should remove this one ok; I will remove my mobile from here just switch off this one, switch off this one.

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now let me see the spectra I can see very nice spectra, actually I can see yellow, I think orange and then orange looks 2 lines there, then yellow then I can see green, then violet is there is quite fares because, this wavelength difference is between the green and this violet. wavelength is before doing this 5460 and for violet 4046 almost it is the 1400 angstrom difference.

that is why. this deviation of this violet colour is more I have to take the spectrometers not spectrometer telescope away from this position. I will get this violet one anyway. now, what I have to do I will set corsair, I will set; I will set corsair on different spectral lines means, for different wavelength and corresponding reading I have to take. this as I showed in here. actually, this here I have shown is now mercury source

now I am getting the spectral lights that I showed you Now this is the 3 0 here. this is the direct one. that already we have taken this reading or at the end of the experiment we will take. Now, I will put the telescope at this position and take the reading then, put the second position second position spectral lines take the reading

if you see the table. that is that will be clear what I will do here, just arbitrary colour I have written is nothing to do with the colour here. what about colour you will see. just that colour is should right, and corresponding wavelength is should note down from the chart Now, for each colours; for each colours. I have to set the telescope corsair on that. I will use the fine screw for moving the telescope. now, I say that the telescope this corsair at a yes, it is the orange colour, it is orange colours

Now, for this orange colour this is not red, it is the orange; it is the orange and it is corresponding wavelength also I can note down I have chart for orange 6 1 5 2, 6 6 1 5 2 angstrom I have to note down and then I have to note down this reading from Vernier I and Vernier II reading from Vernier I and Vernier II. I need the I need the this one and also, I need light but, I am not going to take reading. how to take reading for Vernier I and Vernier II that we should take this reading and note down.

you take twice you take twice you can adjust these corsair position tries to take better way now or you can. there should not be parallax error. you can adjust your head and take the reading twice for Vernier I Vernier II you take the reading and as you know how to calculate. you will get mean R. here I am telling the c for Vernier I and d for Vernier II. c minus a, a for direct reading for Vernier I and d minus b, d is the direct reading from Vernier II. these will be the deviation.

And for this you will get the mean deviation. for this wavelength this is the deviation. Second again I have to; second again I have to put (Refer Time: 30:18) for the next colour, say I have put at yellow colour; yellow colours yes for yellow colour this is the say yellow colour. What is the wavelength from the chart I can as I showed you? I can note down and again take the reading of Vernier I and Vernier II right and get the deviation calculate the deviation. Similarly, set the corsairs at next colour ok, what is the next colours I think green

Then take the reading then set the next colours violet take the reading from Vernier I and Vernier II calculate the deviation. here your reading for deviation for non-wavelength is ready Now, you can plot graph you can plot graph or.

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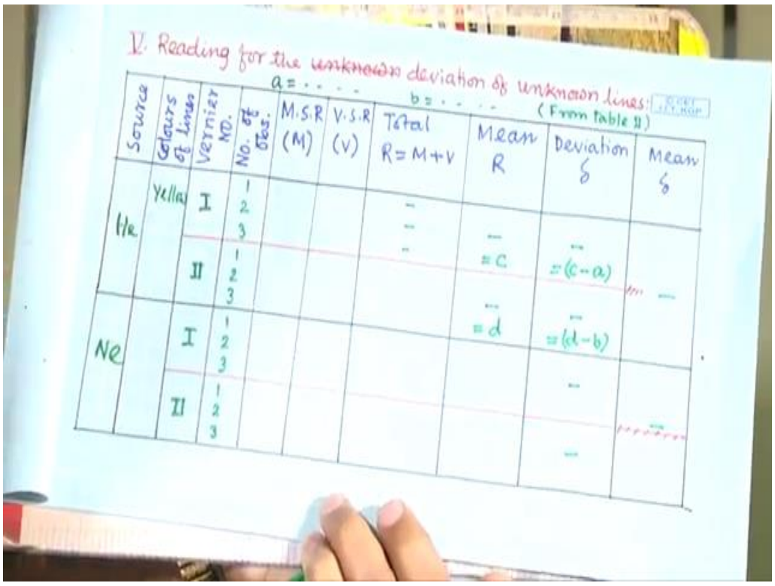

Let us plot graph later on but, before that let us take another source let us take another source The wavelength of that source is not known to us here we will take helium source say we do not know the wavelength although from chart you will find out. for comparison you can use that from experimental value and the standard value whether what is the difference. again, I will just now change with another source unknown source we are telling. here helium source we will use and let us change the source of with helium can you be just replace this; replace this source with helium.

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I think I will show you this we are changing helium if you want to see the spectrum of this helium spectrum of this helium. I will use this again this camera of my mobile and will show you I think let us first. this is the helium source and we have to we give power to the source then, it will eliminate

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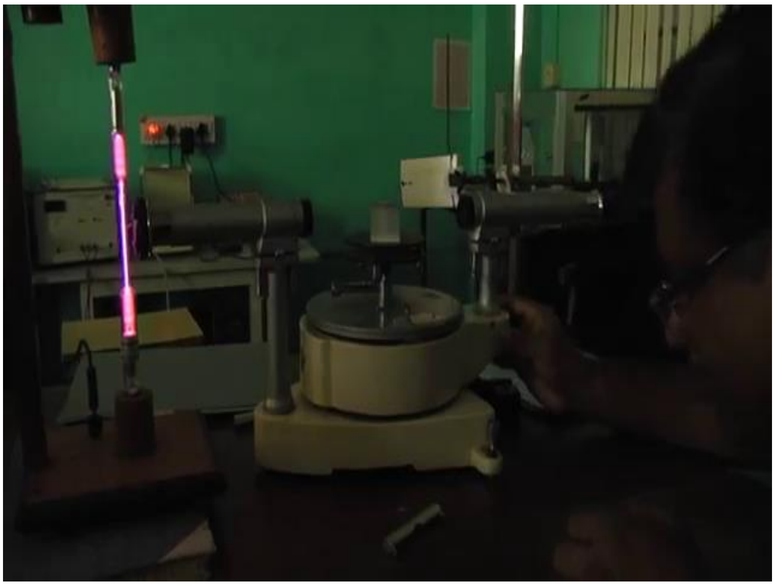

this is our helium source. Now, we have given power to the source it is the high kilo high voltage one has to apply and then let me see the spectra, let me see the spectra it is not ciliate, it is not prominent problem we have to wait for some time yes it is coming; it is coming, it is coming. I think I may need I think telescope I will I should not disturb the prism only I can change the position of the telescope as I mentioned I have to find out because, I have to find out the from here we are I can see yes I can see I think deviation only, I think this is the this position one has to find out basically, one has to find out yes, I can see this one.

finally, we have set another source unknown source is helium here. unfortunately, this source intensity is somehow is very week. that is why this I am getting the spectral lines very fine spectral lines. I think in camera I will not be able to show you but, anyway. I have to set this. I have to set this corsair at the minimum deviation position; at the minimum deviation position. I have to lock it and then set for this particular spectral line ok, note down the colour of that one

for I think he can take 1 2 3 spectral lines of different colour. he we have to or for different source you can use. here we are using helium source, you can use another source neon source but, I will not show you this one. same way you can proceed. here colour whatever I have set here.

that colour is to write it is yellow colour yellowish colour and for that prism Vernier I and Vernier II reading you should take and then this reading from there you will get the minimum deviation for this colour Similarly, for another colour also you can do this experiment you can use different source or you can use the same source ok, take the reading for that colour here for unknown colour unknown spectral lines you find out the deviation not minimum deviation.

Now, you should remove this one and take the direct reading I think I have to use it, at the end of the experiment as I told you take the direct readings set corsair at the direct one yes and you can fill up this one; this one.

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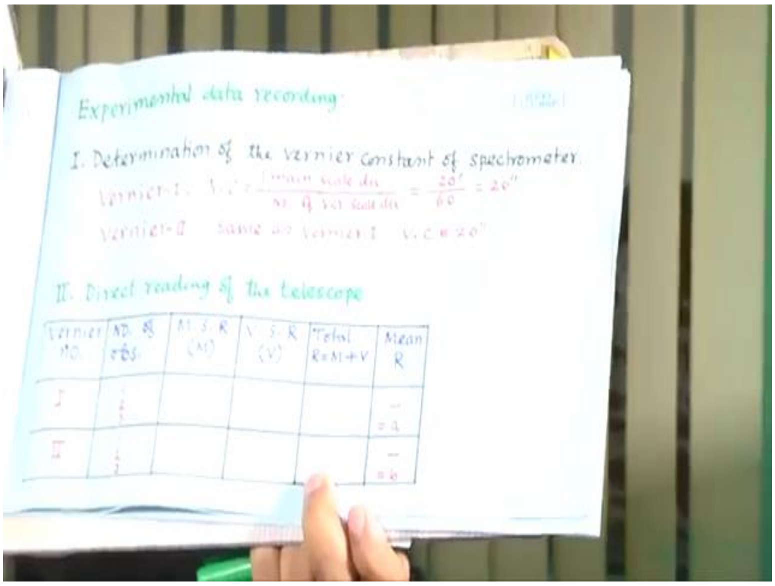

direct reading of the telescope take reading of Vernier I and Vernier II find out this a and b for Vernier I and Vernier II. You calculate deviation for sodium lines.

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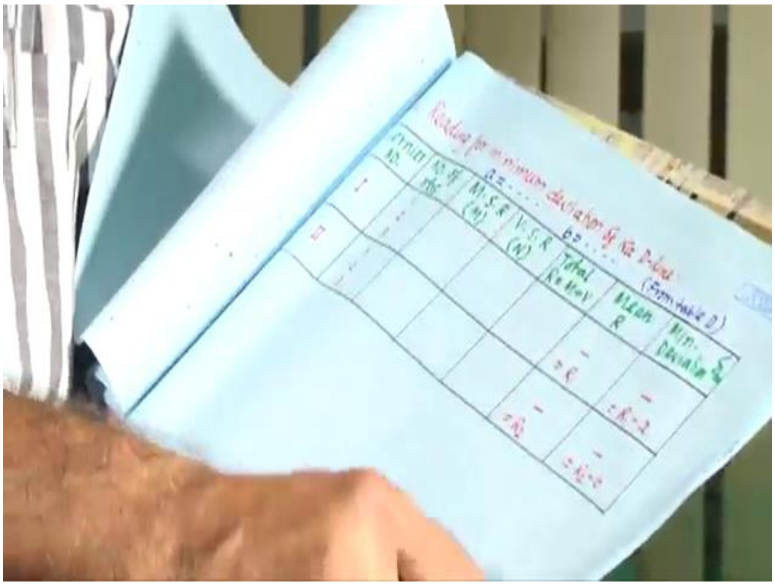

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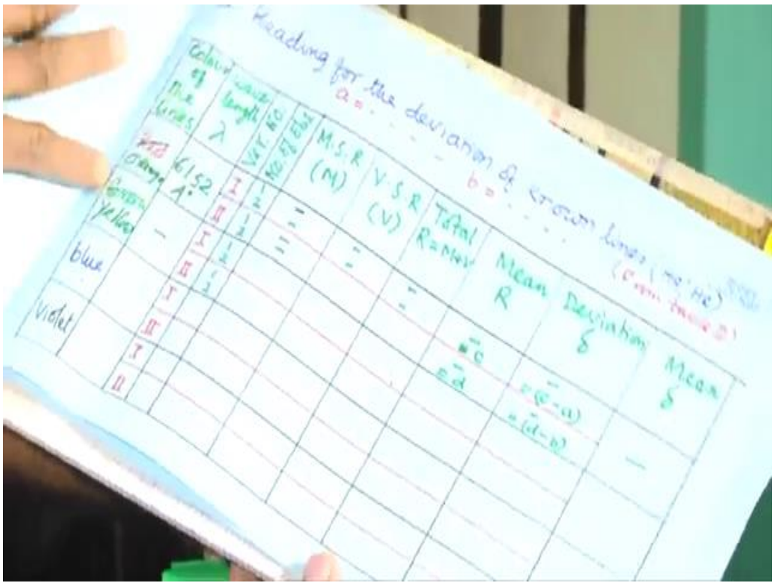

You calculate deviation for known wavelength ok, you calculate the deviation for unknown wavelength. Then just here make a table for data for plotting graph wavelength and you write wavelength and then corresponding deviation, whatever we got from table 5 and table 4 and for unknown wavelength also deviation we got.

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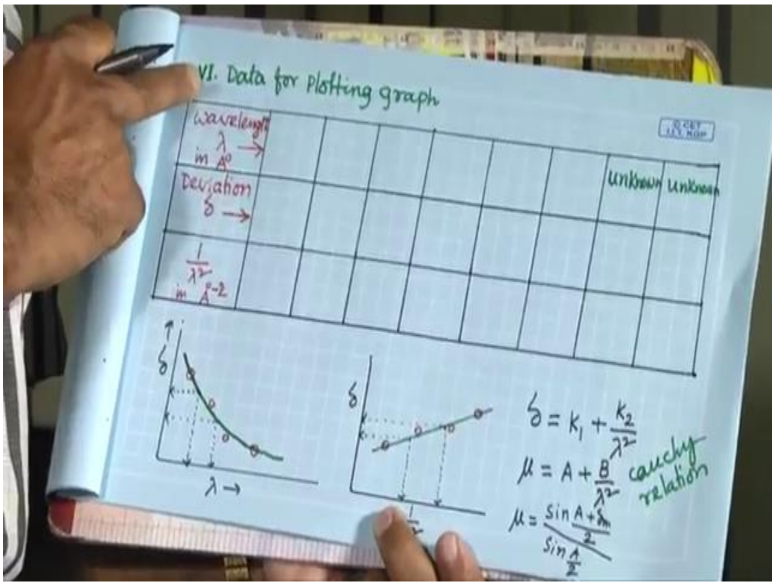

Now, you can plot it ok, if you plot deviation as a function of wavelength see we will get this points and then you fit it just you draw a mean curve this curve generally it will be like this and also this file. this is the; this is the dispersive not dispersive curve, this called the calibration curve, deviation verses wavelength. Now, for unknown wavelength whatever deviation that deviation if you put this deviation in the plot. here says this the one deviation from this table.

corresponding wavelength you can find out. this is the wavelength unknown wavelength as I it was unknown now; it is known from this calibration curve. Second unknown line. if deviation is this one. this is the point on the curve. corresponding wavelength you can find out thus you can find out the wavelength of unknown spectral lines using this experiment

also you can verify the Cauchy's relation this it is the mu equal to a plus b by lambda square, also it can be similarly relation it can follow this delta deviation equal to K 1 different may be different constant K 1 plus K 2 by lambda square, because in mu this is A plus delta m this delta deviation depends on the wavelength

this mu refractive index it depends on deviation and the deviation depends on the only deviation depends on the wavelength. this type of relation Cauchy's relation it can be; it can be if written in terms of deviation also this way. if this relation is valid for this deviation. if you plot deviation verses 1 by lambda square. you will get the straight line actually you can verify whether Cauchy’s this relation is it is valid for the deviation or not. one can verify that one plotting delta versus 1 by lambda square.

Anyway, that is a different story but, main aim for this experiment is to find out the; find out the unknown wavelength for spectral lines or wavelength for unknown spectral lines for that first we have to; we have to give the calibration curve, what is that calibration curve? Delta versus the wavelength known wavelength. Now, from using this calibration curve, if you measure; if you measure the deviation for unknown wavelength ok, spectral lines of unknown wavelength.

now, using this curve we can find out the wavelength of thought of the spectral lines that is the nice experiment how using the prism spectrometer one can measure the wavelength of the spectral line. I will stop here.

Thank you.