Experimental Physics - II
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Lecture - 25
Determination of the angle of prism

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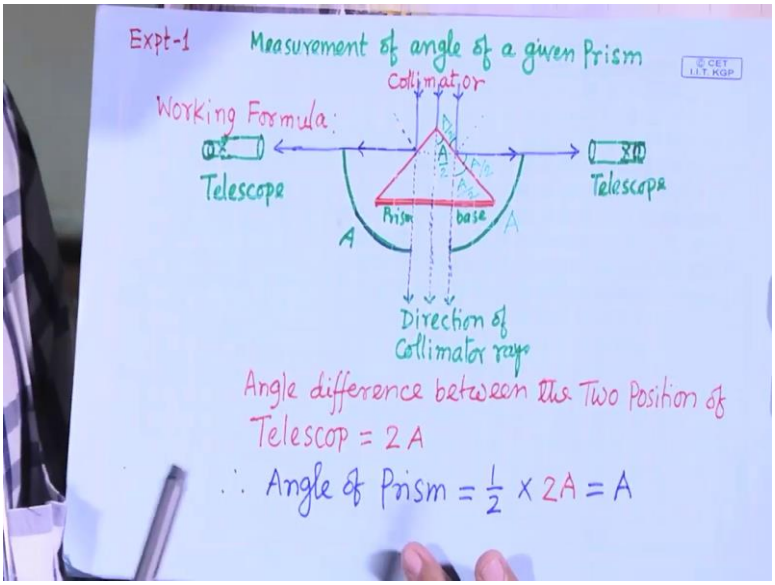

So now, I will demonstrate how to measure the angle of a given prism this is the experiment 1; measurement of angle of a given prism. what is the working formula for this? see this is the prism from collimator parallel rays are coming and falling on the prisms. prism we have put on the prism table in such a way this apex ok, it is towards the collimator and just base of the prism just opposite side of the collimator or towards the telescope.

Now, light or parallel light of falling on the prism. you can see these two are this is the base that mean these, and these two faces are the refracting face transparent face, or it can reflect also. here you can see half of the light will fall on this face and half of the light will fall the other face light will reflect this ray say is reflected in this direction and this ray will reflect in this direction

before so these the this is the from collimator if prism is not there. these the direction of the light, direction of the collimator rays now because the prism it is reflected, it is reflected in this direction also from this surface in this direction. So now, you just think

that this is a reflecting surface. if I take out this prism and if I think that, they mirror I have put that is the parallel to the mirror space, surface is parallel to the incident rays ok.

incident rays will they will pass in this direction. Now, if I if I just make an angle rotating this one if I am keeping the incident rays fixed, if I rotate mirror; if I rotate mirror by angle theta then reflected ray will move by 2 theta will rotate by 2 theta. that is the standard fact we know; if mirror is rotated by angle theta then reflected ray will rotated by 2 theta. here we see this face actually if I think that, it is a from these direction its rotated by angle A by 2. If these the angle of the prism is A this half angle half angle this A by 2.

So now, this deflecting face is from this place if I think that is rotated by A by 2 then reflected ray this ray will be rotated by 2 theta means A by 2 into 2 by; that means, A similarly other side also this face is its say from here we can think that is rotated by A by 2. reflected ray; reflected ray this ray will rotated by 2 into this angle A by 2 so A. this angle between these two reflected rays two reflected rays from the two faces; from the two faces this angle is 2 A ok.

if I measure; if I measure putting the telescope here, if I measure the angle if I measure the what is the; what is the reading of the telescope when it is at this position. And, then take the telescope in this direction and what is the reading of the telescope. if we take the difference of these two reading then I will get this angle and that is 2 A; that is 2 A angle of the prism will be then half of it experimentally what we have to do?

We have to put the prism on the prism table like this ok, keeping affects towards the collimators and opposite to that one is base And then we have to see the reflected ray in the side, put the telescope, take the reading and take the telescope in other side, find out the reflected rays and take the reading of the telescope when it is at this position And, then we can find out the angle of the prism; this is the experiment ok.

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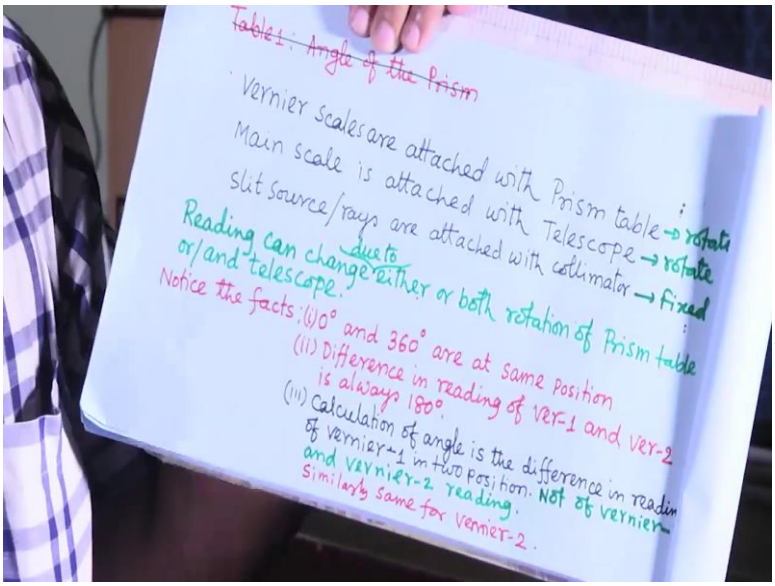

before doing measurement, let me tell you; let me tell you few things.

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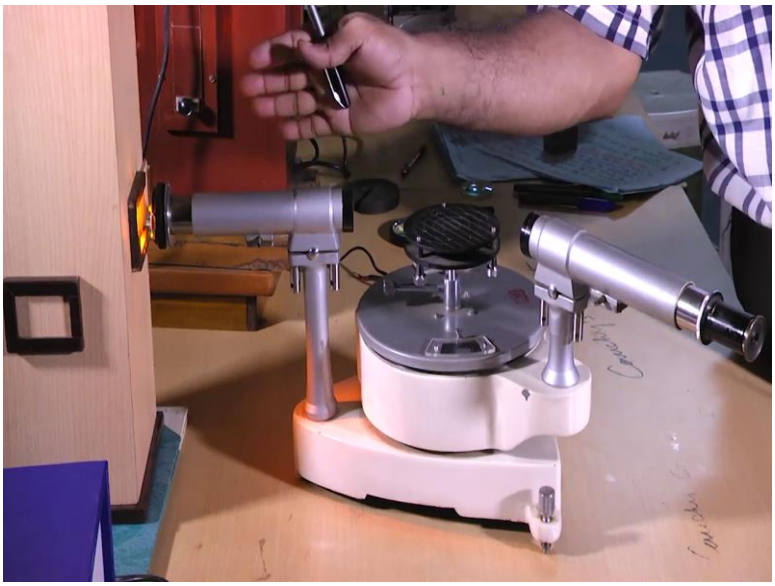

this is the spectrometer I have showed you this is the base basically; this is the base and this base on 3 is leveling screw and this telescope is fixed with this base collimator is fixed. this base we cannot rotate move ok; telescope is fixed with this base. telescope is fixed; telescope will not rotate the telescope so; that means, in telescope what is there sorry not telescope collimator. collimator is fixed, it is attached with the base So that

means, this collimator in collimator what is there? We have slit here, source slit source and from slit source light are coming falling on the lens and parallel rays are coming.

this collimator is fixed means incident, incident these rays are coming from the collimator and falling on the prism. these rays incoming rays are fixed, we cannot rotate. that is why slit source are rays are attached with the collimator that is fixed. Vernier scales are attached with the prism table. this the prism table ok, this is the prism table and prism table height we can adjust using this tightening or loosing this one Now, this prism table is attached with this Vernier base Vernier is attached with this prism table.

that is what so; that means, if I rotate the prism table; if I rotate the prism table Vernier will rotate. reading will change; reading will change that I will tell you in detail. And then this telescope, telescope is attached with the main scale, main circular scale. if telescope rotate; that means, reading will change, if prism table rotates, Vernier rotates then reading will change. for the experiment sometimes I need the provision to change the prism to change the to rotate the prism table without rotating the Vernier. in that case actually there is a provision here.

this we have to fixed it, clamped it and then we can rotate it; in this case you see Vernier is not attaching. when I am rotating this one Vernier then this table also rotating. Now, if I just without changing the Vernier; that means, without changing the reading I have provision to change the prism table. That means, I can change the angle of the; angle of the incident; angle of the incident ray etcetera. this is very important during measurement**.** without changing the reading, I can change the angle of incident ray on the prism

if I change this one reading will change because Vernier using (Refer Time: 11:19), if I change the position of the telescope we can change the reading can change due to either or both rotation of the prism table and or telescope here prism table means I mean this one but notice the facts in the scale if I open this one this the circular scale in this circular scale 0 to 360 degree angles are there; 0 to 360 degree angles are there 0 and 360 degree are at the same position, on the scale; on the scale they are on the same position. Also, there are two Vernier's, there are two Vernier; Vernier 1 and Vernier 2 other side ok, this 2 Vernier.

These two Vernier's are they difference in reading of Vernier 1 and Vernier 2 is always 180 degree their angle is 180 degree third one is calculation of angle is the difference in reading of Vernier 1 in two positions. Not of Vernier 1 and Vernier 2 reading calculation of angle if how much it is rotated if I want to find out actually, we have to take. for this position what is the reading of Vernier 1? What is the reading of Vernier 2? now I rotate it; now what is the reading of Vernier 1? What is the reading of Vernier 2?

So now, this angle of rotation if I want to find out that is difference of two reading of Vernier 1 ok, also the same difference you should get from the difference of two reading from Vernier 2 these two always separately we use ok, we never mixed, we never subtract or add reading of Vernier 1 and Vernier 2. Whatever the subtraction, addition whatever these for Vernier 1 and separately for Vernier 2 And when we will take this reading for particular for this position; say suppose this reading is 40 and other one other one is how much it will be?

See if some student tells sir it is 110 210 it is wrong if you remember that they are at 180, they are difference is 180. if it is 40 it will be 180 plus 40 220 it may not be exactly 220, but it will be close to the 220s. always one should cross verify when you are taking reading; there should not be measured mistake in taking reading.

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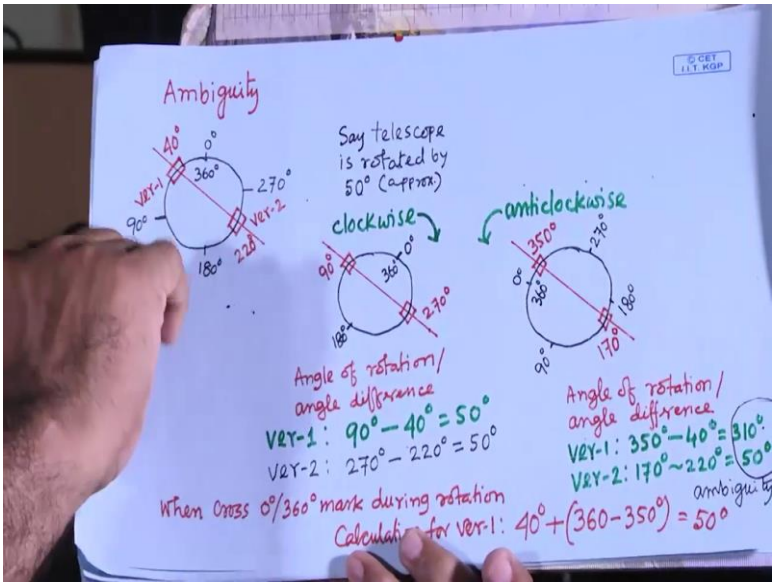

Next another thin I would like to discuss this ambiguity during taking reading or during calculation of the reading. these also generally we do mistake. this is the main scale

circular scale. 0 and 360 degree same point. if it is 0 or 360 then it is 180 this this 90 and this is 270 and in between 1 2 3 4 etcetera. here so these marking is 0 10 20 30 40 like this Now, this is the Vernier position, if this is the Vernier position 1 Vernier reading is 40

something like this 1 reading of the Vernier is a say Vernier 1 see is 40 and Vernier 2 if I see this reading is 220. this is the initial position I have noted down the reading. I may need to rotate it clockwise or I may need to rotate it anticlockwise depending on my experiment, depending on my demand if I rotate it clockwise by 50 degree say telescope is rotated by 50 degree approximately. if I rotated it is the clockwise, clockwise means this way ok; if I rotated it by say 50 degree. What will be the reading of the Vernier? If you see the reading of the Vernier; what I have rotated?

I have rotated Vernier that is constant, this part is constant keeping constant; I am not rotating the prism table this part remains this same position. actually, I rotate the I have telescope means I have rotated the; I have rotated the main scale, main circular scale by 50 degree; that means, we have 40 then more 50 is rotated. this 90 will come at this position Vernier 1, 90 will come at this Vernier position and 270 that reading will come at Vernier 2. reading will be if you see the reading; we will see this reading will see this 90 degree and this reading is 270 degree

fine because then as I told we have to take difference of this two reading of the Vernier 1, to reading of the Vernier 90 degree minus 40 degree equal to 50 degree and we can take that difference of two reading of the Vernier 2. Vernier 2 270 degree minus 220 degree equal to 50 degree this rotation I have given 50 degree as I just told. from calculation we will get 50 degree from both and then take (Refer Time: 18:57) exactly not 50 degree, it is a 49 degree, 59 minute say 45 second. using the Vernier constant one can find out. then reading or angle of rotation whatever from Vernier 1 we will get an Vernier 2 we will get, then we will take the average of these two reading.

We come back; we come back to this original position when again this position Vernier at reading as is the 40 degree and other one is 220 degree Now, you rotate it anticlockwise by 50 degree again, you rotate it anti clockwise by 50 degree again. anticlockwise I will rotate it anticlockwise approximately by 50 degree again this Vernier are fixed, we have not touch this table during will change either you change the

telescope position, or you change the Vernier this prism table position we have kept the prism table position fixed means Vernier fixed.

when rotated by anticlockwise main scale is rotated by 50 degree what will happen? this part will come at this Vernier position at this Vernier position this series what is this? 1 2 3 up to this these are 350 and then 360; here this side this part has come below the Vernier. reading say it is 350 degree ok, it will show 350 degree and the other side it will; this will go there anticlockwise have rotated the 170. Vernier 2 it is giving reading 170 and this reading is 350 degree Now difference between these two reading; difference between these two reading of Vernier 1; what is the difference? 350 degree minus 40, it is 310 degree and difference of these two reading 220 minus 170 220 minus 170 or whatever.

170 difference between 170 and 220 that is the 50 degree I mention that I rotated it approximately 50. this Vernier 2 it is giving me this rotation, this reading result I am getting 50 degree, but Vernier 1 is telling me no this angle of rotation, this whatever rotation it is 310 degree, but it is impossible. It this both has to be same approximately same, there may be difference in second or in minutes what is the ambiguity? What is the ambiguity? Here look when I am rotating it is the anticlockwise; that means, that 0. when 0 is coming here so; that means, it's already it is rotated by 40 degree.

And then it is rotated more 10 degree then this reading is coming 350 this 40 degree and this is this rotation is extra 10 degree. how we find out this 10 degree? 360 degree minus 350 in such case we have to take 40 plus this plus, this reading is not 0 its 360 degree minus this 350 degree, that is 10. 40 plus 10 equal to 50; calculation for this Vernier 1 we have to do like this 40 degree plus 360 minus 350 degree equal to 50 degree that is the ambiguity one has to be very careful during calculation ok.

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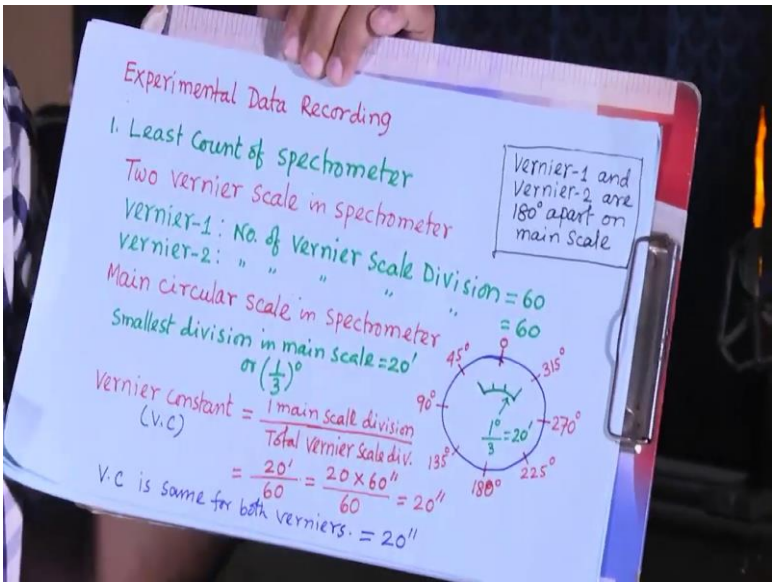

now let us do the experiment, record the data. we have to record experimental data, experimental data recording. first task is to find out the least count of the spectrometers ok; that means, Vernier constant of the two Vernier's ok; Vernier 1 and Vernier 2. what we have to see? They are how many division?

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from here I have to see how many divisions there are I can see 0 10 20 30 40 50 60, 60 divisions are there. We have to note down Vernier 1, number of Vernier scale division equal to 60, smallest division Vernier 2 have also this 60, both are have been same

Vernier constant. Now, one has to find out main scale; what is the smallest division in main scale. we have to see we have to find out for your spectrometer, in our spectrometer 1 degree between 1 degree there are 3; there are 3 division. 1 division is 1 division is 1 by 3 degree

smallest division in main scale equal to one-third degree or 1 degree we know the 60 minute; it is a 20 minute. Vernier constant is 1 main scale division divided by total Vernier scale division. if we calculate it is the 20 second. for both Vernier the Vernier constant is 20 second, that one has to find out first Then set the experiment as I showed how to set the experiment, as I showed you; as I showed you that this is the geometry of the experiment this is the base, this is the apex it will be towards the collimator, this my prism. this is the apex, this is the apex ok, this prism angle.

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here we have taken sodium source is a single wavelength sodium d line ok, yellow color see its wavelength is 500 5893 5893 most probably Angstrom 5893 Angstrom. this spectrometer is leveled and also it is focus for parallel rays how to do that, I explained. one has to do that using the spirit level, putting here, adjusting this etcetera. I will not repeat that one.

now I have to this is the base just opposite to I will put this way, I will put this way. generally, this way we can put. here initially what these two Vernier scale a we should keep in this position. that you can take the reading easily in both side. So now, this one

approximately I will put apex is towards the collimator and that base is other side then what we should do? We should do we should just look there will be reflection from this face and there will be reflection from the other face ok.

with their I we can just approximately see ok; I can see here; I can see here the reflected one. then I will what I have to do? Now, I will clamp; I will clamp the prism table ok; I clamp the prism table. this Vernier will not change the position will not rotate. whatever the change of reading, it will come due to the telescope. telescope I will take in this position in this position yeah. approximately I have taken the at the position of the reflected rays; reflected rays. So now, I will just tighten this part I should tighten this one, but here there is this obstacle any way.

using this screw one can just change the cross wire position of the cross wire and make it coincide with the line ok, spectra line. one should do that and. say it is at this at this position cross wire is aligned or here this cross position, I put on the line is like this. This is the line, and this is the cross wire ok, this way I have put. Now, I have to take the reading of Vernier 1, reading of Vernier 1 and then 1 should take the reading of Vernier 2. then you need table data table for recording the data.

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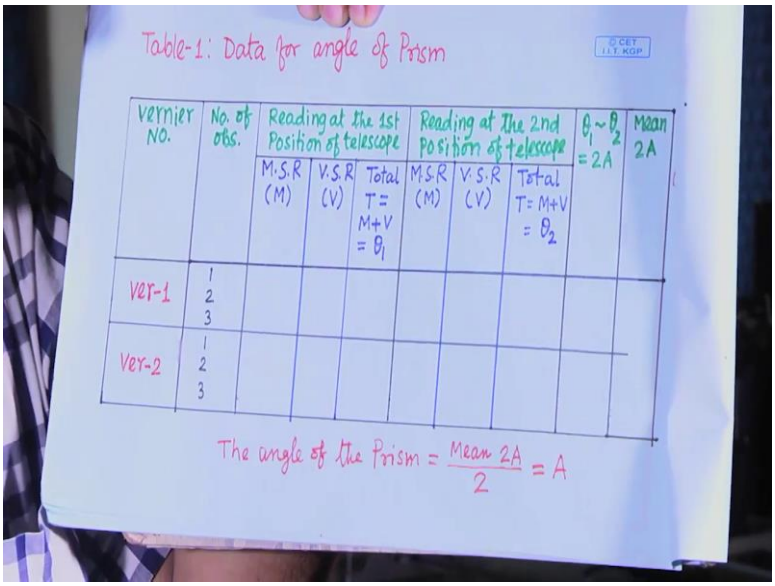

this is the table; from the table what we have to measure we can understand. here this column is Vernier number; I have two Vernier; Vernier 1 and Vernier 2; the number of observation means in Vernier 1. we will measure 3 times and at the same time this for

Vernier 2 simultaneously we will get this reading at the first position of the telescope, at the first position of the telescope reading at the second position of the telescope. Means, if I take this is the first position of the telescope for this position, I will note down the reading of Vernier 1, note down the reading of Vernier 1.

What is the main scale reading, main scale reading and then this just simply (Refer Time: 31:21), for same way? The way we have taken reading from (Refer Time: 31:26) for same way. main scale reading then Vernier scale reading ok, here this Vernier constant you know this 20 second. including that one one can write this Vernier reading. then total reading is this M plus V ok, then you can just disturb it; again, come back here, then take the second reading.

for Vernier 1 here we have taken reading and then for Vernier 2 we have taken reading. just you disturb it and come back again take second set reading second set reading, then third set reading the just to minimize the error experiment of error we take generally not a one data or more than one data. here we will take reading for the first position of the telescope, I have to see yes I can see and then take the telescope in this position I got it actually I have to tighten it, yes I can tighten it and then I can use this fine screw to move it ok, to align this one.

Now, take the reading taking reading in same way for the second position ok, for the second position of the telescope you take the reading from Vernier 1 observation number 1. Then for Vernier 2 observation number 1 take reading and then again you disturb and come back again or just you try to align properly, try to get more accurate and then again take reading. this way 3 times we take reading for both from both Vernier Now, here if this is theta 1 and this is theta 2 from is setting, we will get for observation number 1.

we will get theta 1 minus theta 2, for observation number 2, 3 you will get 3 data yes, here also we will get 3 data ok; they should be more or less approximately same there may be difference or there may be mistaking taking reading that is what now we have 6 data ok, now take average of this 6 data that will be the mean 2 A. whatever reading you are getting here that I mentioned that that is 2 A 2 A. we will get 2 A, now angle of the prism we can calculate mean 2 A whatever we get divided by 2 is equal to A ok.

this experiment is very simple and nice important fact is that; we have to; we have to be habituated with the leveling of the spectrometer and with the Schuster's method or other

ones, other method I mention that if you a focus the telescope instant object; that way also we can get the parallel, we can get the condition for parallel rays. after that you have to understand the theory, geometry of the experiment whatever we are going to do and according to that geometry we just do the experiment, take the reading properly and calculate. here I demonstrate how to measure the angle of prism. I will stop here.

Thank you for your attention.