Experimental Physics - II
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Lecture - 10
Basic Components (Contd.)

I will continue the leveling of the prism table, not prism table, but spectrometer, as we were discussing in last class. Using the spirit level we have tried mechanically, we have tried to make the telescope tube, collimator tube and prism table horizontal and I will continue the discussion.

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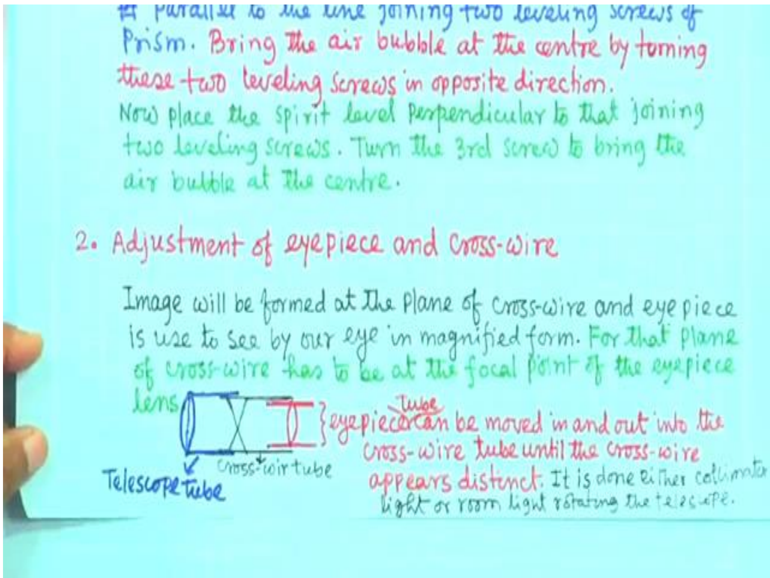

The next important part is the adjustment of eyepiece and cross-wire. Already I was mentioning when I was showing the picture. Adjustment of eyepiece and cross-wire, as I told that there is a tube. In that tube the cross wire is fixed. you have a tube; you have a tube. In that tube this cross-wire is fixed. That is what I have shown here.

Now, this tube you can put in, you tell, this is cross-wire tube. This, I think, this cross-wire tube, we put inside the telescope, you can push, I will take this, you can push, you can take in and out of this tube in the telescope tube.

Now, eyepiece this is the eyepiece, it is this lens is fixed in another tube, that tube again you can insert into the cross-wire tube. Eyepiece tube can be moved in and out into the cross-wire tube until the cross-wire tube appears distinct. So; that means, when it will be distinct; that means, the cross-wire is at the focal point of this eyepiece. That is what here adjustment of eyepiece and cross-wire.

it is done either collimator light or room light rotating the telescope. you have to use light to for this adjustments. Either you can use this collimator light or you can rotate the telescope and take the room light and then you can look through the eyepiece move eyepiece in and out if to see the cross-wire distinctly. So; that means, you are seeing the image of the cross-wire through the eyepiece lens; that means, it is at the focal point of the eyepiece lens.

This other telescope tube and this cross-wire tube now this is fixed will not disturb now, a focusing knob when you are rotating when you rotate. This cross-wire tube will move in and out of this telescope tube to put it at the focal point of the of the telescope lens.

That is the next step after mechanical using the spirit level, the next step is the adjustment of eyepiece and cross-wire, you can actually you can take it out and see eyepiece you can see and then you can insert into the cross-wire tube and then you will see this when you are rotating the focusing knob; that means, this eyepiece is going in and out that you can see.

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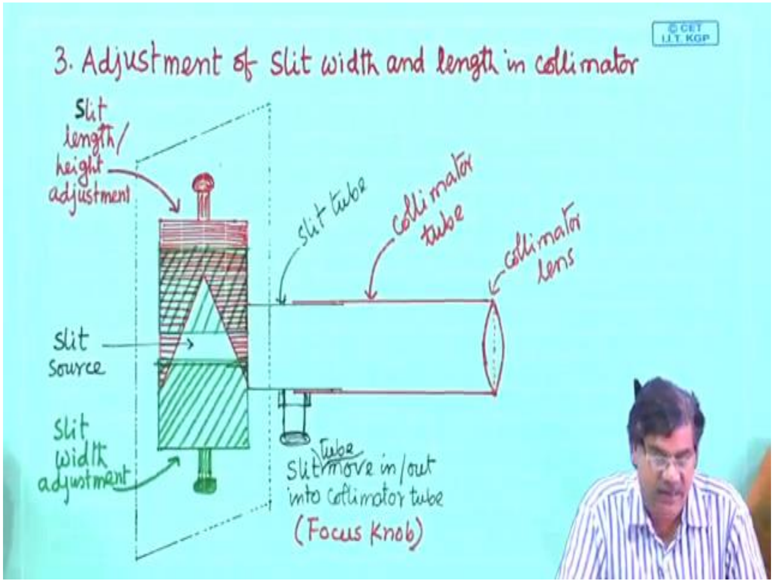

Then third step after mechanical leveling and the adjustment of eyepiece and cross-wire, next adjustment is of slit width and length in collimator. in collimator there is a collimator lens as I told and then this is a collimator tube and other end other end the slit; slit is attached with the with the tube with a slit tube. That tube you can take in and out using the focusing using the focusing knob as we mentioned, but this slit here I tried to show that it is on in this plane it is in this plane.

That is what I have drawn like this; it is in this plane. Here this is this and this other part is this you can this is the slit basically. you can this width slit width, you can change using this just you can push in and out; push in and out, you can change the width of this slit and another adjustment is there is a like this you know. You can push in and out. When you are pushing in this side you are decreasing the height; you are decreasing the height and if you are taking pulling out this side you are increasing the height.

This is the arrangement in the in the slit to adjust the slit width and length in the collimator for adjustment of this width and length this is the mechanism that I tried to show in a drawing a picture.

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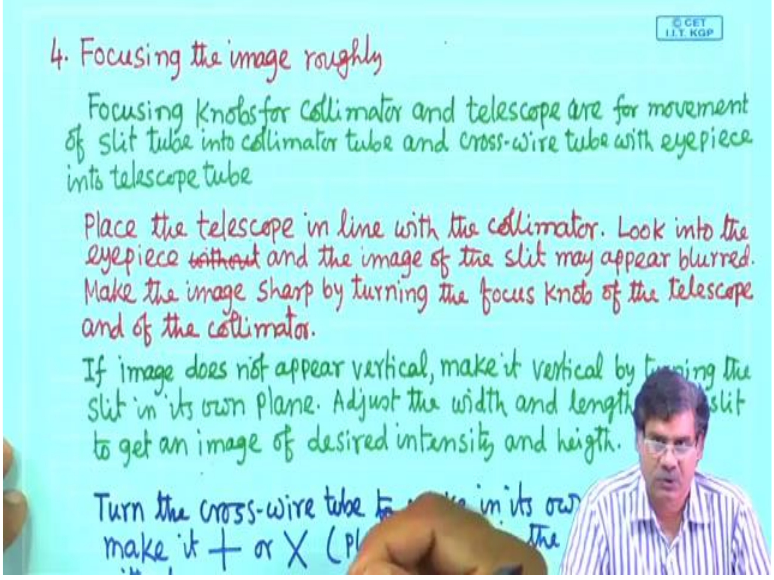

Then next we have to go for focusing the image; focusing the image so; that means, the collimator is a source of light; is a source of light prism table is for is a source of optical device either lens or prism or the grating and then telescope is for seeing the image Focusing the image roughly slit source are there on prism table nothing is there.

Through the eyepiece in the telescope, you want to see the image of the slit at the screen means at the plane of the cross wire. to see that one roughly we have to just rotate the focusing knob of collimator and the telescope to look at the image. to make it sharp roughly to make it sharp just you try to adjust the focusing knob of collimator and telescopes, that your image will be sharp.

That is why focusing the image roughly. When you are rotating the focusing knob what you are doing, you are doing changing the position of the slit source and you are changing the position of the cross-wire where image will be formed. it will be focused when they are roughly at the focal point of the collimator lens as well as the telescope lens. but we are not sure that whether they are at the focal point or not, but when they will be close to the close to the focal point of these two lens the source as well as the cross wire.

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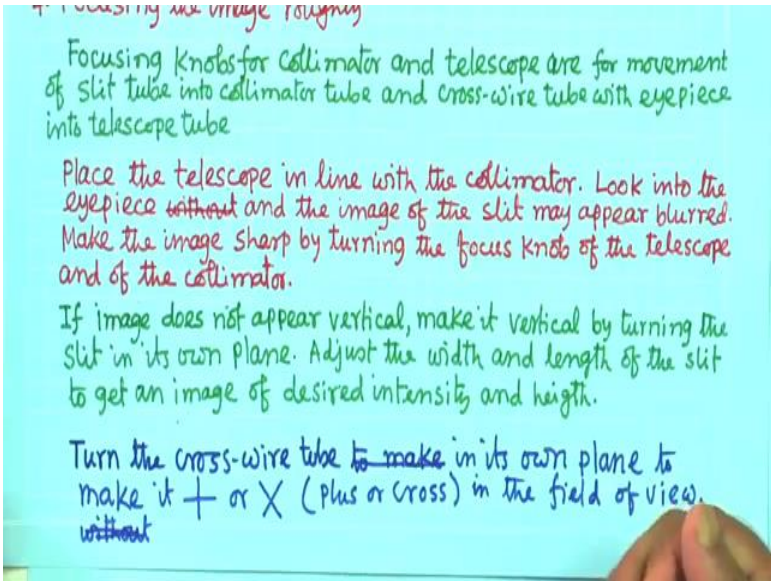

Then only you will see the sharp image that is the rough focusing for the image. Then that is what I have I have described here written here. Place the telescope in line with the collimator, look into the eyepiece and the image of the slit may appear blurred. Make the image sharp by turning the focus knob of the telescope and of the collimator. if image does not appear vertical, make it vertical by turning the slit in its own plane there is a also provision to rotate the slit in its own plane adjust the width and length of the slit to get an image of desired intensity and length.

Turn the cross wire tube in its own plane to make it also either this cross this plus or this cross in the field of view. So; that means, there is a scope to turn the cross-wire means cross-wire tube you can rotate and this slit also you can rotate the slit in its own plane to make it vertical . Then things are you are seeing image.

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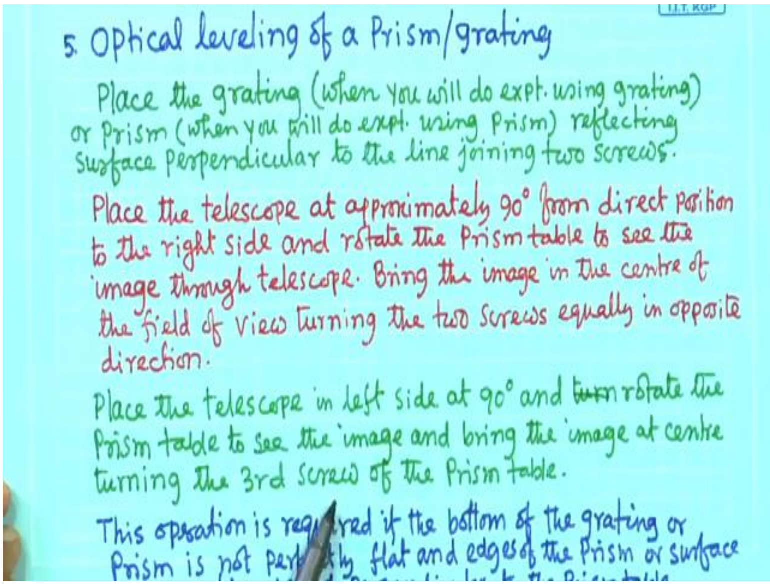

Now, as I told that we have to make these three telescope, then prism table and the collimator there axis will be. Their surface length and surface of the prism table they have to be horizontal and also normal to them has to be vertical. to make sure that they are satisfying these conditions next step is optical leveling of a is not that is not done. Now, you are using the optical device on the prism table. When you are using optical table on the prism table. The surface of the optical table optical device, surface of the optical device either it is a prism surface or the grating holder.

They may not be smooth surface, they may not be the vertical their axis may not be vertical. For that we need again leveling that is we tell the optical leveling. This prism place the grating when you will do the experiment using grating or prism when you will do the experiment using prism. If you use grating, put grating if you use the prism for your experiment. For optical leveling, you use the prism and reflecting their reflecting surface that has to be perpendicular to the line joining two screws.

Again the way spirit level you put this way either one edge of the reflecting surface of the prism or one face not edge or the reflecting surface of the grating. That you put perpendicular to the line joining the two screws. Place the telescope at approximately 90 degree from direct position to the right side and rotate the prism table to see image through telescope. Telescope you put approximately 90 degree and rotate the prism table, on prism table we have either grating prism.

try to see the image through the telescope; that means, that reflecting surface it has to be 45 this angle has to be 45 with the with the collimator. Then you will get reflection at 90 degree. bring the image in the centre of the field of view turning the two screw equally in opposite direction in the same way as you did for using the using the spirit level. Now, place the telescope in left side at 90 degree and rotate the prism table to see the image and bring the image at the centre turning the third screw of the prism table.

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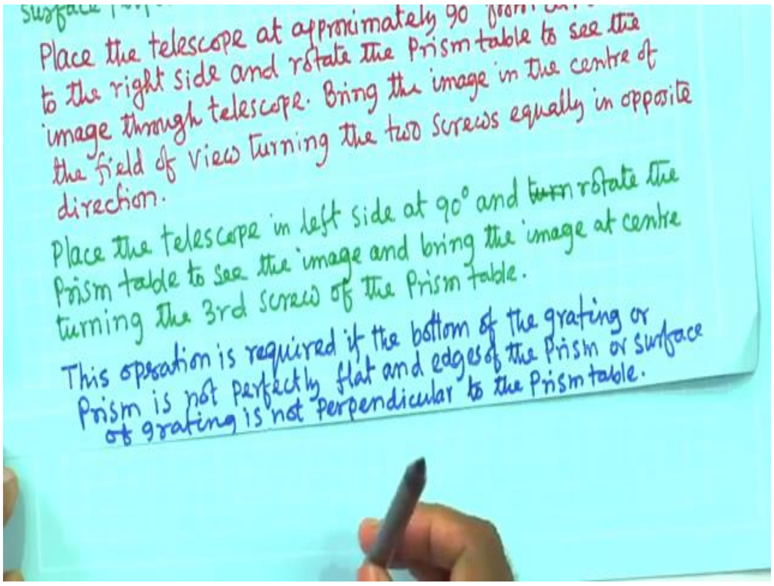

This operation is required if the bottom of grating or prism is not perfectly flat and edge of the prism or surface of grating is not perpendicular to the prism table. if this is the case and reality that happened for that you have to do the optical leveling to make sure that this purpose is to make this because prism table will rotate now, this your prism is there.

If this prism is not edge is not vertical or its refracting surface is not vertical. This again purpose for leveling the whatever the purpose of the leveling that will not be fulfilled. That is why this operation optical leveling is required for the prism or grating.

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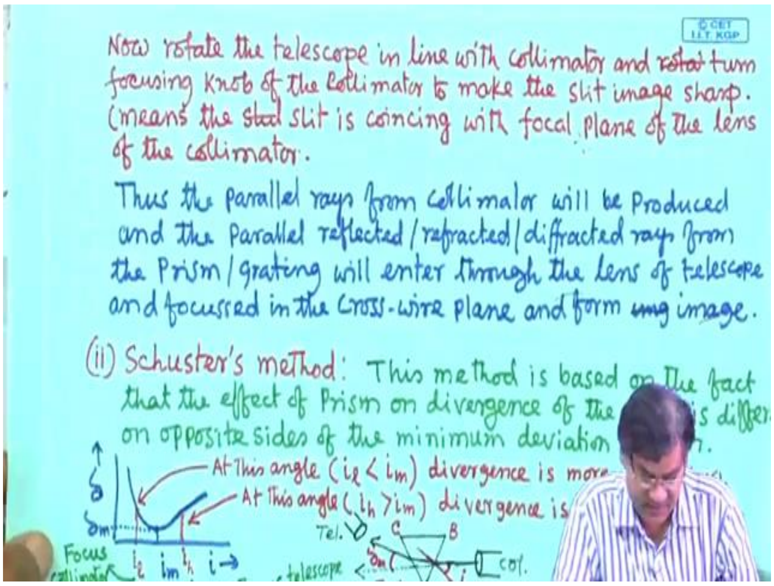

Now, rotate the telescope in line with the collimator and turn focusing knob of the collimator to make the slit image sharp, means the slit is coinciding with focal plane of the lens of the collimator. Thus the parallel rays I think this is ok.

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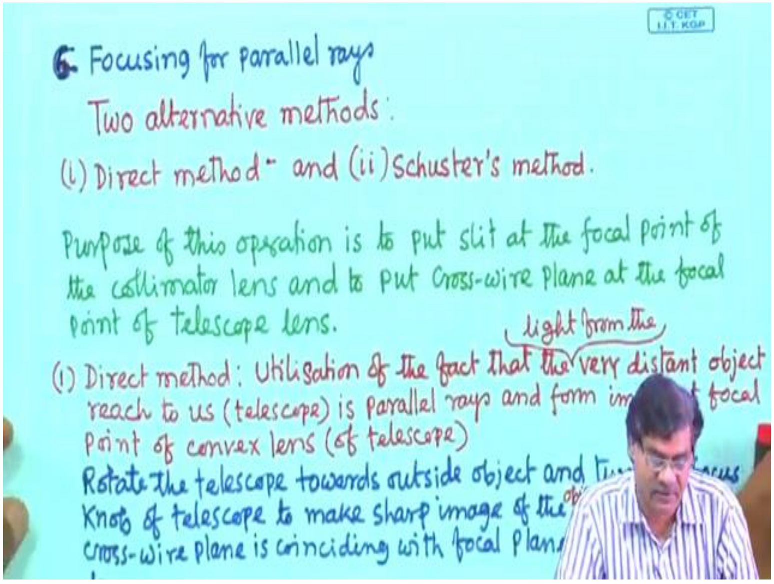

I think this page I have to show. Fifth one was that one optical leveling was fifth one that is the next step is focusing for parallel rays next step is focusing for parallel rays. Roughly we focused to make the image sharp now there is a method to make it perfectly that we are telling focusing for parallel rays

Two alternative method one can use. One is Direct method another is Schuster's method. Purpose is that these we have to put the slit at the focal point of the collimator lens and we have to put cross-wire at the focal point of the telescope lens. Then will get the parallel rays. How to do that? There are two methods: one is direct method another is Schuster's method. you know is when light is coming from long distance the light coming towards that we tell that it is a parallel rays.

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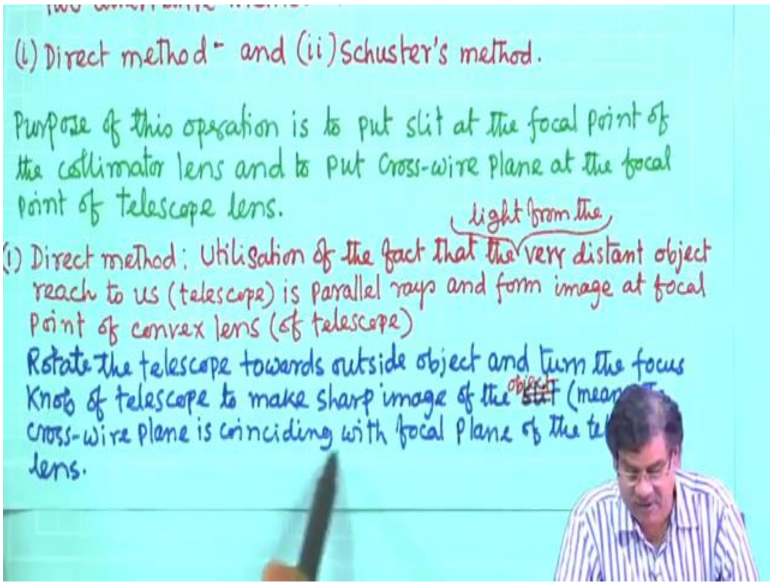

If you; in that direct method utilizing of the fact that light from the very distant object reach to us is parallel rays and from image at focal point of convex lens of the telescope.

Rotate the telescope towards outside object and turn the focus knob of telescope to make sharp image of the object means the cross-wire plane is coinciding with the focal plane of the telescope. This is the direct method.

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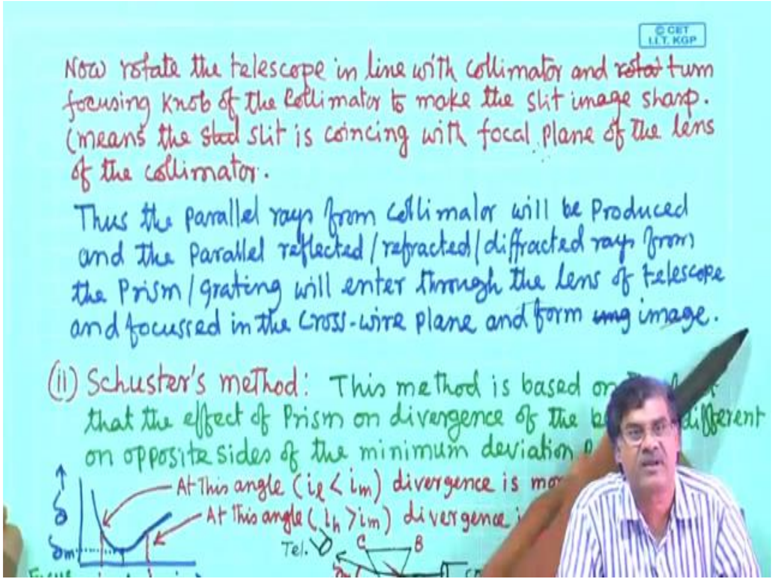

And now you rotate the telescope, rotate the telescope in line with the collimator and turn focusing knob of the collimator to make the slit image sharp. The rest of the part we have to do just rotating the focusing knob of the collimator. Thus the parallel rays from the collimator will be produced and the parallel reflected or refracted or diffracted rays from the prism or grating will enter through the lens of the telescope and focused in the cross-wire plane and form the image.

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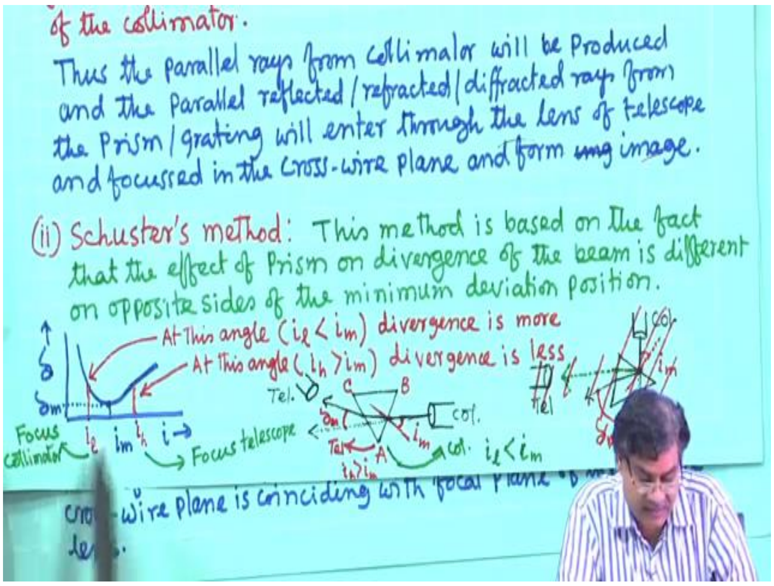

Next one is Schuster's method. This method is based on the fact that the effect of prism on divergence of the beam is different on opposite side of the minimum deviation position. Minimum deviation position this is from this is the light from collimator falling on this refracting edge. Now, it is a refracted and going this way is the telescope. this way this is the direction of direct light this the refracted one this the deviation meaning this the deviation. Deviation changes with the incident angle you know deviation changes with the incident angle like this.

This the minimum deviation for this angle i m minimum deviation incident angle. focus what we are telling that keeping the telescope; keeping the telescope at higher incident angle sorry keeping the telescope first we have to find out the minimum deviation position and then from minimum deviation position just 5 degree away from this minimum deviation position we will keep the telescope. Now, will change the incident angle, one will be higher than the incident this minimum deviation angle and other will be lower than the minimum deviation angle.

i is lower and i is higher, for these two position when we will keep at higher angle then you focus the telescope and when you will keep the lower angle from the minimum this incident angle. Then this the incident angle we have to rotate the your source is fixed change the incident angle you have to rotate the prism table right.

Means normal to the surface of the of the prism edge prism face which face you are using that normal will change means the angle will change because your incident direction is fixed collimator is fixed. That time focus the collimator that is that is the operation one has to do. at the at the lower angle divergence is more and at the higher angle divergence is less. This Schuster's method use this effect this method is explained here.

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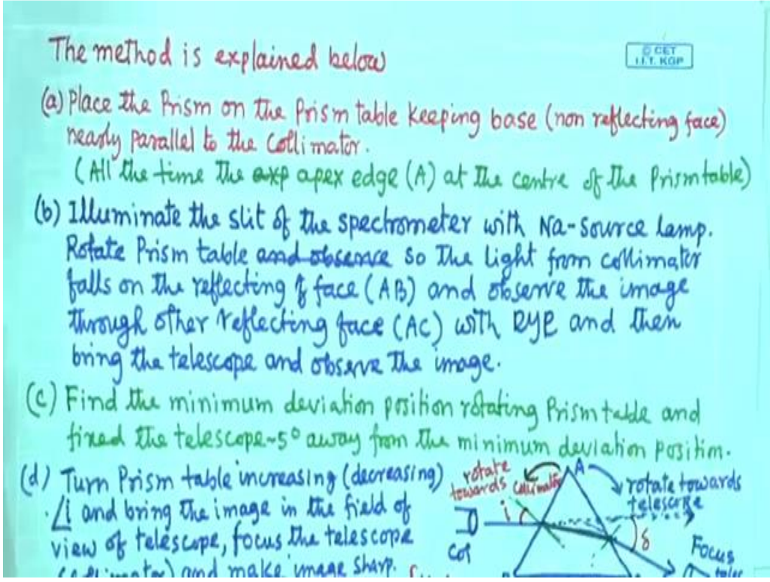

First, what you have to do place the prism on the prism table keeping base means non non-reflecting face nearly parallel to the collimator. All the time the apex edge at the centre of the prism when you put the prism on the prism table, this apex edge there we tell A angle of prism that will be at the centre of the prism table. now, after placing the prism table in this case placing such a way that this is base non-reflecting surface that one that keep nearly parallel this face to the collimator.

Now, illuminate the slit of the spectrometer with the sodium lamp monochromatic light nearly monochromatic light rotate prism table that the light from collimator falls on the reflecting face say AB. this is AB, this is AC, this is apex edge and this is base; this is base.

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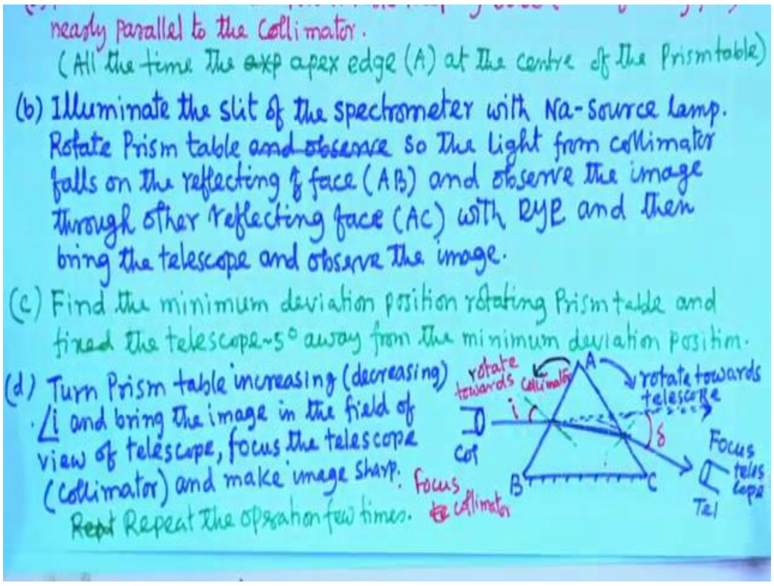

The light from the collimator falls on the reflecting face AB and observe the image through other reflecting face through other reflecting face AC with eye and then bring the telescope and observe the image.

Find the minimum deviation position rotating the prism table and fixed the telescope 5 degree away from the minimum deviation position, how to find out the minimum you have to rotate the prism table and then you will see this your image just after for a certain position of the prism or prism table it will come back; it will come back that position we tell the minimum deviation position.

Find out that minimum deviation position now, from that position turn prism table increasing or decreasing incident angle and bring the image in the field of view of the telescope, focus the telescope, focus the telescope when increasing, focus the collimator when decreasing. that is why I have kept in bracket this part and make image sharp, repeat the operation few times when it us done.

Then this you are getting the parallel rays. This is Schuster's method. for Schuster's method, you have to find out the minimum deviation position, from the minimum deviation position you have to increase the angle and when your when angle will increase, you see when this apex edge when it is rotated towards the telescope towards the telescope because this the collimator light is coming you are rotating towards the telescope means this angle will increase because this normal is rotating this way this angle will increase.

When angle increases you have to adjust the telescope. Other way people generally remember that when this prism edge that is rotated towards the telescope, you focus the telescope. When you are decreasing the angle means rotating this way rotating this way that is normal will go this way this line is fixed from collimator light is coming. Angle will decrease that time you have to adjust collimator; that means, when you are rotating towards collimator, you focus the collimator.

Repeat this operation few times and then you will see, this telescope as well as collimator, they are properly focused for handling the parallel rays for the experiment. Now, your spectrometer is ready for doing experiment either using the prism or grating or anything else. Whatever I described theoretically here, in lab I will show and again I will explain the operation. I will stop here.

Thank you.