Experimental Physics - II
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Lecture - 23
Schuster's method

today I will discuss Schuster's Method for Parallel Rays. we have seen the spectrometers,

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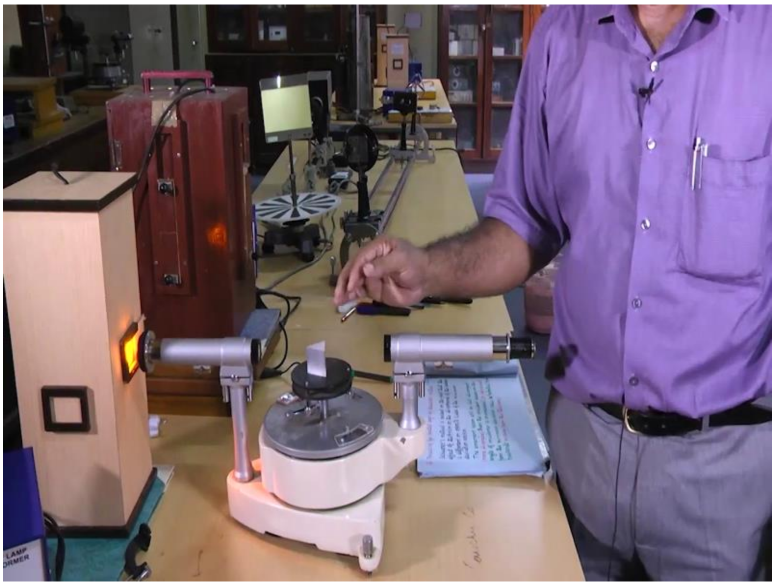

When we are going to do experiment in the spectrometer, so first one has to level the collimators, telescope and the prism table, to make the axis of collimator and the telescope horizontal. And axis of rotation of rotational axis of the telescope has to be vertical, ok and prism table surface has to be horizontal,

After that whenever you will use the prism or grating, so putting the prism or grating, taking reflection one has to do optical leveling. that this surface faces of the prism or the grating is perpendicular to the prism table,

after leveling the spectrometer, next work is to set collimator and telescope for parallel rays means this the source is at finite distance, so from finite distance if light comes and fall on the prism or grating, so that light; incident light will not be parallel, light means they are huge number of rays, individual rays together it is a beam it will fall on the grating or prism, so they will make different angle, that is not the condition for the experiment. For condition of the experiment is that all rays will fall at same angle on the prism or grating, so that means, we need parallel rays falling on the prism or grating,

Now, that refracted rays or diffracted rays from prism or grating, so they will be also; there will be set of parallel rays for different colors means different wavelengths or for different diffracted angles, now this parallel rays, will form the image only at infinity, but if you want to see at finite distance, so we use telescope. telescope, in telescope lens is there.

this parallel rays refracted or diffracted parallel rays will converged at the focal plane of the of the lens, of the lens telescope lens and at the focal plane we have to place the skin, in our case this is the cross wire, And the eyepiece, we have to place at the at a distance in such a way that the cross wire will be at the focal plane of the focal plane of the eyepiece lens.

actually, I cross wire will be at the common focal length, common focal plane of the convex telescope convex lens and eyepiece convex lens, for getting these parallel rays from the collimator and the image, image in the telescope from the parallel rays, so there is a method; one method already I have shown you. telescope one can focus at a distant object and rotate this knob telescope focus knob to make this distant object sharp image of the distant object sharp,

And then cross wire is focused at the is placed at the focal point of this telescope lens, ok, then this telescope then we will see the collimator we see the collimator slit, collimator slit and to make this image sharp we just focus, we just focus this collimator using the focusing knob of the collimator, this is one way to get the parallel rays,

And second method I will describe now that is called Schuster's method. what is that Schuster's method? And how we can get the parallel rays? that is what I want to discuss now.

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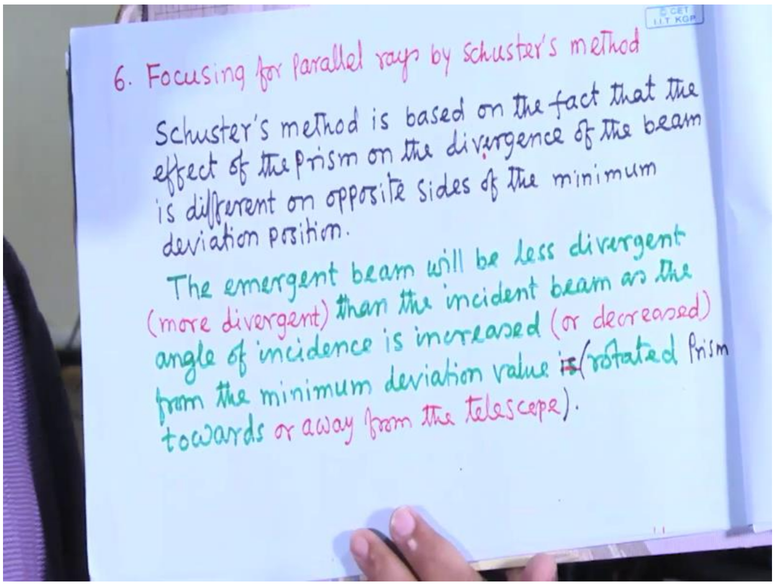

Schuster’s method is based on the fact that the effect of the prism on the divergence of the beam is different on opposite sides of the minimum deviation position. for prism this is the characteristics of a prism, having the angle of minimum deviation, for each prism has a particular angle of minimum deviation, for a particular wavelength of course it depends on wavelength,

if you go to the minimum at the angle of minimum deviation position, the effect of the prism on the divergence of the beam is different on opposite sides, means from minimum deviation if you go in opposite sides, left side and side, so divergence of beam in one side it will be sharper thinner and other side it will be thicker, that is what the meaning of this. this property, this phenomena is used, this phenomena is used for making the parallel rays of the spectrometer,

the emergent beam will be less divergent, when it will be less divergent when will be more divergent, It will be less divergent when the incident beam as the angle of incidence is increased, when incident angle will increase then the means at a particular incident angle you will get the minimum deviation position. now from that position if you increase the incident angle, then the divergence of the beam will increase. And if you decrease the incident angle; if you decrease the incident angle then the minimum deviation, decrease the angle from the decrease the incident angle from the minimum deviation position then the divergence will be more, incident angle is increasing, divergence will be less; incident angle is decreasing, divergence will be more, we can tell in other way also if just; what the things I told that will understand here.

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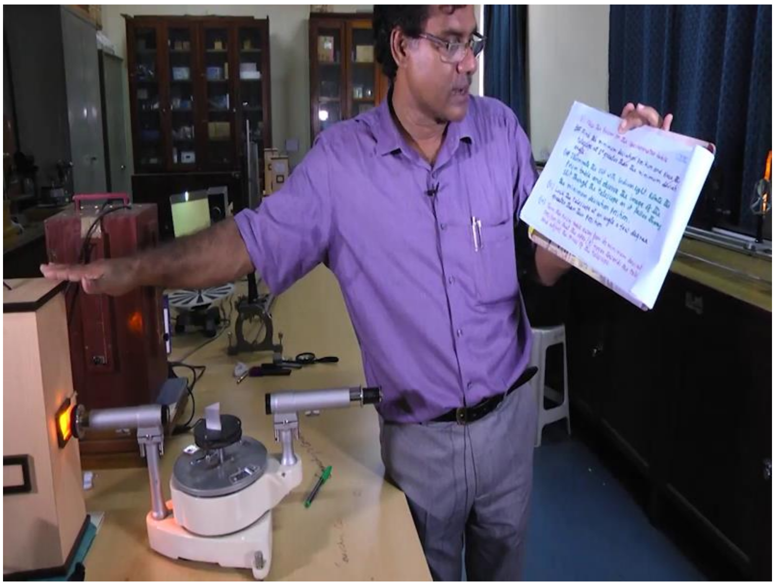

let us place the prism on the spectrometer table. I have placed the prism on the spectrometer table, Now, so this now this is illuminated this collimator the slit is illuminated with the sodium light with the sodium light, Now, rotate the prism table and observe the image of the slit through the telescope as it passes through the minimum deviation position. minimum deviation position, to find out the minimum deviation position actually I have set at minimum deviation position, but. this is the base you know; this is the base you know; this light is coming, light is coming falling on this,

Now, I have to see I have; what is the incident angle? this is the perpendicular to the; two refracting face one is transparent this one and the other one. this is the normal, this is the normal. light is falling this way, so this is the incident angle, ok, this is the incident angle. this is the normal, This vertex is this one, so this is the prism angle, vertex of the prism is this one, now think that incident light it will fall always in this direction, This is the normal, if I rotate this prism in this direction, ok, rotate this way clockwise, ok, in this (Refer Time: 12:07) of clockwise so that means, this normal is coming this side, incident angle will increase, that means, this vertex of this edge, vertex apex, if it rotate towards the telescope incident angle will increase, if it rotate towards the collimator that means, normal will go this way, so this angle will decrease, that means, as I told that when angle incident angle will increase, you will get less divergence, when it will angle will decrease it will be more divergence,

from here I can see that. when angle is increased it will be less divergence and we have to adjust this telescope focus knob to make it sharper, And when angle will decrease, when angle will decrease means I will rotate this way, so that mean this edge will go towards the telescope, sorry towards the collimators that means, incident angle will decrease and the divergence will be more, and that time this collimator focus knob will adjust, to make it sharper,

when angle is increased? When this apex this edge apex edge of the prism however, these two refracting surface met, so this when it will rotate towards the telescope, we have to adjust the telescope, when this apex it will rotate towards the collimator we have to adjust collimator, this we have to do from the position of the minimum deviation. first we have to get the minimum deviation position rotating the prism table. here it is the, I set it at minimum deviation position. I think we can show you; we can show you, yes, this is the yeah this is the minimum position deviation. this now I can take telescope to see this one. I think, so I first I have to see, and yes, it is in this position.

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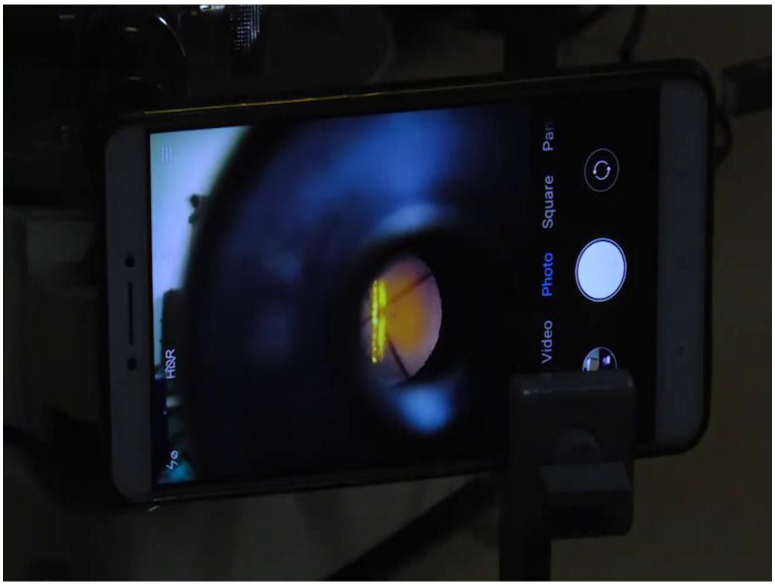

this is the minimum deviation position, how you will know? If I just change the incident angle, so it will move at the same side. I am now increasing the incident angle, so it is moving towards left, I will I am going to the original position and continue decreasing the angle then it will go to the same direction you know,

now I am coming back to the same direction, this is the minimum deviation position, this is the minimum deviation position, from where it is going back, so this is the minimum deviation position, At this minimum deviation position this method, Schuster's method is is telling that when this vertex, this apex of this prism the just opposite edge of the base, when you will move towards the let me check it is there yeah, so it is nicely. when incident angle is increased that means, this edge I am rotating towards the telescope and telescope I will keep few degree more than the minimum deviation position. Now, I have increased the angle this edge apex it rotates towards the telescope, now I have to adjust this telescope focus knob to make the image sharp, I have done.

Now, I will rotate this other direction that means, this apex it will this moves, it will rotate towards the collimator; that means, the angle is decreased, incident angle will decrease, initially it will go the minimum deviation position and then further I will go and then this telescope I kept at few degree higher angle then the minimum deviation position, minimum deviation angle of minimum deviation. this reflect, this deviated ray will come back at this position. I will rotate as long as I am getting back this image at this position of the telescope. Yes, I got back; yes, I got back.

now it is really thicker you know; it is the thicker I have to now adjust the collimator focus knob to make it sharper**.** Yes, it is done. This way we have to repeat the process, we have to repeat the process, then this we; it will this process this method will make sure that the collimator and the telescope are ready for handling the producing or focusing the parallel rays, one has to repeat few times. again, I will increase the angle, ok, I will adjust this one because I move towards the telescope, I adjust this one, it is already sharper, and then this I am moving towards the, so I have to adjust this one it is thicker, yes. this way few times one has to do, let me come back to this it is very nice, very sharp,

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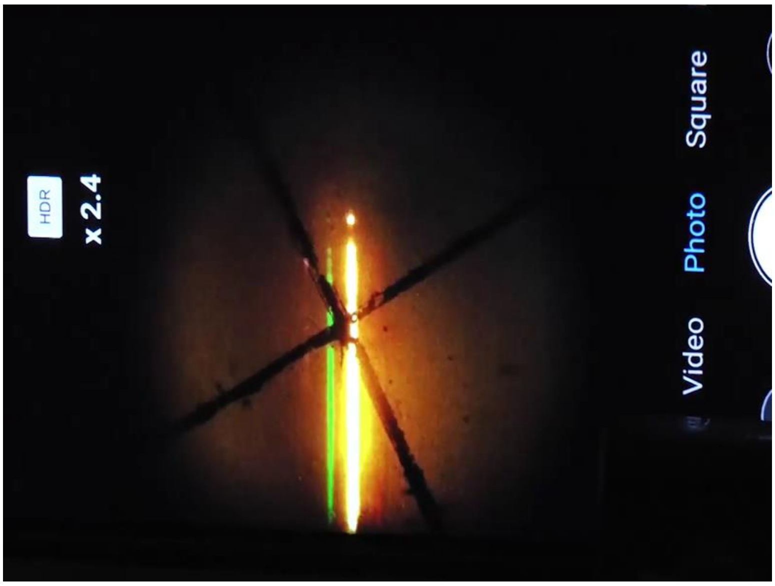

this now is set for the parallel rays. It is really nice. Yeah, actually if these lines, these are very sharp if I see through this, but through camera is not that sharp. This is the line. Here look slightly diffuse, but through this eyepiece I can see this is very sharp, anyway. that is the way, one can get the system in collimator and the telescope for parallel rays,

for our experiment we need parallel rays from the collimator and other side this telescope should form the image form the parallel rays coming from the prism or grating. this method I described that is called Schuster's method and, in this method, also one can make the telescope and collimator for parallel rays, focusing for parallel rays, so this is another method.

in next class then we will discuss experiment based on the prism, experiment based on prism, what are the experiment one can do using the prism. how to measure the angle of the prism? this is the angle of the prism, how to measure the angle of the prism. How to measure the minimum deviation, angle of minimum deviation as a function of wavelength as a function different color for different color? Allow to measure the refractive index of the material of this given prism? How refractive index depends on the, depends on the wavelength?

that is Cauchy's formula, in Cauchy's formula, Cauchy's constants are there. one can find out Cauchy's constant that depends on the material of the prism, dispersive power of the prism, how to measure get the dispersive power of the prism? How to get the resolving power of the prism? This prism may not have the resolving power, but there is other prism one can get the resolving power,

these are the experiment using the prism we can do and for that whatever for spectrometer whatever we have described so for, this condition required for starting the experiment for the prism or for the grating,

in next class, I will describe demonstrate some experiment.

Thank you very much.