Experimental Physics - II
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Lecture - 61
Experiment on Rydberg constant (contd.)

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now, I will demonstrate the experiment. this is our experimental set up for determination of the, for determining the Rydberg constant. is very simple setup. here you can see you need source; you need source I think this is the source, it can be hydrogen source; it can be helium source, this experimental is for hydrogen, Rydberg constant was found for hydrogen, But, unfortunately we have hydrogen source, but it is very weak it will be difficult to show you the spectra. that is why we have taken here it is the helium source, but experimental procedure is same.

In this case also we will see the similar spectra, but their wavelength are different then the hydrogen, but our aim is to show you to demonstrate the experiment how to measure the parameters and I would like to show you the spectra, that is why we have taken strong source, it is the helium source, but just you have to repeat the experiment replacing these helium source by the hydrogen source nothing else. you think that this is the hydrogen source there is no problem.

now, this is the discharge tube. you have to apply very high voltage. this is the high voltage source I should not touch it this high voltage power supply kilo volt we can apply. here we have option to apply up to 4.5 kilo Volt, but at present we can applied 4 kilo Volt. this power is given to the, you see discharge tube and since it is very high voltage kilo Volt. we can see this this electrical insulators so; this very strong insulator is used. this is the source for our experiment. This is the source this is the hydrogen source. Although it is helium as I told you think that is the hydrogen source.

Now, here we have a grating we have a grating. grating I have showed you; I can show you which type of grating you have used here.

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this is the grating same grating we have put on this stand. Later on, I will I do not want to disturb you because in our mobile camera we have we caught this spectrum and that first I will show you and then I will disturb it. I will try to get it back, but it may be sometimes difficult within this very short time. this type of grating here we have used.

this lines per millimeter for this grating is 600; 600 lines per millimeter from there you can calculate d, and that d you should note down. this grating is here and here you see this scale this is the screen position you can say. This is the screen position where we will see the image where we will see the diffraction pattern is nothing, but image of the source we will see. Image of the source, how we see? We see through the reflection we see through the refraction; we see through the diffraction.

image we will see on this at this position on the scale and now this spectral lines of first order spectral lines as I told you we will be able to see here. this is the middle. left side side this side you will see the first order spectra of four colors in this case you will see a four colors and left side also you will see the four spectral lines. that spectral lines if I see through the grating then I will be able to see the spectral lines, but I cannot this show you without using this mobile camera.

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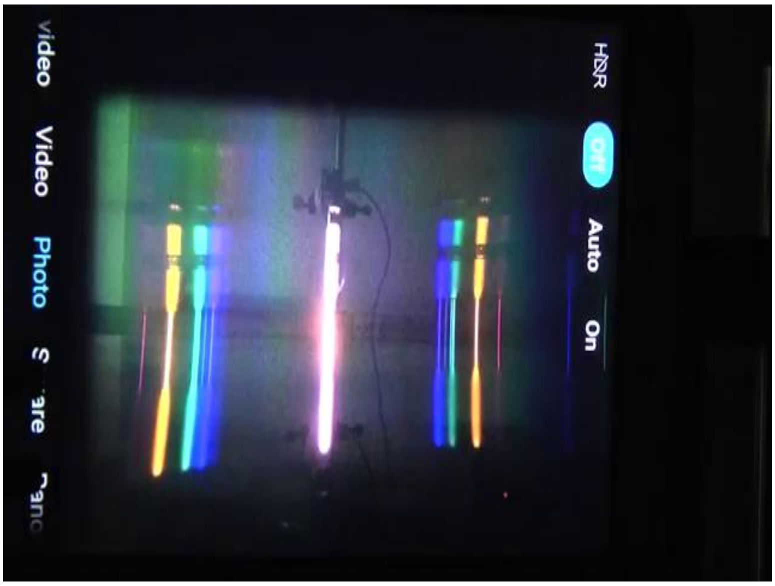

this mobile camera we have used. in mobile camera you can see we can see that this middle one is the directly this we are seeing the source this side you see this four spectral lines you are getting this is I think these it is a violet more or less violet color, then green color, then yellow color and other side you can see this violet or for blue kind of things and then green and then your yellow color and then this red, this very faint one red.

this symmetric first order diffraction pattern we have seen whatever I am seeing through the grating that that only we have we are showing in mobile camera. And so, this type of I will remove this mobile camera. this type of spectrum we are seeing now what I will do. I have to measure the distance. I have to measure the distance between this central one and the say this violet spectral line. what is the reading of this side violet one spectral lines and left side spectral lines of the same color?

Then, similarly I have to find out for the other color. that reading I have to note down left side reading and hand side reading for each color and for from there we will get small l and capital D, the distance between these grating and the that scale where we are measuring the that image distance from the central one; that I will show you now, how to measure. whatever here you are seeing I will remove it now this camera. I am seeing through this grating that you will not be able to see in the camera.

I will remove it; I will just remove it here you see this is the scale and, on that scale, this two what I should tell the two knife edge indicator are there. when I will see, when I will see the that same spectral diffraction patterns through this yes, clearly, I can see that same one. what I will do, I have to; what I will do. this I think I will just to match with this with the spectral line of this indicator because I am not using my hand because high voltage power supply is there power is there 4 kilo Volt power is heavy power. I should not go near to that high voltage. I am using this insulating the scale.

now I will just try to match this edge, this edge, this edge of the indicator with the violet one. Yes, I have match this one. other side also I will try to match the violet one, yes. now, I will take reading what is the reading it is 30.6 and other side it is I can see it is 70, other side it is 70.

not 30, I think this 600; 10, 20, 30 36, 636 this side reading, and this side reading is it is in millimeter. this side reading is this is 200 then 300 then it is 60 means it will be 40. it will be 340. left side reading and side reading I got now I will take difference of these two. 636 minus 360, 300 not 360, it is 40 because 50, 60 other side. I should note down the reading here for that I have table; I have table I will note down the reading.

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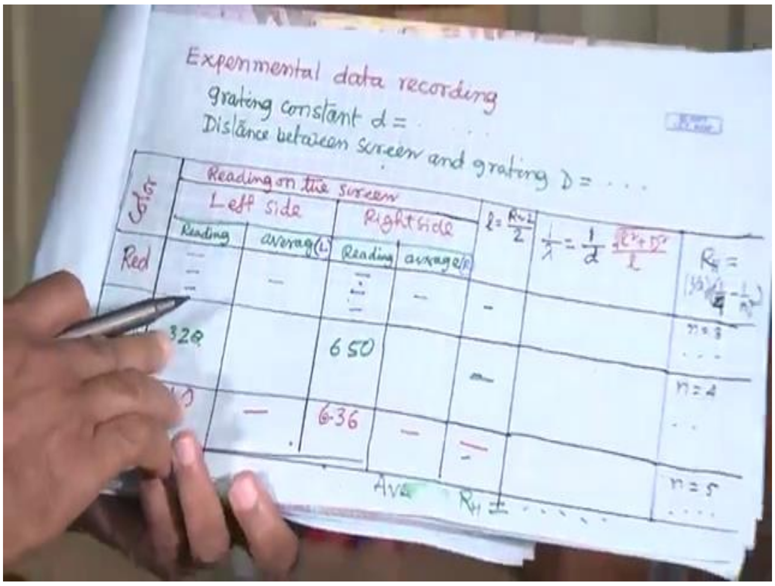

this is a blue color. I will note down this reading. What is the reading from left side I got? Left side is this one, that is 340 millimeter and side I got reading 636 millimeters. l you will get this difference of this two divided by 2. one can calculate. this reading generally, we should take 2 3 4 times to minimize the error. I am not going to repeat that one.

you take 2 – 3 times reading, 4 times reading, take average of that one. Then, here also same way average of that one from there you can find out l small l. from there you can find out 1 by lambda. that means, you are measuring the wavelength. Your step forward you are measuring the wavelength of the spectral lines.

Similarly, if I try for the green one or yellow one here actually this color I wrote for the hydrogen, but at present we are reading helium. that is why it is not matching. anyway, you should check it the color and write and corresponding reading you take. for next one just for trying once more for next color it is the for green one. If I go green one green one, I have to move it; I have to move it for red green one. Yes, it is there and for other side green one I have to, yes.

that way we just this edge matching with the spectral lines when I am seeing through this grating. Now, you take reading; now you take reading. Now, at present reading is 650 and, in this case, it is 320 more or less it is a looks to me 21. note down this reading you note down, for green color you note down 320. This side 320 and the other side 650.

same way you calculate the small l, same way you calculate the small l, 320 and 650. calculate small l, corresponding lambda you can calculate 1 by lambda and for that you find out the R H Rydberg constant for just same way you continue for the other two colors are there anyway.

beauty of this experiment is that using the spectrometer we could do this experiment and generally people do it. But, without spectrometer also what spectrometer is doing? Spectrometer we are using for measuring the angle. this is an alternative method to measure the same angle, but I think spectrometer have better resolution than this technique.

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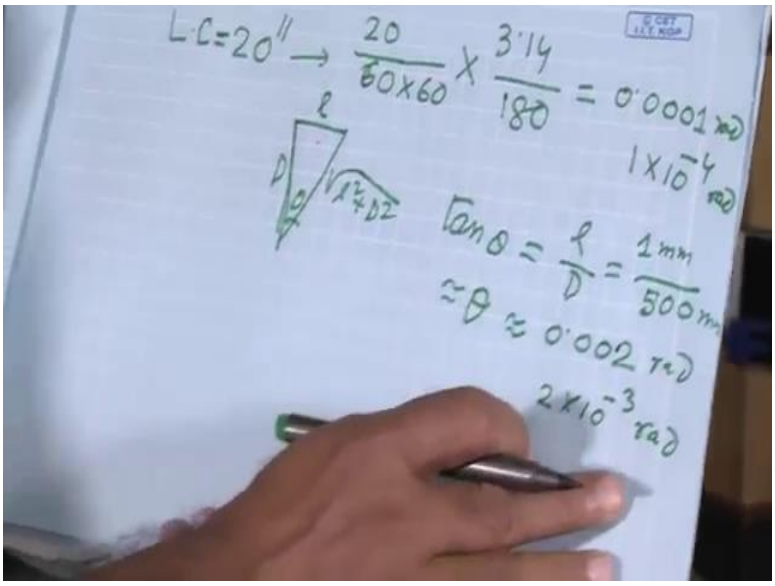

how to estimate that resolution I can tell you what is the least count for the spectrometer? See, with generally, it is generally 20 in our case it is the very good spectrometers. it is a 20 second. 20 second is the least count for spectrometer. if I convert it; if I convert it to the radian what I have to do?

this 20 I will convert it to the minute. 20 by 60 and then that again I will convert to the degree, this is one degree. you know that 180 degree equal to pi. pi value is 3.14 and divided by 180, then you will get the value in radian. we have seen this value is around I think it comes around approximately 0.0001 radian, it is a 1 radian. it is the 1 into 10 to the power minus 4 radian; that is the least count for spectrometer. But, for these what is the least count? It is the in this case least count is in length, it is the 1 millimeter.

approximately you can think that this is our angle theta, this is D, this is l ok, this is square root of l square plus D square. I sin theta I can write this l by this one, but if theta is small sin theta is equal to tan theta is equal to theta. in this case theta of course, small I can write tan theta tan, theta equal to this by this l by D,

our least count is 1 millimeter, . for 1 millimeter for divided by this one is more or less it is slightly more than half a meter. that means, 500 millimeter 50 centimeter 500 millimeter. angle regulation in this case you will get 1 by 500 this also millimeter, this also millimeter. it is a, it will give you radian this will give you radian. tan theta for small theta I can write as a theta. theta equal to here you are getting 0.00; I think you will get to 2, 2 radian. here it is 2 into 10 to the power minus 3 radian,

in this case the least count in angle it will be 2 into 10 to the power of minus 3 radian whereas, for spectrometer it is the better. if you use the spectrometers you will get better accuracy innovation than this technique. But this technique is very simple and alternative technique how to measure the angle and from there you can do the calculate the thing whatever possible using the spectrometer.

I think this is the way we measure; we measure the Rydberg constant in our laboratory. This is very simple experiment. that is why I also we use also spectrometer for this experiment, but I have for the simplicity of this experiment of the set up I have chosen the setup as well as many times we have used spectrometer. here I would like to I thought of telling you another new method to deal the experiment, I think I will stop here.

Thank you for your attention.