Experimental Physics - III
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Lecture – 55
Electron Diffraction (Contd.)

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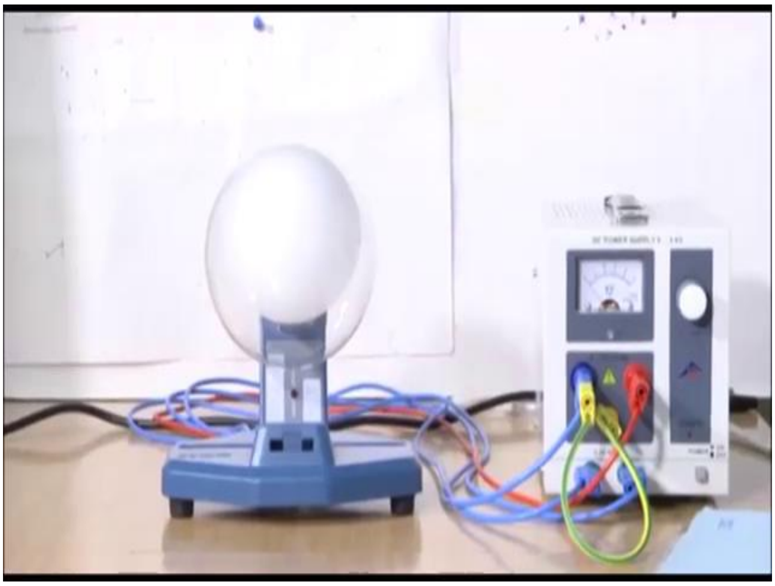

This is a simple setup for Electron Diffraction. this it is a cathode ray tube, cathode ray CRO tube And with this CRO tube this spherical this ball kind of ball, this is the whole system is in vacuum this one can think of that it is a skin since CRO cathode oscilloscope the same types of tubes are used electron beams are coming and falling on the skin. Here this part white part we will use as a skin.

Here lot of a is the power supply you know in CRO CRT, cathode ray tube one has to apply it is a kilovolt, kilovolt to accelerate the electron. in CRT, what is there? You will have as I have explained that it will have filament and then a cathode negative voltage is given to the cathode. From there electron will emit and then we will have some arrangement p acceleration etcetera some arrangements are there ok.

what I will I should main part is that filament then cathode then anode positive voltage with respect to the cathode electron will be accelerated then focusing arrangement ok.

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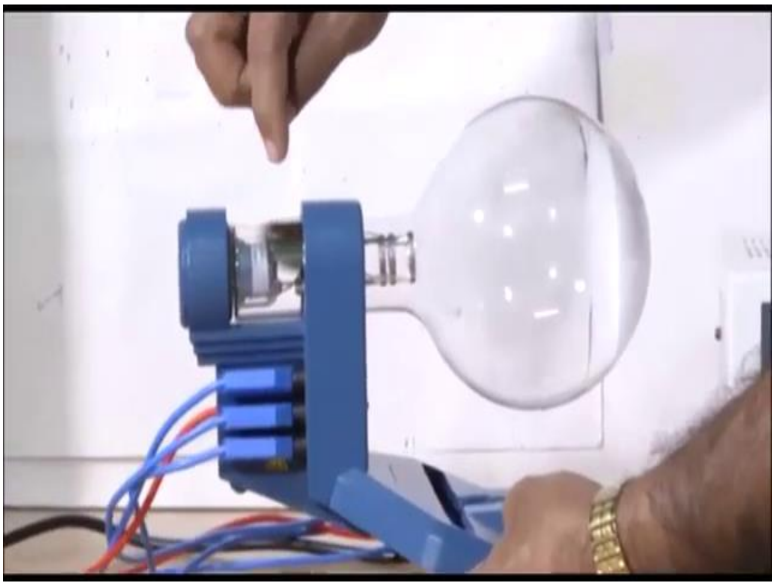

This whole things you can see here this is the here you have a; you have a filament as well as I think yes. In addition, cathode I think is you can see inside, this one cathode, then you will have an anode, then you will have a focusing one, next one focusing one and this one on the top they are we have kept this that crystal, graphite crystal. From here I can see this yes, some crystal is there.

these are the compact it is a compact equipment for electron diffraction all these a handy small one, but it has a lot of this, I think these are nothing, but the CRT cathode ray tube and then in CRO we use the deflection plate Vertical and horizontal, two sets of deflection plate to or to shift the electron beam in x and y direction. Then it will be CRO cathode oscilloscope, but here we are not using this deflecting skin, but we are using graphite, polycrystalline graphite material ok.

We are using grating. Electron beam; we are using grating here graph polycrystalline graphene it is here, just here it is on the on the surface, this crystal is kept on the surface of this of this sphere radius and this is the skin radius of this diameter of this of this sphere is diameter of this sphere is the capital L as I told. Length; length of the skin from the sample.

that will be L this I think this is supplied one though lower need to major because it is the it is it will be very serious issue to measure this one because, one has to be very causes during doing experiment because these are made up glass.

This power supply if I switch on; now this lot of connections are going a connection it is connection power filament current and then for cathode power, then anode power, then for focusing for that power. Electrostatic lens is used for focusing.

Here it is accelerating voltage it is 0. Now, if I apply voltage ok; apply voltage and other I think it is it is when I will change other parameter for what will be the filament current, what will the cathode voltage, what will be the focusing power electrostatic lens of power for focusing there also we need some power. That all are fixed.

Here only I will change the anode voltage. it is in kilovolt, the reading I will get from here. now, it is 0 volt; now it 0 volt Now I am applying voltage; I am applying voltage and if you look here you should be able to see first we will see the electron beam just you can see here electron beam it is the 1.4 volt see electron beam.

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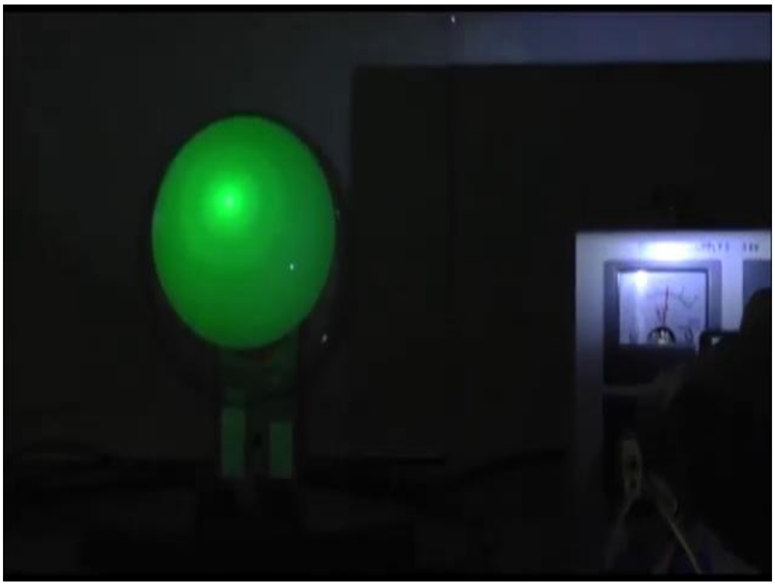

Now if I increase the anode voltage you see if we increase the anode voltage. I am seeing I think I will switch off light just see here it is I think I can use the torch for showing the current. Yes, it is the 3 volt, it is the 3 kilo volt for 3 kilo volt when I apply 3 kilo volt. Now, clearly, I can see the two; clearly, I can see the two ring; one is here and another is this one.

At this what I will do? I will what I have to do. I have to measure the dam radius of this I have to measure the radius of this ring; ring 1 and ring 2. ring 1 for a d 1 say plane interplanar distance d 1 say 1 for a particular one plane, this is for another plane is planar facing will be different say d 2.

Now, for this I have to measure the I will measure diameter and half of it will be radius I will use the use the slide calipers, I will use the slide calipers I will measure the inter internal that because this is the it is now very sharp ring. It is a broad ring I will measure the diameter of the insight inner diameter and outer diameter. I will measure inner diameter and outer diameter using the slide calipers.

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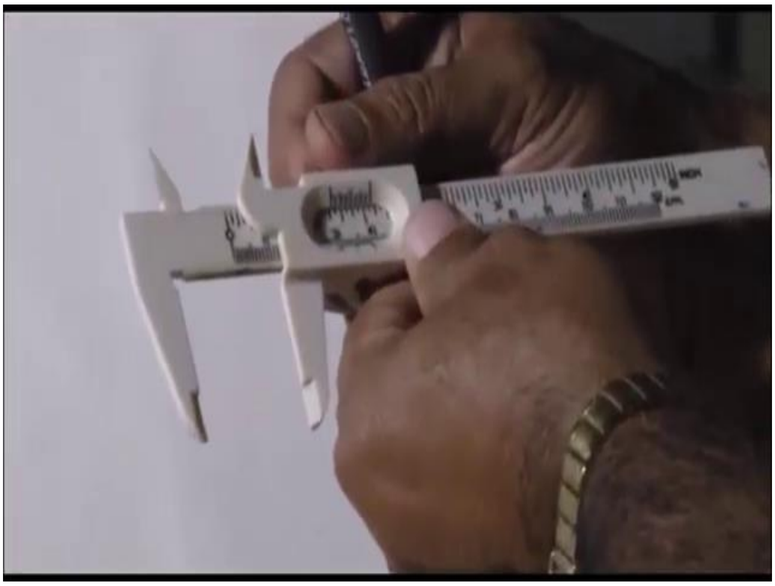

it is Vernier constant is for this 0.1 millimeters, 0.1 millimeter 0.01 centimeter ok, yeah yes 1 by 10. I think this is the very elementary I have discussed ah this one in experimental physics so on, how to find out the Vernier constant I will use for this first ring whatever the diameters outer diameter and inner diameter I have to measure for second thing also same way I have to measure. Now, you see just see table experimental data experimental data ok.

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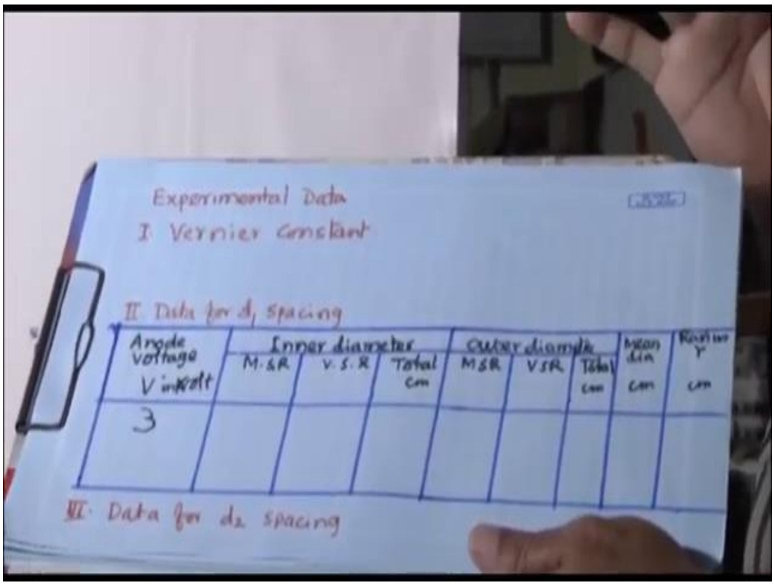

Vernier constant I have to find out because I need slide calipers. Now, data for d 1 spacing means for a particular one for a particular plane; for a particular plane; for a particular plane. d 1 and for d 2, data for d 2 spacing and data for d 1 spacing because here we are seeing two ring that is for two plane. two interplanar spacing we will get one is d 1 another is d 2 fine.

Now, applied voltage V in kilovolt. I will write I have applied kilovolt that is I will write 3 kilovolt ok; I will write 3 kilovolt. For this 3 kilovolt I will get this two ring and I have to I will measure the inner diameter and outer diameter as I told because this is this, this ring have thickness it is not very sharp ring it has thickness. Inner diameter outer diameter and then mean diameter, we will take mean average of these two diameter average one ok.

From there half of it will be the radius r small r for 3 volt then I will change and the same I have to I have not ah shown here this table, but same table you have to make and for this 3 kilovolt, you measure the diameter of the second ring ok.

Now, I will go to the next energy say it is next say 3.5 we can go now it is 3.5, then you can same way for 3.5 we measure. Now, I am going to 4-kilovolt ok; now I am going to four kilovolt it is an it is becoming more prominent ok, it is becoming more prominent fine it is nice.

Same way you use this for this 4 kilovolt you measure the inner diameter outer diameter then average diameter you will find out. from there you will get the radius. this is the radius of the; radius of the first ring 1 and radius of the ring 2 for 4 kilovolt means for a particular wavelength lambda corresponding 4 kilovolt ok.

then I will go 4.5, then let me go 4.5 then 5 here I am at the 5 It is a more prominent you see it is looks better, but you can see this diameter is reducing decreasing with increasing the, increasing the kilovolt increasing the accelerating voltage. If accelerating voltage increase lambda will be small ok

If lambda is small 2 d sin theta equal to lambda, if lambda small then for a particular d theta will be small cone whatever cone we are getting I explained. That cone angle that will be that cone angle will be is smaller higher the energy, higher the energy means; higher the accelerating voltage, smaller the wavelength smaller the wavelength theta will be smaller the circle will be radius diameter of the circle or radius of the circle of the ring will be smaller. That is why it becoming smaller. once should measure this.

Just I am now decreasing and you can check that. Now, I am decreasing there you see diameter of the ring is increasing you see diameter of the ring is increasing so that means, energy is decreasing of the electron beam. Wavelength is becoming higher. theta will be higher if theta is higher tan two theta equal to r by r by L small r by L it is going out as if this is going out it is very small energy that it is a diameter of this ring is so big. It is not in this range ok.

If you are increase again it will come back just for different energy we will measure let me just keep at lower yeah. This way you take the; this way you take the you take the reading for 3, 3, 3.5 3 point 4.0, 4.5 5. 5 reading you can take 2 yes, 5 reading you will get this for 5 wavelength you are getting the; you are getting the you are getting the diameter or radius of ring 1 and ring 2. this corresponds to different wavelength this corresponds to different wavelength ok.

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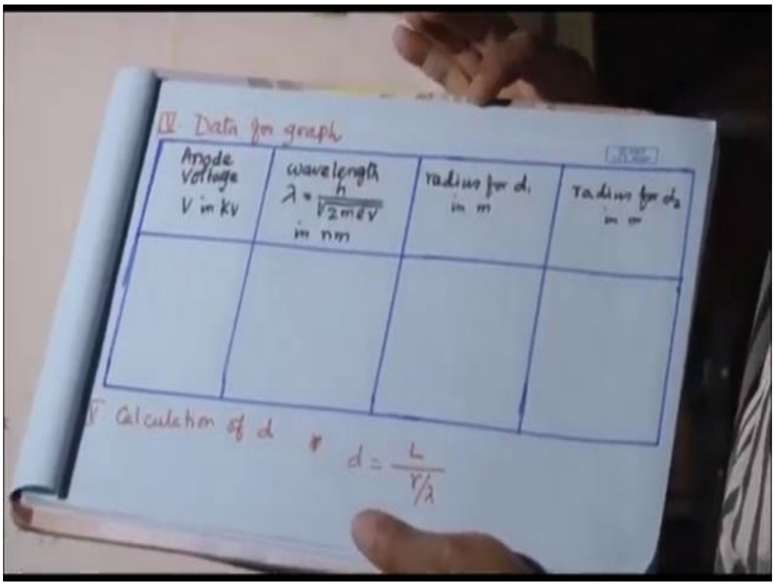

That means; data for graph anode voltage in kilovolt. corresponding wavelength you can calculate from this relation ok, say it is in nanometer. A radius for d 1 in say meter. from that table you will get so that and this for d 2 means second ring, for second ring this. From here lambda versus r lambda versus say r 1 and lambda versus for r 2 you can plot graph. Now from that graph, the slope will give you r by r by lambda as I mentioned r by lambda slope would give you r by lambda.

From this graph, we can find out this r by lambda. that the slope this is for ring 1 and this is for ring 2 and corresponding you will get d 1 and d 2 other planes are there, but their angle is very high or very small whatever it is not in this range; it is not in this range that is why we are seeing this just only to this we are getting this ring for 2. And this also depends on the distance of this 2 more can be seen also, but here the distance capital L is fixed, we cannot change.

that is I think supplied it is I do not remember, but I think it will be around diameter will be around I think maybe 15 to 20 centimeter, so that is the capital L. that I think one has to see this manual for this it is a company supplied. One can get calculate the value of d 1 d 2. this is very nice experiment ok, just simple cathode CRT cathode ray tube and one skin spherical skin this part is I think phosphor material is just put on this part. We are able to see the electron position of the electron ok.

Here clearly we are getting the diffraction pattern one has to understand why if we use grating sometimes you are seeing the lines; you have seen this we are says the lines. In this case, we are seeing the ring why we are seeing ring that I tried to explain ok, why it would be concentric ring. In addition, each ring is corresponds to that, each ring corresponds to the to a particular plane.

I think this girly diffraction, no doubt about it and this diffraction is a visible in a very simple way in the laboratory and these very compact one and all things are known this we need electron beams CRT is used and then we need a skin like CRO. this type of arrangement is made and as a grating we are using some graphite material in polycrystalline form. That we do not need to rotate the crystal to vary the angle ok.

These are; these are it is the using our experience and knowledge from other experiment. this experiment easily one can set and demonstrate. I think these are experiment is very simple, but it is rather fundamentally is very important experiment where we can show the diffraction pattern of particle. Therefore, that means, particle also have wavelength and that is what we demonstrated in this from this experiment not only that we also can study the crystal ok.

We can find out the interplanar distance d spacing, if you know the d spacing then you can find out lattice constant Because, it is the related abc if it is cubic a by square root of a square plus k square plus l square h scalar similar in this case and yes.

One can identify the plane also which plane anyway. more details we are not going to tell you, but just simple way this is the how to measure the interplanar spacing using this electron diffraction that we could see from this experiment as well as the wavelength of the electron beam.

It is related with the anode voltage and exactly for that wavelength one can find out, one can verify through this experiment that this planar spacing d 1 d 2 whatever we are getting if you just check with the compare with the literature value, then you will see the this is the it is a very close to the literature value. That means, the wavelength of the electron whatever ah we are calculating this is the wavelength of this electron. No doubt, about it and I think I will stop here.

Thank you for your attention.