Experimental Physics - II
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Lecture – 55
Zone-plate experiment

in last class I have discussed about the theory of a Fresnel Zone plate experiment. today now, I will demonstrate this experiment in our optics lab of Department of Physics of IIT Kharagpur.

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this is the setup; this is the experimental setup for zone plate experiment.

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that this is zone plate as I showed you it is, so as I showed you this is the zone plate. that we have put on this holder, on this holder. this is the ; this zone plate is here on this holder. Now experiment is as I told that; from source light will fall on the zone plate, and then from the zone plate; , alternate zones are blocked Half cured zones are blocked, so this will act as a convex lens; like convex lens, but multi facet means, there will be multifocal length means. light if it is lens, light in this other side light will be focus that the focal length.

light will be focused at different point; means a different distance ok, because it has different if focal length. that means, there are two part: one part is I want to put parallel rays on this zone plate, for that I need arrangement. And second part is that; this light will, so from the other side; light will be focused at the focal length.

that focal length I want to find out, and focal length as whether the focal length or different for focal length are different; that we are expecting from our theory. here we want to see; whether multifocal length we get or not. we have to, so we have to if, so then we have to you want to measure the focal length ok, focal length and that focal length for different m.

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this is the laser source, this is the laser source; generally, laser source gives the monochromatic light, and also parallel light; also, parallel light, but there is a divergence of this light.

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But, for this experiment this it is the since, we want to skip this distance of the object. that is why we want to get the parallel the perfect parallel rays; which will fall on the zone plate. these three in this is the laser and this is the zone plate between these or this three holders are there. What are they are in these holders? Actually, in this holder these lens is there.

Here you can see it is the plus 20 millimeter. here convex lens is there of 20 millimeter focal length. And, then here you can see the minus 50 millimeter. there is a concave lens of focal length minus 50 millimeter and this is another lens convex lens this plus 100 millimeter. there is the focal length of convex lens.

here this three lens; combination of three lens keeping a different, keeping at a particular separation of be among the or between the lenses We will keep, we will keep the parallel rays; we will give the parallel rays which will fall on the on the zone plate. to understand that one I think this; I will show you it will be easy for you to understand if I show this diagram.

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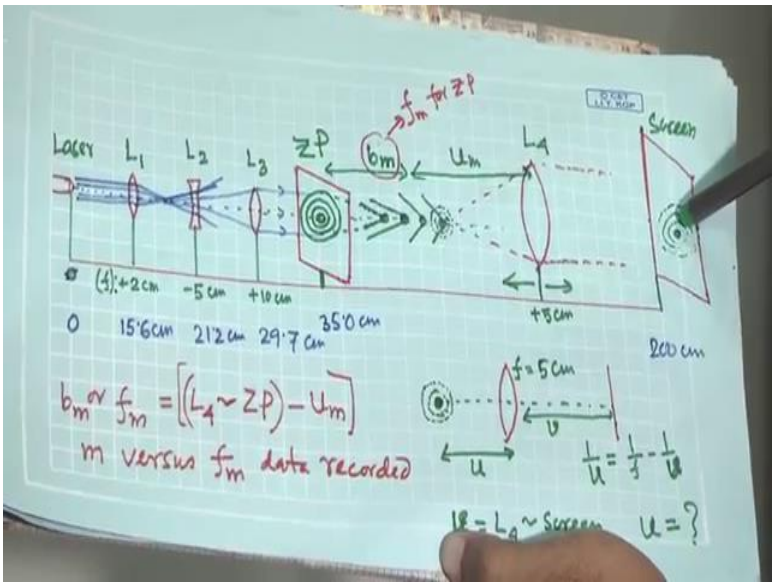

here you can see; here you can see this laser It is a laser, so this is this laser this laser. I can show like this. I can show like this. this laser ok, then this is the lens of 20 millimeters or 2 centimeters, plus 2 centimeter, focal length convex lens. And, then this is 50 millimeters, minus 50 millimeter, minus 5 centimeters these convex concave lens and this is 100 millimeters 100 millimeters. this is the L 3 and this a that or plus 10 centimeter convex lens and they are placed, they are placed at if this laser source.

we have a scale, we have a scale, so laser source we have put a 0 On the scale; we have put a 0, laser source we have put a 0 ok, this holder. and then L 1, this is L 1. It is it is put at 15.6 centimeters then L 2 21.2 centimeters. difference between these two we can find out, it will be I think a 5, 5.6. It takes depend, so this separation is 5.6 and this one is put a 29.7. there is a separation, so it will be I think 8.5, 8.5. this combination, this combination or this separation ok, of this; this lens is having the focal length mentioned here

We will give , we will give parallel rays you know, on the other side of the L 3. here then we have zone plate. Now on zone plate this parallel laser (Refer Time: 08:46), as if this light is coming from the infinity. a a e 0 a e 0 . Now this part ok, this arrangement is for parallel rays falling on the, parallel rays falling on the zone plate. Now we see here, I can show you. what will happen on zone plate?

light is falling on the zone plate. then, there will be diffraction And, then we will get diffraction pattern on the other side, diffraction pattern on the other side can I have a white paper? One white paper, I will.

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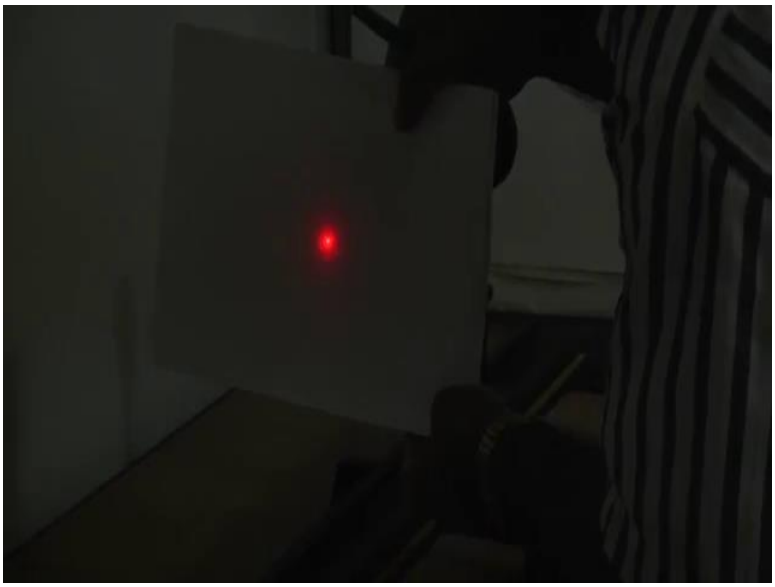

other side, we will get you see; other side we will get, you see this some spot you are seeing at the center thus some sport you are seeing at the center, but it is very difficult to; it is very difficult to see that one you know, You are getting some pattern at the center, at the center you are getting at the center you are getting spot on it is a high intensity spot you are getting you know.

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Intense what you are getting Not, if you are very intense you see; here these are looks very intense. If I go further away; if I go further away, so you see here is very intense If I go further it is a again, so we are getting intense light intense light. this intense light is intense light at the center that most of the light are focused on the focus at the center, at the center and also this as I told that on the screen; on the screen we will get the diffraction pattern

And, that diffraction pattern will be dark by dark by this kind of circle But here our interest is to find out the focal point of the zone plate And focal point will be a different distance, so that we want to find out what is the focal, what is the focal point of this or

focal length of this of the zone plate and that focal length are we have many focal length that we want to find out. this can be here one is here, another is here, third one is here, fourth one; I do not know ok that I want to find out.

that means, I have to I want to find out this v value or v value 1 by a plus 1 by b or 1 by u plus 1 by v. source distance is at infinity and then I want to find out this thin distance ok, that will be the; if I want if I can look at the position where the beamer concentrated the center. then that will be by the that the focal point and corresponding length will be focal lens. it is somewhere in this range it will be there and there will multi focal length, multi position, you just think for one position. Now what we will do; I will we will take help for we will take help of for this lens.

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Another convex lens, so of it is the focal length is 50 millimeter plus 50 millimeter focal length is plus 50 millimeter. Now what we want to do is that. light is, so what is happening? what is happening? here you can see; here you can see that; so far, I have discussed the parallel rays are coming falling on this zone plate. after zone plate, so after diffraction there will be it is since it has it is it is multi force at different distance ok. light will be focus at different at different points this will be a one focal point, this is another, this is another, this is another, if maybe first one, second, third, fourth or other way I do not know that, we have to see. now, so that I have to find out, that I have to find

out. then we can tell that the zone plate n th and this one of them that distance will be b, so b m and that is nothing but the f m for zone plate

now we are taking help of another convex lens; having the plus 5 centimeters the focal length. Now what we will do? We will search, we will search for different this. this will act as a source for this one ok; point source for this one. this light will come, and it will make it parallel ok, by this lens and that will fall on the screen, that screen is there.

here what will happen? these lens will help us to whatever here, whatever the here it is the pattern is formed; that pattern this will be put on the this pattern will be put on the screen with the help of this fourth lens; we will get the image ok, whatever at this point in this region that we will get on that screen

in that case; we can say that this is the, so this is the object for this lens. this is we can say, this is the u ok, for this lens. And, then these screen that; where we are seeing the image it is a larger distance that is v 1 by u plus 1 by u equal to 1 by f minus 1 by v. distance between the screen and lens that experimentally we can measure we can measure ok, and corresponding u will find out.

Now, this u this u this u is nothing but, this u is nothing but, b m and that No. We will find out the u. Now, when we will find out u; now if I know the position of the zone plate; this side is not disturbed. If I know the position of this one ok; difference between this L 4 and zone plate; difference between the L 4 and zone plate that position. that will give this distance ok, minus u minus u, minus u m for different order for different into minus u m; we will give you this b m or f m it will give you b m or f m

; we have to shift, we have to shift the L 4 lens And find out the high intense center; high intensity at the center of this pattern on the screen And, then for that position we have to note down this for position of the L 4, L 4 and zone plate position is known, screen position is known if I know the L 4 position; then here is here, from this relation; you know the f for this lens 4 L 4 that, focal length is known to u and we will get also yeah v from these reading you will get. u, u is used here ultimately, we have to find we have to record the reading for record the reading m versus f m ok, m versus f m

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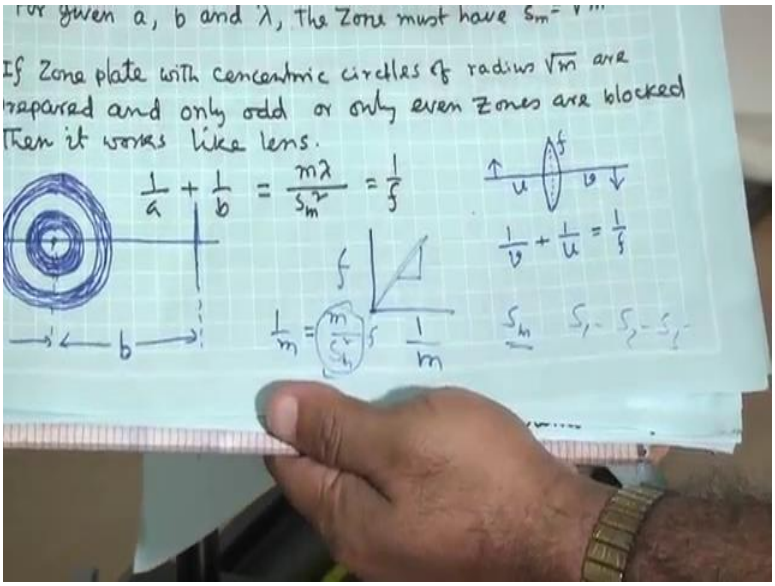

Then, after the reading; we can as I mentioned that we can plot 1 by m versus f, 1 1 by m versus f m from the slope we will get; one can find out the radius of the phenol subzone just here you see; now, I think.

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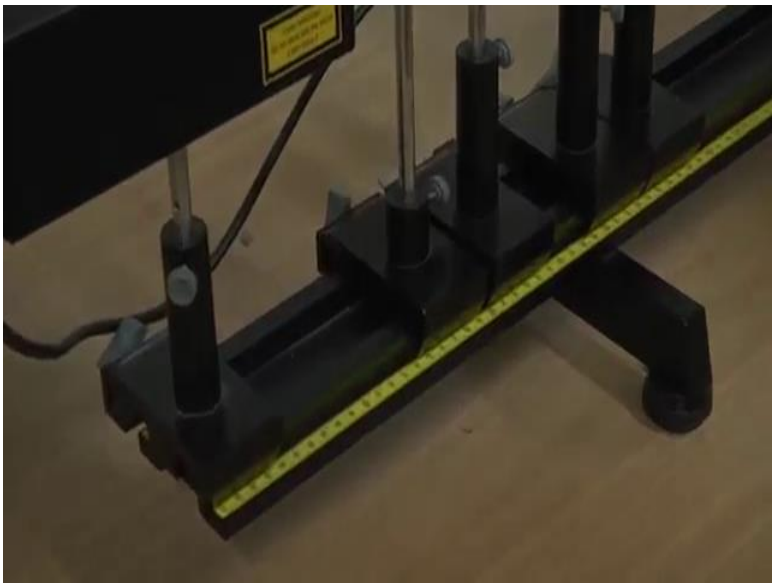

parallel rays are coming. we have to note down for this reading we have to note down for this reading as I already note down here, as I already note down here you have this data these are these are fixed and that we cannot disturb them because, then only we will get, one can calculate and see only you will get the parallel rays

Now, what? actually you can find out; you see this, now whatever this focal length, now focal now this I think one more I should show you yes. Now, this multi facet points are there, multi facet points are there; that points are the object for this lens object for this lens. it will be on at many places

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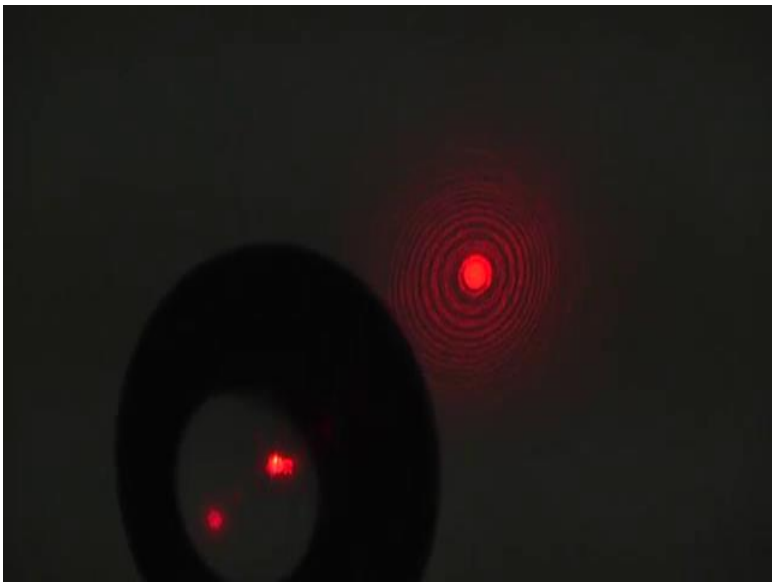

now if I start from this side; I will, so here what do you want to see; as I told that we have to get consented intensity at the center.

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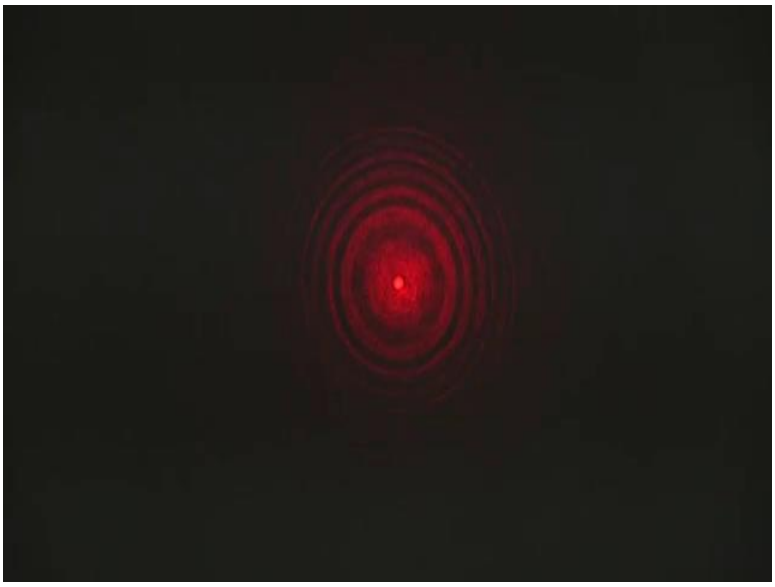

let me; I start from this at the end. No. I will changing; and you check it. The center one has to be very intense one. Yes, I am getting almost yes you can see, yes, we have to take reading of this L 4; you have to take reading of this L 4, Then you can calculate a f m. So here, this one probably m equal to 1, next I am going ahead, I am going ahead and then I have to find the next position.

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Yes, here yes, yes, yes, yes. You can see this for the second order m equal to 2, ok, do not then you go ahead. It is now very close tensor. very slowly I have to go. You see now; this is the m equal to this third one. take reading of this L 4 Then that way you take few more; you can find out few more we one has to adjust slightly yeah and find out this is the for m equal to 4.

this way; this way just you have to take just reading of the L 4 lens. And, you can find out; you can find out, you can calculate the f m for different order. Now, you plot as I told 1 by m versus f m, 1 by m versus f m and from slope, we can find out the radius of the zones. and you can then just compare with the theoretical value s m should be square root of m

that is the experiment; this is the, I think beautiful experiment either, very good example for very good example for the Fresnel diffraction. I will stop here.

Thank you for your attention.