SHAOUL EZEKIEL: Now we're ready to look at Fresnel diffraction. We're going to look at Fresnel diffraction associated with a single slit. And then later, we'll look at Fresnel diffraction associated with circular apertures. The setup for observing Fresnel diffraction is here, is the laser, is the beam from the laser again reflected by this mirror. And then we reflect the beam again by this mirror into this lens.

Now this is a short focal length lens that focuses the light and passes it through a pinhole over here, which we center it at the focus spot. The light coming out from the pinhole then is shown on the card here and then goes and falls onto the screen. So this is the setup.

Now I'm going to bring in the slit. So I'm going to put this slit in front of the laser beam without disturbing anything, I hope. So here is the single slit.

Now I'm going to adjust the spacing to be very small, so that we start out with the Fraunhofer diffraction pattern. Now here it is. You can see on the screen, we see the Fraunhofer diffraction pattern because the slit width is small enough, so that we're in the Fraunhofer region.

Now what I'm going to do is I'm going to start to widen the slit, so to bring in the Fresnel diffraction pattern. So here I am. I start widening. And you can see now you have to watch what happens to the fringes.

Now things are going to get pretty bright. And so what I'm going to do, I'm going to introduce another screen that is not so sensitive, so that we can observe the bright Fresnel pattern on that one. Here we are.

And you can see, I get a dark line in the middle. Now we get two. And others, you can see how the fringes behave in this case. I want to see what the fringes near the edges look like and in the center.

Now I know that the effect is not observable very well under these conditions. So what I'm going to do is to turn down the room lights and see if we can improve the visibility of the Fresnel diffraction pattern. Now with the room lights dimmed, we're going to start again with the Fraunhofer diffraction pattern on the sensitive screen.

So again, you can see that, at present, we have Fraunhofer diffraction. And I hope it's a little clearer than with the room lights on. OK? So I'm going to start here. And then as I increase the slit width, we're going to have a transition to Fresnel diffraction.

But as we know, the brightness is going to get pretty large. So I will then bring in the other screen here, so that we're not going to saturate the camera too much when we observe Fresnel diffraction. So here we go. This is Fraunhofer.

Then I will now go make the transition to Fresnel. And it's very, very interesting how the light going through the slit solves Maxwell's equations. And here we are. We got that dark line in the middle. And then we have to go back again and have the two lines, then the three.

Now it's very important to notice that the contrast is not 100% like it is in the Fraunhofer diffraction. And those of you who will do the calculation will, of course, understand what I'm referring to. The spacing, you notice that the spacing between the fringes gets tighter and tighter as you approach the center or the center between the two slits. In fact, the fringe spacing gets so fine with large slit separation that you can't even resolve them by eye.

So there's lot of information in that diffraction pattern. And I hope that you've adjusted your monitors, so that you can see these patterns. So here we are all the way to Fraunhofer. And there's a little transition, which is not that easy to calculate, and then go into Fresnel.

Here we are. Make it larger and larger. You can even see the fringes in the center. Now that we've seen Fresnel diffraction associated with a single slit, now we're ready to look at Fresnel diffraction associated with circular apertures.