MITOCW | Optics: Optical isolator | MIT Video Demonstrations in Lasers and Optics

PROFESSOR: In this demo, I'd like to show how you can make a very simple optical isolator based on polarization components like a polarizer and a quarter-wave plate. An optical isolator prevents a laser beam from re-entering the laser cavity. Because if it does, it can create a lot of intensity variations in the laser and also a lot of frequency variations in the laser. And in a lot of experiments, this can be very detrimental to the results.

I'm going to illustrate this in this simple setup. Here, we have a helium neon laser. Here's the beam from the laser. I'm going reflect it to this mirror and then reflect it again to the second mirror, and let the spot fall onto the screen. Then, I'm going to take a mirror, and I'm going to place it here to reflect the laser beam back into the laser cavity.

And so, in order to see where I'm reflecting the laser beam, I'd like to direct your attention to the laser head, where you can see the reflected beam is very close to the output of the laser or the axis of the original laser beam. Now, I can actually put the reflection right back into the laser, and you can see a little bit of a smear. But for clarity, I'm going to put this spot-- reflect the spot slightly off from the original laser beam so you can see what's happening.

So right there. So you can see that if I block the reflection, I block that spot. Now, I want to come to the isolator. Now, this isolator is made up of a polarizer, and I'm going to place the polarizer right here. And I'm going to set the transmission axis of the polarizer, indicated by the white arrow, along the vertical. And again-- let's go back and look at the spot again-- if I block the laser beam, I can see I can switch it off. But in the presence of the polarizer, the reflected beam is still going back into the laser.

Now, I'll place a quarter-wave plate in here. And if I set the polarization of the light along the aprinciple axis of the quarter-wave plate, as indicated by this vertical arrow, you can see that the reflection is still there. Which means that the quarter-wave plate essentially is acting like a piece of glass. And, again, if I go along the other principal axis, the reflection is still there, going right back into the laser.

But if I orient the quarter-wave plate at 45 degrees with respect to the polarization of the light set by this polarizer, then I can, as you can see, extinguish the reflection. And so there's always light in here where I can do an experiment, there's light here, but there is no light reflected back into the laser. Of course, the reason why this works is because plane polarized light, coming from this polarizer here, is going once through the quarter-wave plate and then reflected back, going twice through the quarter-wave plate.

So now, the planar position is perpendicular to the original direction. So now, this 90 degree rotation in the planar polarization then prevents the light from getting past the polarizer here set with the polarization vertical. And that's why this works.

So, in summary, we have illustrated that you can make yourself a very simple optical isolator, which is very, very useful in many experiments, using a polarizer and a quarter-wave plate.