MICHELSON INTERFEROMETER

LIGO Hanford Observatory in aerial view

Interferometers have many applications in science and engineering. They are capable of measuring really small displacements and changes in distance.

A light source, in our case a laser, is split and sent in two directions, then recombined. Because light travels as a wave, when the beams are recombined, they will create interference, depending on their phases. If the distance of one of the beams changes, even a really tiny bit, the interference pattern will also change.

Fringe!

Our device in action

A laser beam is emitted from a diode (1) and goes through a beam splitter, a kind of 2-way mirror (2). Half the beam goes to one mirror (3) and half to the other (4). The beams go back through the beam splitter (2) that (ironically) combines the beams into one. The combined beam goes through a lens (5) which makes the projection a little easier to see.
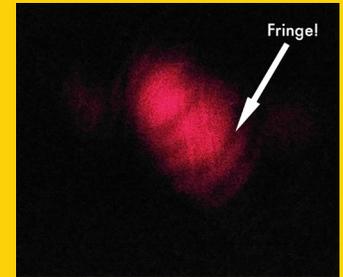
Observe: Look at the big red 'dot' from our combined laser beams. You will see dark areas, or stripes. They are caused by the interference created by the two beams being *out of phase*; this means that the peaks and troughs of the waves from the two beams do not coincide.

Experiment: If you apply a little pressure with your finger to the metal frame, the interference pattern will change because the mirrors have moved a *tiny bit* relative to each other, and therefore the beams are traveling different distances, and are now at different phases.
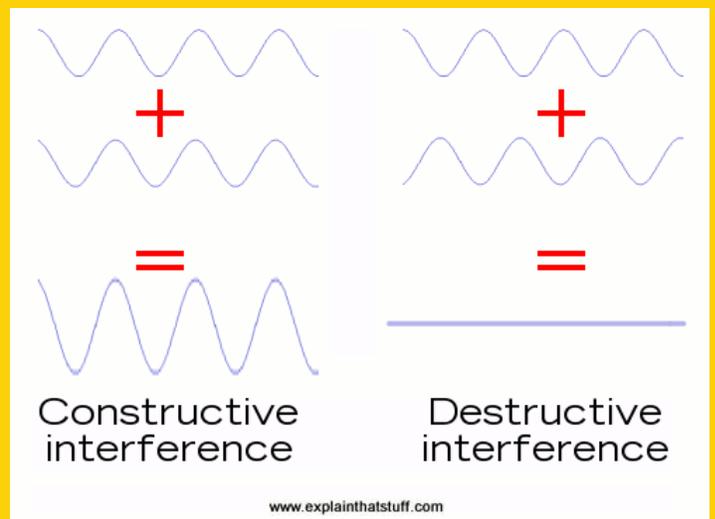
How sensitive is this device? The red laser has a wavelength of 650 nanometers. That's a little bigger than the largest virus. So, if one of our mirrors was moved the width of a virus, our device would register that. LIGO can measure movements as small as about 4 attometers, or about one trillion times smaller than the wavelength of red light.

The interferometers used by LIGO to detect gravitational waves are 2.5 miles long on each side. Our model is about 6 inches to a side.

Constructive interference

Destructive interference

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