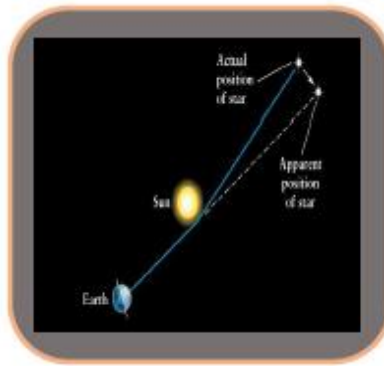
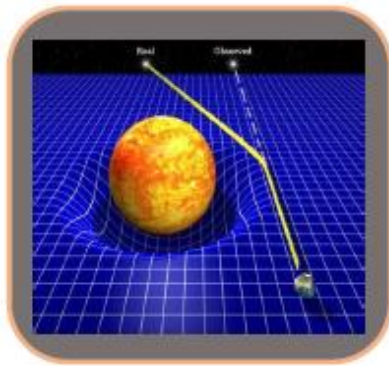


Can you bend light?

Out in space, light rays bend when passing near very massive objects such as stars and galaxies. The presence of matter curves space, and the path of a light ray will be deflected as a result. This process is called gravitational lensing because of its similarity to the way normal lenses bend light rays that pass through them. Einstein predicted that light rays would be bent by the gravity of massive objects. Scientists observed this effect soon after the theory of general relativity was published. Since lenses bend light, we call any massive object that bends light rays a "gravitational lens." By measuring the bending, scientists can determine the mass of the object causing the bending.



Materials: Stretchy fabric (~1 yd.), open-top cardboard box, stapler, 2–3 weighted balls, 10–15 steel ball bearings

Activity: Stretch the fabric over the box and staple it on the sides (fabric represents the space). Put a weighted ball in the center of the fabric representing a galaxy. Roll the ball bearings (representing photons—light particles) from one side of the box to the other and observe their path. Add another ball in the center and repeat this experiment. Observe how the weight of the ball affects the photons' path.



Questions to ask:

What happens to the photon's path when it passes near a galaxy? How does the bending depend on the mass of the galaxy? How do scientists determine masses of galaxies?

Useful links:

https://ed.fnal.gov/lsc_exhibits/list.html

<https://www.liveworksheets.com/id/dn39936ut>

<https://twitter.com/FermilabEd/status/1230869787435139072>