

## Gravitational Lensing

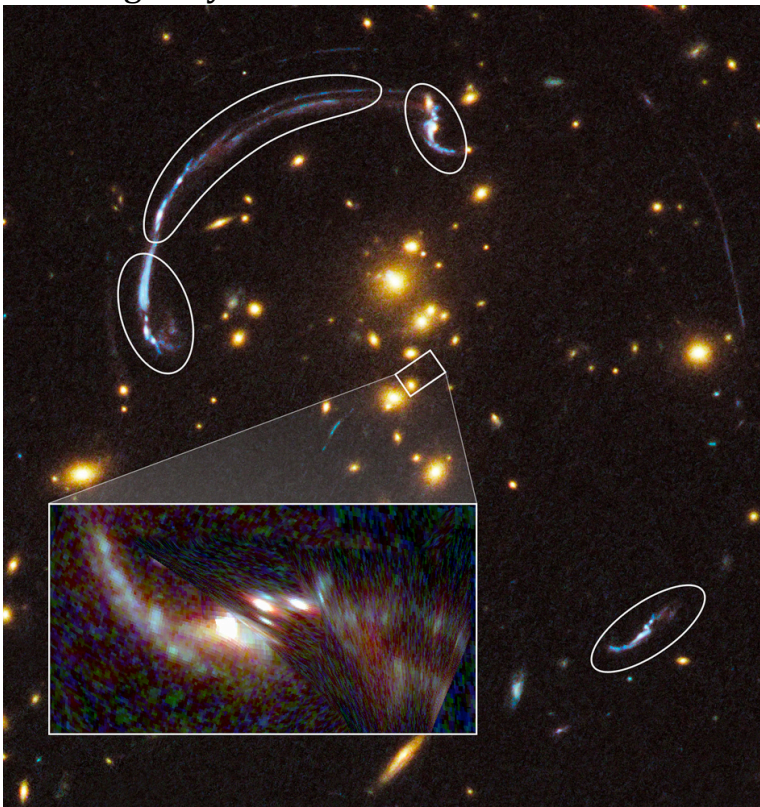
When a comet passes by a star, gravity pulls the two together and the comet bends toward the star. One of the surprising results of general relativity is that gravity will also cause the light to bend toward the star even though light has no mass!

When light passes by massive objects, it is bent just like when light passes through a lens. Therefore, this phenomenon is called a *gravitational lens*.

### Try this:

The bottom of a transparent wine glass produces a distortion similar to what a gravitational lens in space produces. The bottom of the wine glass acts as a lens and bends the image of the paper underneath. The rounding of the images is due to the rounded curve of the base where the middle is thicker than the outside.

The circled portions of this picture are each an image of the same galaxy whose light has been bent by a galaxy cluster in the center of the picture. The box to the lower left is a reconstruction of what the undistorted galaxy looks like and indicates where the galaxy is located. Note that if it weren't for the gravitational lens, we would not be able to see the galaxy at all since it is behind another cluster of galaxies.



# Gravitational Lensing

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## To do and notice:

Place the wine glass on top of the graph paper. Move the glass around on the graph paper.

Notice, the lines or grids of the paper change shape, stretching and compressing as the glass moves.

## What's going on?

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**LIGO Connection:** Gravitational lensing and gravitational waves were predicted by Einstein and are due to the geometric nature of spacetime. All of which are from Einstein's Theory of General Relativity.

