Explained in 60 Seconds: The Ripples on Everyone's Lips

Georgia Bladon
Science communication consultant and writer
gr.bladon@gmail.com

Keywords
Gravitational waves, Einstein, LIGO, general relativity, gravity, black holes, spacetime

Gravity is the force that binds us. It pulls mass together to create the celestial bodies that give form to the Universe and warps the very fabric of spacetime.

But it is also at the heart of some of the Universe's most cataclysmic events.

When two black holes collide, compelled together by gravity, the moment of merging produces a gravitational jolt which disrupts spacetime and creates characteristic ripples radiating from that spot. These ripples, predicted by Einstein over 100 years ago, are gravitational waves and until now had never been detected. Black hole mergers, some of the biggest events in the Universe, had never been seen and their existence couldn't be proven.

Then came the Laser Interferometer Gravitational-Wave Observatory (LIGO) which has twice now successfully detected these waves — from two separate black hole mergers. It does so by measuring the subtle stretching and compressing of spacetime caused by the gravitational waves.

LIGO splits a laser beam, sending two beams down two identically sized, perpendicular, tubes. All being normal, the beams will bounce off mirrors at the end of the tubes and reconvene at the splitting point, having travelled an identical distance. But the presence of gravitational waves will distort space, if only by a minute amount, and slightly change the difference in length between the two tubes. The result is an almost inconceivably small difference in the alignment of the two light waves that return to the laser's splitting point. For the particular arrangement of the optics in LIGO this means that rather than the waves cancelling each other out a small amount of light is detected seeping through to a detector placed beyond the splitting point. This light disappears as the length between the tubes returns to normal, and reappears when the tubes are once again warped by the gravitational wave.

From Einstein first prediction that gravitational waves existed, to successfully executing this experiment, has taken a hundred years and has required the development of exquisitely precise technology, but it marks the beginning of an exciting new field of astronomy. This is not the last that we will hear from these ripples through time and space.

Figure 1. *The LIGO Laboratory detector site near Livingston, Louisiana, USA. There is another site near Hanford in eastern Washington, USA. Credit: Caltech/MIT/LIGO Lab*