

# Gravitational waves observed directly for the first time

A major advancement that opens a window on the universe

## Origin

The waves came from the violent collision of two black holes 1.3 billion years ago that rippled through space and time.



## Detection

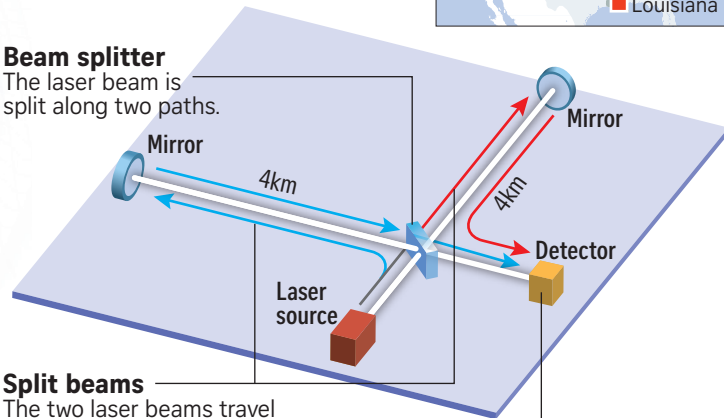
Two ultra-sensitive laser detectors picked up the waves travelling through space. The giant laser interferometers (beam tunnels), several thousand kilometres apart, worked in unison to detect the very small vibrations from the waves as they passed through the Earth.

## Ligo (Laser Interferometer Gravitational-wave Observatory)



### 1 Beam splitter

The laser beam is split along two paths.



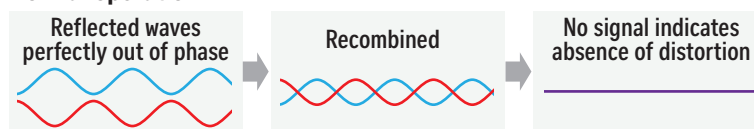
### 2 Split beams

The two laser beams travel perpendicular to each other, get reflected and are recombined at the detector.

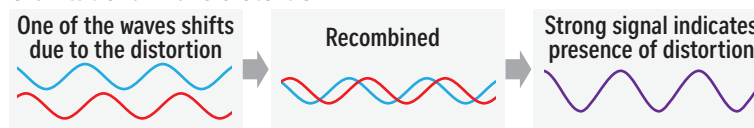
### 3 Detection

A tiny difference between the length of the two beams indicates that a gravitational wave has travelled through the tunnel.

#### Normal operation



#### Gravitational-wave distortion



## Effect of the waves

Zooming along at light speed, a wave stretches space in one direction and squeezes in the perpendicular direction, then reverses the distortions.



\*Illustration greatly exaggerates the distortions

## History and application



Albert Einstein predicted gravitational waves in 1916 in his General Theory of Relativity.



Detection of gravitational waves makes it possible to work backwards to the first millisecond of the Big Bang.