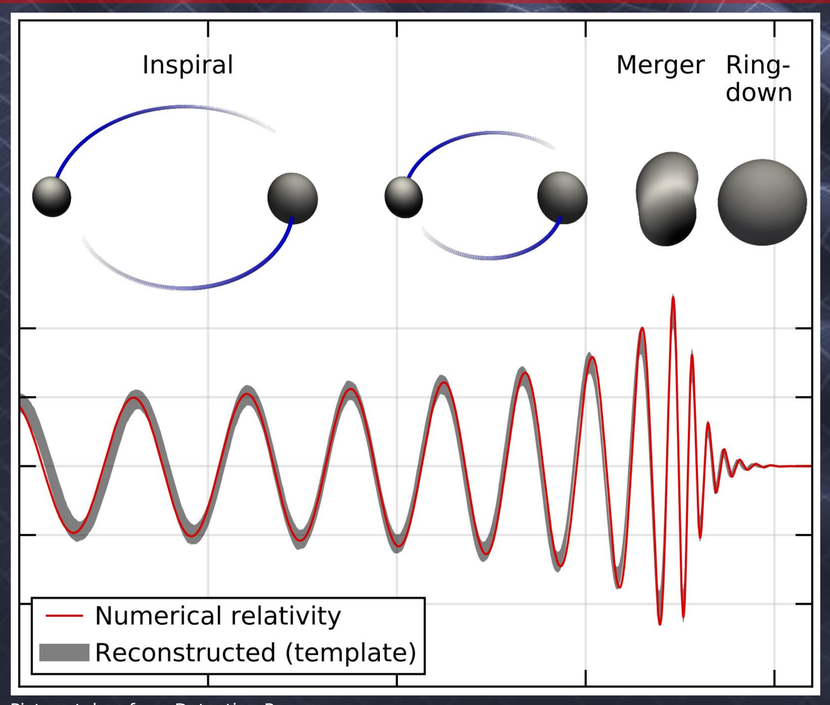
GW150914

The First Observed Gravitational Wave Event

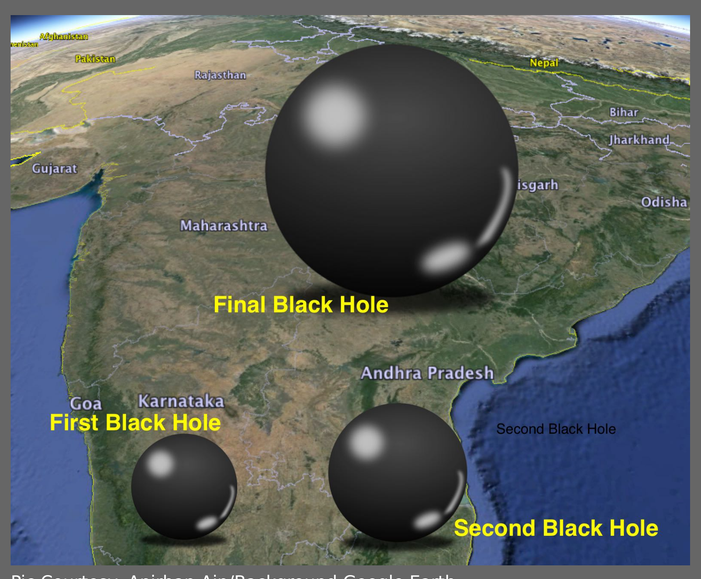
The LIGO Hanford and Livingstone detectors observed the gravitational-wave event GW150914. The observed signal was created by two huge black holes merging together in a galaxy 1.3 billion light years away. The mass of the black holes are 36 and 29 times the mass of sun.



Picture teken from Detection Peper

Whenever the system detects a potential candidate it saves it in a Database. On 14 September 2015 a candidate G184098 was recorded. Subsequent analysis revealed the possibility of this candidate being a detection.
A naming convention was suggested where a short-lived sources will be named according to the date they were discovered and long-lived sources will be named by their position in the sky. So G184098 was renamed to GW150914 because it was detected on 2015, September 14

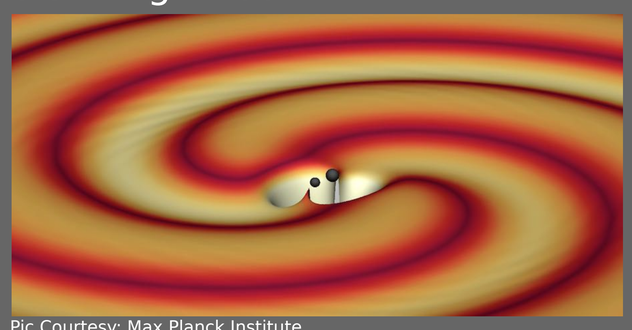
The maximum observed strain from this wave is 10^{-21}.
Which means this wave changed the distance between sun an earth by a length of an atom.
The frequency of the wave at this amplitude was that of the fundamental frequency of Lower Shuddha Rishab swar.
Although the black holes are much more massive than our sun but their size is much smaller than earth.



Pic Courtesy: Anirban Ain/Background:Google Earth

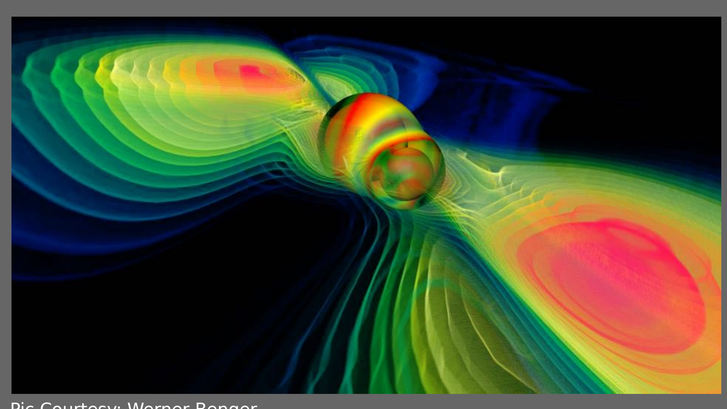
A black hole is a place in space where gravity pulls so much that even light can not get out. The gravity is so strong because matter has been squeezed into a tiny space.
Most black holes are made when the centre of a very big star falls in upon itself, The picture shows how a black hole with accretion disk might look.


Pic Courtesy: Kip Throne


Pic Courtesy: Max Planck Institute

A binary black hole is a system consisting of two black holes in orbit around each other. In close orbit such binary systems radiates energy through gravitational waves and their orbit keeps shrinking.

The orbit keeps shrinking until the black holes collide and become one larger black hole. These kind of events emit huge amount of Gravitational Waves just before the black holes collide. These events are known as Black Hole - Black Hole Coalescence and they are one of the things LIGO was expected to detect.

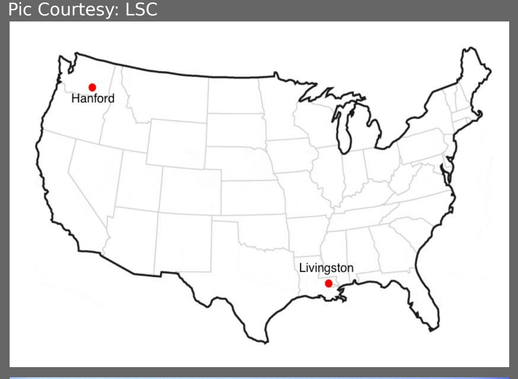

Pic Courtesy: Werner Benger

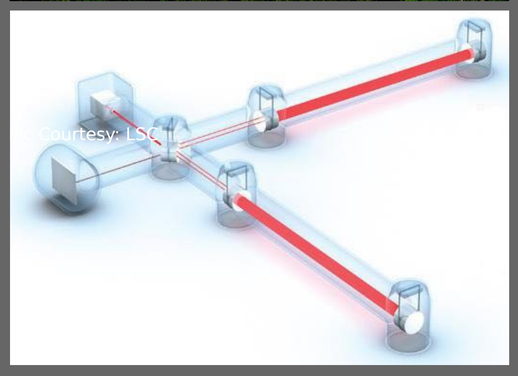
The Laser Interferometer Gravitational-Wave Observatory (LIGO) is a is a pair of two interferometers each of which have two 4 km long arms. They aim to directly detect gravitational waves. Cofounded in 1992, LIGO is a joint project between scientists at MIT, Caltech, and many other colleges and universities. LIGO Scientific Collaboration includes more than 1000 scientists worldwide.

Initial LIGO operations between 2002 and 2010 did not detect any gravitational waves. On September, 2015, Advanced LIGO began its first formal science observations at about four times the sensitivity of the initial LIGO interferometers. Its sensitivity will be further enhanced until it reaches full sensitivity around 2021.

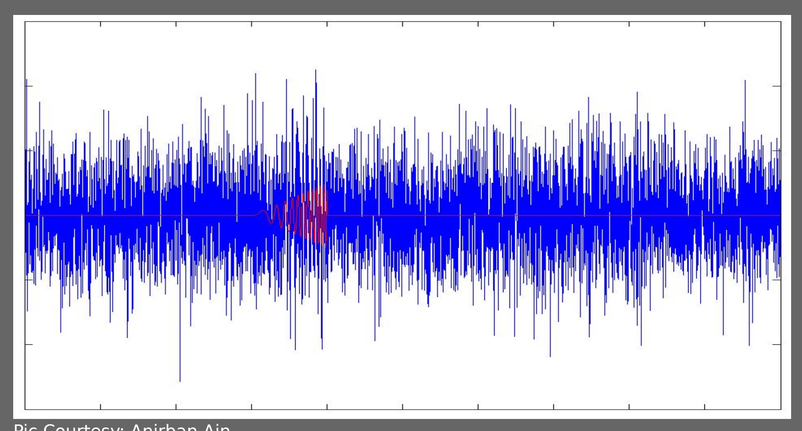

Pic Courtesy: LIGO Lab


Pic Courtesy: LSC





The gravitational wave signal is so weak that the noise from the instruments and surrounding is much louder than the signals.


Pic Courtesy: Anirban Ain

Advanced mathametical techniques are used by high performance computers to identify the signal buried deep in the noise. The calculation required to confirm GW150914 was 50 Million CPU year. Which means your laptop will take more than 1,000 years to do the same calculations.

Here having two detectors really becomes useful.

Noise is random but signals from sky should be detected by both detectors. Which has hap pened for GW150914.

The chances of this happening randomly is negligable.