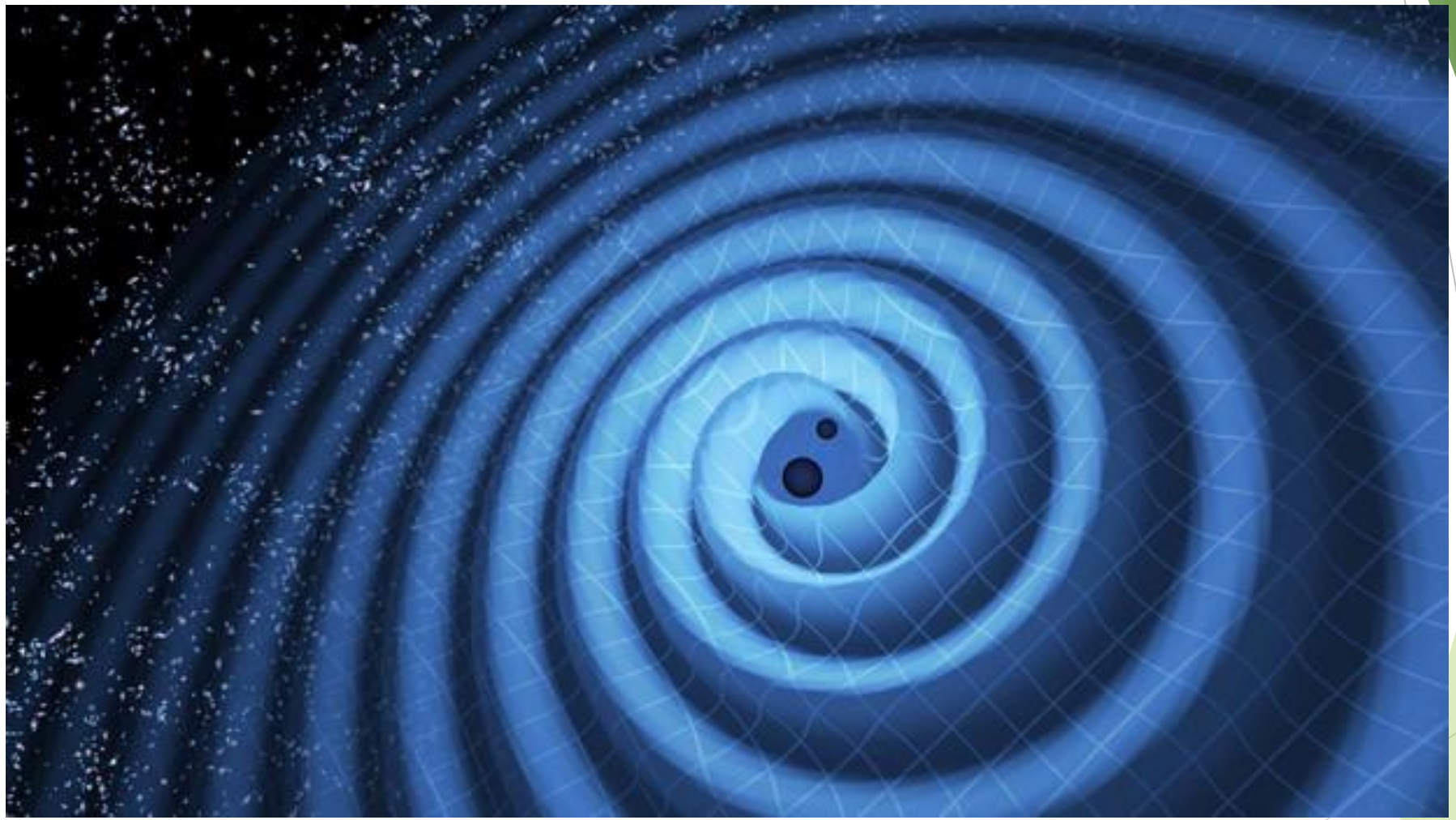
Gravitational Waves and Sources



Aleksandre Beriashvili

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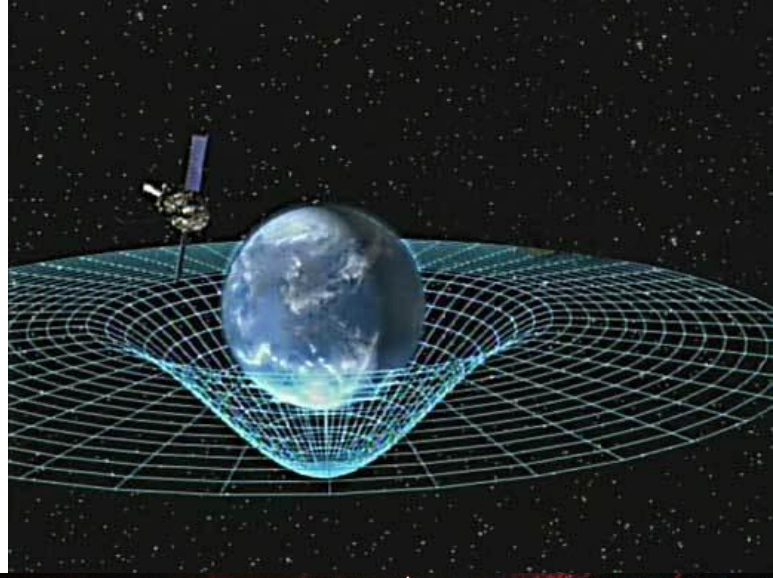
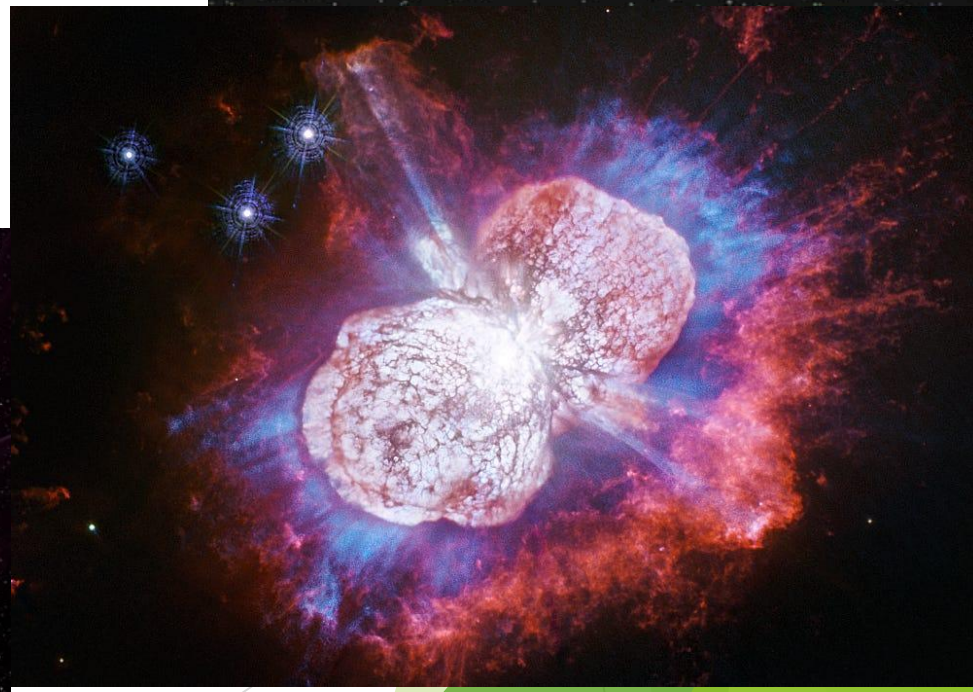
3. Sources and Types of Gravitational Waves
4. WHY DETECT THEM?

What are Gravitational Waves

- Gravitational waves are 'ripples' in space-time caused by some of the most violent and energetic processes in the Universe.
- Albert Einstein predicted the existence of gravitational waves in 1916 in his general theory of relativity.
- The strongest gravitational waves are produced by cataclysmic events such as colliding black holes, supernovae (massive stars exploding at the end of their lifetimes), and colliding neutron stars. Other gravitational waves are predicted to be caused by the rotation of neutron stars that are not perfect spheres, and possibly even the remnants of gravitational radiation created by the Big Bang.



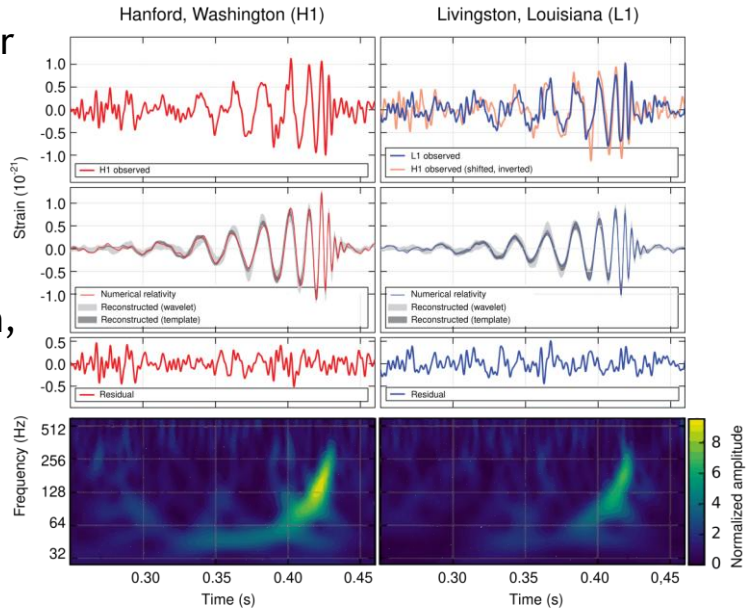


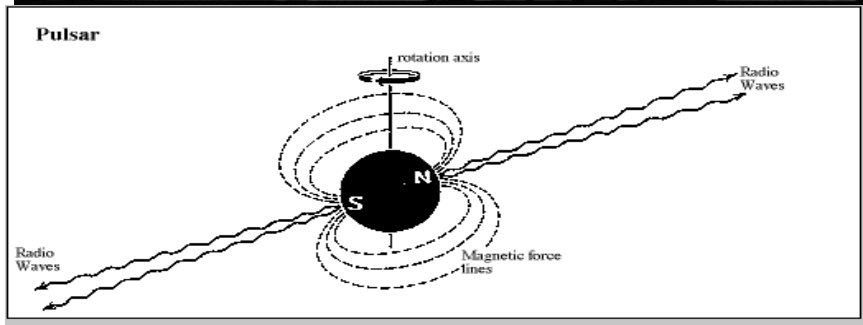
WHO MEASURED GRAVITATIONAL WAVES FIRST?

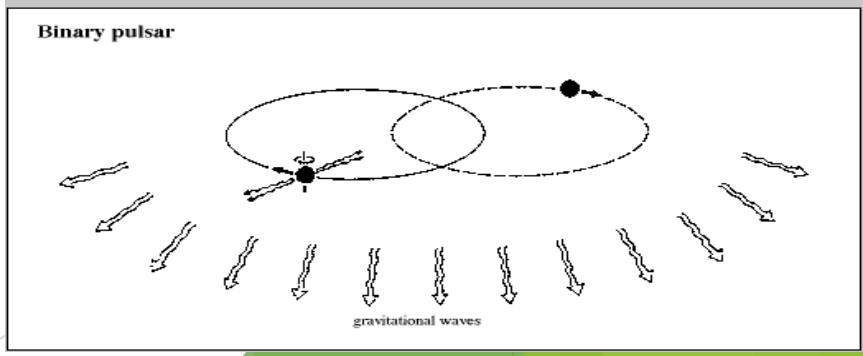
Twenty years after the death of Einstein 1954 physicists Russell Hulse and Joseph Taylor used the Arecibo Radio Observatory in Puerto Rico to discover a tantalizing hint at gravitational waves in the form of a pair of rapidly spinning neutron stars or pulsars.

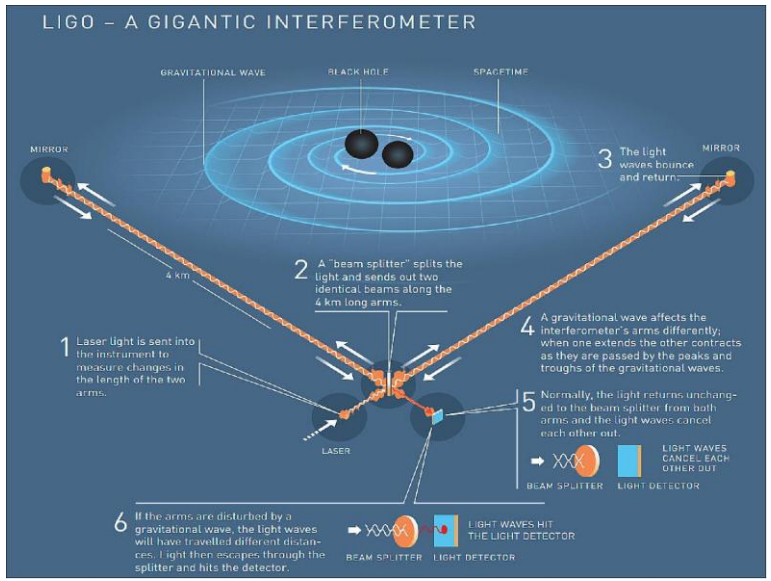
Knowing a pulsar should emit gravitational waves robbing the binary pulsars of energy and forcing their orbits together, the duo tested Einstein's theory of general relativity by watching the binary pulsars for eight years.

The first direct observation of gravitational waves came on September 14, 2015, 100 years after the publication of Einstein's theory of general relativity. The twin LIGO interferometers, located in Livingston, Louisiana, and Hanford, Washington observed gravitational waves from the merger of two black holes, each about 30 times the mass of our sun.



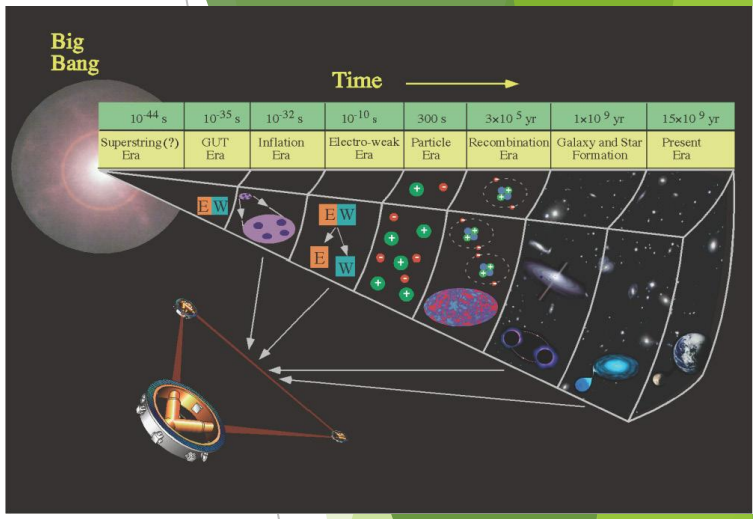


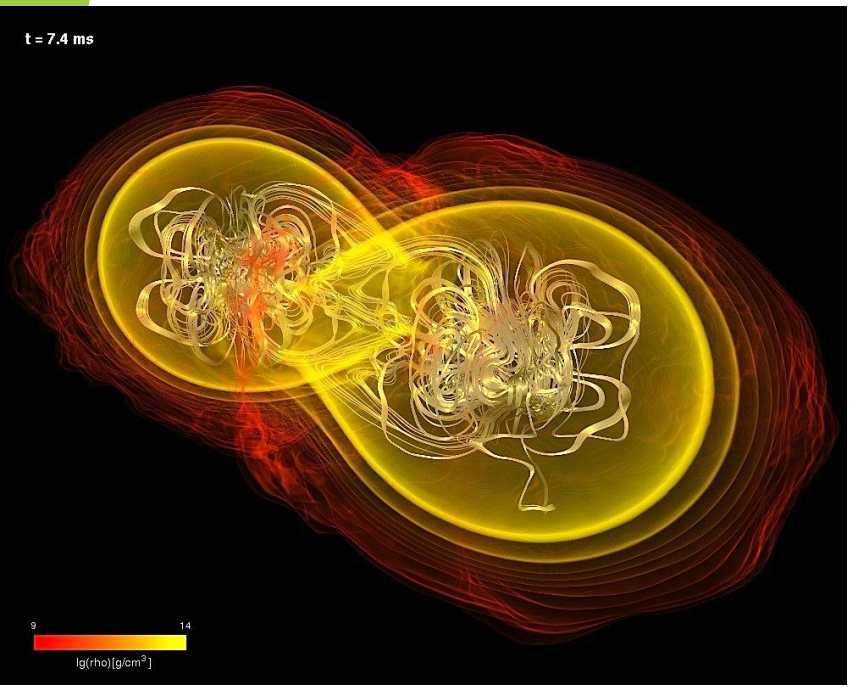


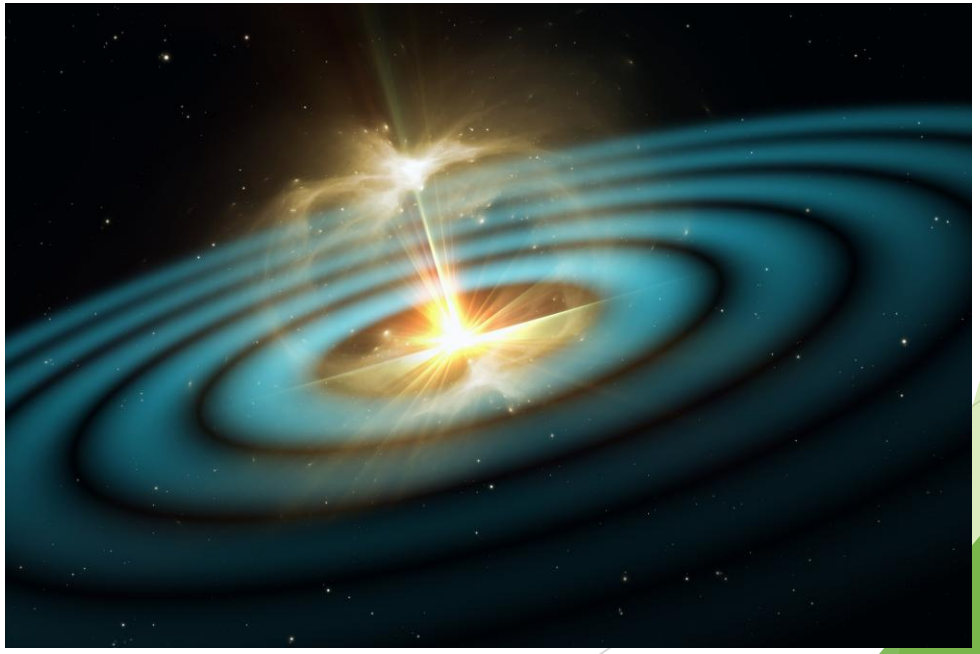


Sources and Types of Gravitational Waves

1. Compact Binary Inspiral Gravitational Waves
2. Continuous Gravitational Waves
3. Stochastic Gravitational Waves
4. Burst Gravitational Waves

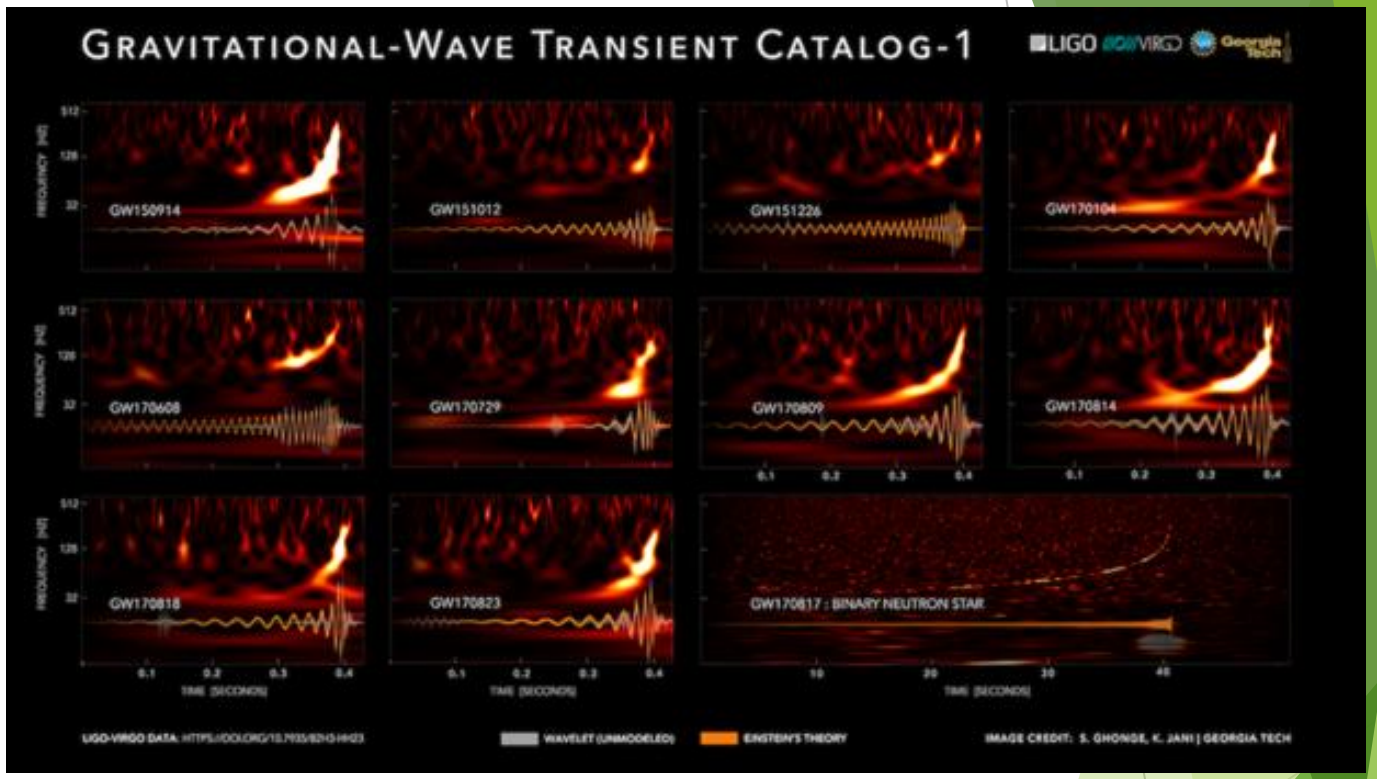






WHY DETECT THEM?

Historically, scientists have relied almost exclusively on electromagnetic (EM) radiation (visible light, X-rays, radio waves, microwaves, etc.) to study the Universe. Some are trying to use subatomic particles, called neutrinos, as well. Each of these 'messengers' of information provides scientists with a different *but complementary* view of the Universe. More importantly, since gravitational waves interact very weakly with matter (unlike EM radiation, which can be absorbed, reflected, refracted, or bent by gravity itself), they travel through the Universe virtually unimpeded, carrying information about their origins that is free of distortion.



The gravitational waves that LIGO detects are caused by some of the most profoundly cataclysmic events in the Universe—colliding black holes, merging neutron stars, exploding stars, and possibly even the birth of the Universe itself. Detecting and analyzing the information carried by gravitational waves is allowing us to observe the Universe in a way never before possible, providing astronomers and other scientists with their first glimpses of un-seeable wonders. LIGO has removed a veil of mystery on the Universe, and in so doing, has ushered in exciting new research in physics, astronomy, and astrophysics.

Thank You!!!