FAQs

New Source of Gravitational Waves Discovered

Q. Why is this in news?

A. Recently, **LIGO Scientific Collaboration (LSC)** has made the **discovery of gravitational waves from a pair of neutron star-black hole (NS-BH) mergers.**

- The reverberations from these two objects were picked up using a **global network of gravitational wave detectors**, the most sensitive scientific instruments ever built.
- Until now, the **LIGO-Virgo Collaboration (LVC)** was only able to observe collisions between pairs of black holes or neutron stars. The **NS-BH merger is a hybrid collision.**

Q. What is Black Hole?

A.

- 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.
- **Gravitational waves are created** when two black holes orbit each other and merge.

Q. What are Neutron Stars?

A.

- Neutron stars c**omprise one of the possible evolutionary end-points of high mass stars.**
- Once the core of the star has completely burned to iron, energy production stops and the core rapidly collapses, squeezing electrons and protons together to form neutrons and neutrinos.
- A **star supported by neutron degeneracy pressure is known as a 'neutron star',** which may be seen as a pulsar if its magnetic field is favourably aligned with its spin axis.

FAQs

Q. What are Gravitational Waves?

A.

- These are **invisible ripples in space** that form when:
  - A star explodes in a **supernova**.
  - Two big stars orbit each other.
  - Two **black holes** merge.
  - Neutron star-Black hole (NS-BH) merges.
- They **travel at the speed of light** (1,86,000 miles per second) and squeeze and stretch anything in their path.
  - As a gravitational wave travels through space-time, it causes it to stretch in one direction and compress in the other.
  - Any object that occupies that region of space-time also stretches and compresses as the wave passes over them, though very slightly, which can only be detected by specialized devices like LIGO.

Q. What about the theory and discovery?

A.

- These were proposed by **Albert Einstein in his General Theory of Relativity**, over a century ago.
- However, the first **gravitational wave** was actually detected by LIGO only in 2015.

Q. What is the detection technique?

A.

- As the **two compact and massive bodies orbit around each other**, they come closer, and **finally merge, due to the energy lost in the form of gravitational waves.**
- The Gravitational Waves signals are buried deep inside a lot of background noise. To search for the signals, scientists use a **method called matched filtering.**
- In this method, **various expected gravitational waveforms predicted by Einstein's theory of relativity, are compared with the different chunks of data** to produce a quantity that signifies how well the signal in the data (if any) matches with any one of the waveforms.

FAQs

- Whenever this match (in technical terms **"signal-to-noise ratio" or SNR) is significant (larger than 8), an event is said to be detected.**
- **Observing an event in multiple detectors** separated by thousands of kilometers almost simultaneously gives scientists increased confidence that the signal is of astrophysical origin.