



CURRENT AFFAIRS



Argasia Education PVT. Ltd. (GST NO.-09AAPCAI478E1ZH)
Address: Basement C59 Noida, opposite to Priyagold Building gate, Sector 02,
Pocket I, Noida, Uttar Pradesh, 201301, CONTACT NO:-8448440231

Date - 3 July 2023

GRAVITATIONAL WAVES

This article covers "Daily Current Affairs" and the topic details "Gravitational Waves". The topic "Gravitational Waves" has relevance in the Science and Technology section of the UPSC CSE exam.

For Prelims:

What are Gravitational waves?

What is LIGO?

For Mains:

GS 3: Science and Technology

LIGO India?

Benefits for India?

Why in the news?

Scientists have said that they have found evidence to suggest that the universe is replete with low-frequency gravitational waves – ripples in the fabric of space-time that are created by huge objects moving around, colliding, and merging with each other, and predicted by Albert Einstein's General Theory of Relativity more than 100 years ago

What are Gravitational waves?

Gravitational waves are ripples or disturbances in the fabric of space-time that propagate through the universe at the speed of light. They are caused by the acceleration or movement of massive objects, such as black holes, neutron stars, or even the entire universe itself. Gravitational waves are a consequence of Einstein's general theory of relativity, which describes gravity as the curvature of space-time caused by mass and energy. Gravitational waves were first detected in 2015 using LIGO detectors.

What is LIGO?

LIGO (Laser Interferometer Gravitational-Wave Observatory):

- Purpose: LIGO is an international collaboration dedicated to detecting and studying gravitational waves.
- Detection Method: LIGO uses highly sensitive interferometers to measure tiny changes in the length of laser beams caused by passing gravitational waves.
- Observatories: LIGO consists of two identical observatories located in Livingston, Louisiana, and Hanford, Washington.
- Interferometer Design: Each observatory has two perpendicular arms, each 4 kilometers long, where laser beams are split and recombined to detect gravitational wave-induced length changes.
- Sensitivity: LIGO can detect changes in length on the scale of a thousandth the size of a proton.
- First Detection: LIGO made history in 2015 by directly detecting gravitational waves, confirming Albert Einstein's general theory of relativity.
- Besides the United States (in Hanford and Livingston), such gravitational wave observatories are currently operational in Italy (Virgo) and Japan (Kagra).

- To detect gravitational waves, four comparable detectors need to be operating simultaneously around the globe.

LIGO India?

- **Objective:** The LIGO-India project aims to detect gravitational waves from the universe.
- **Detector Design:** The Indian LIGO observatory will consist of two vacuum chambers with a length of 4 km each. These chambers will be placed perpendicular to each other, forming highly sensitive interferometers.
- **Scientific Runs:** The project is expected to begin scientific runs starting from 2030.
- **Location:** The LIGO-India observatory will be located in the Hingoli district of Maharashtra. It is situated approximately 450 km east of Mumbai.
- **Network Node:** LIGO-India will serve as the fifth node of the planned network, joining the existing LIGO detectors.

Benefits for India?

- **Scientific Advancement:** LIGO-India will position India at the forefront of gravitational wave astronomy, contributing to cutting-edge scientific research and discoveries.
- **Technological Expertise:** The project will drive the development of advanced technologies in India, particularly in the fields of precision measurement, optics, and vacuum systems.
- **STEM Education and Outreach:** LIGO-India will inspire and engage students and researchers in the fields of science, technology, engineering, and mathematics (STEM), promoting scientific literacy and fostering a culture of scientific inquiry.

Source:

<https://indianexpress.com/article/explained/explained-sci-tech/scientists-detect-hum-gravitational-wave-background-explained-8696086/>

Q.1 Which of the following statements about LIGO (Laser Interferometer Gravitational-Wave Observatory) is/are correct?

1. The first direct detection of gravitational waves was made by LIGO in 2015, confirming Einstein's theory of general relativity.
2. LIGO-India is an operational observatory that has joined the LIGO network.

Select the appropriate option:

- (a) 2 only
- (b) 1 only
- (c) Both 1 and 2
- (d) None of the above

Answer: (a)

Q.2 Which of the following statements about LIGO-India is/are correct?

1. LIGO-India is an international collaboration for the detection and study of gravitational waves.
2. LIGO-India is located in the Hingoli district of Madhya Pradesh.
3. LIGO-India is expected to begin scientific runs in the year 2025.

Select the appropriate option:

- (a) 1 only
- (b) 1, 2, and 3 only
- (c) 2 and 3 only
- (d) 1 and 3 only

Answer: (a)

Q.3 What are the objectives and significance of the LIGO-India project in advancing gravitational wave astronomy and India's scientific and technological capabilities?