# Laser Interferometer Gravitational-Wave Observatory (LIGO)

## Why in news?

The Union Cabinet has cleared Rs 2,600-crore project to construct and set up a Laser Interferometer Gravitational Wave Observatory- India (LIGO-India), which is likely to be completed by 2030.

## What are Gravitational waves?

- **Gravitational wave** - A gravitational wave is an invisible yet incredibly fast ripple in space.
- Their existence was initially predicted by Albert Einstein in 1916 in his general theory of relativity.
- **Properties** - Gravitational waves travel at the speed of light.
- The waves can squeeze and stretch anything in their path as they pass by.
- **Causes -** The gravitational waves are caused
    - When a star explodes asymmetrically (supernova)
    - When two big stars orbit each other
    - When two black holes orbit each other and merge
    - When neutron star collide each other
- The objects that create gravitational waves are far away and sometimes, these events only cause small, weak gravitational waves making them hard to detect.

## What is LIGO?

- **LIGO** - LIGO stands for *"Laser Interferometer Gravitational-wave Observatory".*
- It is the *world's largest* gravitational wave observatory.
- It is an ambitious project by *U.S* to detect the faintest ripples from cosmic explosions millions of light years away.
- LIGO exploits the *physical properties of light* and of space itself to detect and understand the origins of gravitational waves (GW).
- LIGO Comprises two large observatories located 3000 kilometers apart - at Hanford in the State of *Washington*, and at Livingston in *Louisiana*.

- **Working** - Each LIGO observatories consists of *two arms of laser interferometers* that can merge two or more sources of light to create an interference pattern.
- The *interference patterns* generated by interferometers contain information about the object or phenomenon being studied.
- A passing gravitational wave causes the length of the arms to change slightly.
- LIGO's interferometers are designed to measure a distance *1/10,000th the width of a proton*.

- LIGO *cannot detect electromagnetic radiation* such as visible light, radio waves and microwaves because gravitational waves are *not a part* of the electromagnetic spectrum.
- **First detection** - In 2015, LIGO physically sensed gravitational waves generated by two colliding black holes 1.3 billion light-years away.

### Other detectors

- **Virgo** – A gravitational wave located outside of Pisa, Italy
- **GEO600** - A 600 m interferometer located near Hannover, Germany.
- **KAGRA** – Located in Japan

## What is LIGO India?

- The LIGO India [roject is an international collaboration between the LIGO Laboratory and three Indian lead institutions.
- The project is piloted by the *Department of Atomic Energy (DAE) and Department of Science and Technology (DST).*
- **Aim** - To improve the detectors' collective ability to pinpoint sources of gravitational waves in the sky.
- It is to be located in *Hingoli district, Maharashtra, India.*
- LIGO India will consist of a detector (3$^{rd}$ detector) to be built in the image of the twin LIGO instruments already operational in the U.S.

## What are the opportunities for India?

- India could become a global site of gravitational physics research.
- Training and the handling of precision technologies could improve the current status.
- Big Science projects could be increased.
- It has the potential to provide employment opportunities.
- Indian society's relationship with science could take a new dimension.

## Quick facts

### Einstein's General theory of relativity

- It was conceived by Einstein in 1915.
- General relativity is understanding of how gravity affects the fabric of space-time.
- It expanded the theory of special relativity.

**References**


1. The Hindu|LIGO India
2. LIGO| About LIGO

3. LIGO | India About LIGO India
4. LIGO | Other Detectors

