

Union Cabinet approves LIGO-India

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In news— Recently, the Union government has given the final go-ahead to India's Laser Interferometer Gravitational-Wave Observatory, or LIGO, project.

About the Project-

- The Union Cabinet's approval to set up a **gravitational-wave detection facility in Maharashtra**, a ₹2,600 crore project.
- It is one that will **consist of a detector called the Laser Interferometer Gravitational-wave Observatory (LIGO)**, to be built in the image of the twin LIGO instruments already operational in the U.S.
- The facility's construction is expected to be completed by 2030.
- The observatory will be the third of its kind, made to the exact specifications of the twin Laser Interferometer Gravitational-wave Observatories (LIGO), in Louisiana and Washington in the U.S. LIGO-India will work in tandem with them.
- **US LA third detector is being built in India as part of the LIGO-India collaboration** in order to improve the detectors' collective ability to pinpoint sources of gravitational waves in the sky.
- **The Cabinet's approval throws up two opportunities:** first, **India could become a global site of gravitational physics research**, aiding training and the handling of precision technologies and sophisticated control systems, ultimately, cementing a reputation for successfully running an experimental Big Science project.
- **Second, LIGO-India can demonstrate an ability to reckon**

intelligently with Indian society's relationship with science, using the opportunities that Big Science affords.


- India has had a contested relationship with such projects, including, recently, **the Challakere Science City and the stalled India-based Neutrino Observatory (INO)**.
- The project is jointly funded by the department of science and technology and the department of atomic energy.
- The mega-science project in astronomy promises breakthrough research, development of cutting-edge technology and opportunities for students and researchers.
- LIGO-India will be built by the Department of Atomic Energy and the Department of Science and Technology, with a memorandum of understanding with the U.S. National Science Foundation and several national and international research institutions.
- The U.S. will provide key components for the lab worth around Rs 560 crore.

WHAT IS LIGO?


The advanced Laser Interferometer Gravitational Wave Observatory (or LIGO) is at the centre of the path-breaking find:

The LIGO experiment is an example of extreme engineering chasing an impossible dream

The twin LIGO installations – one in Livingston, Louisiana, and the other in Hanford, Washington – are located 3,000km apart




Two "blind" L-shaped detectors with 4km long vacuum chambers that can accommodate 11 Boeing 747-400 commercial airliners



When a gravitational wave comes through, it stretches space in one direction, and squeezes space in the other direction

By measuring the interference of the laser as they bounce between the different points, physicists can measure very precisely whether the space in between has stretched or compressed



- Built 3,000km apart, operating in unison
- To make the smallest measurement ever attempted by science – a million 10,000 times smaller than an atomic nucleus
- Caused by the most violent and cataclysmic events in the universe occurring millions of light years away
- Can detect gravitational waves in a volume of 1 billion cubic light years – covering about 1 million Milky Way type galaxies
- To detect a gravitational wave we should be able to tell when something changes in length by a few parts in 10 to the power 23
- LIGO makes the smallest measurement ever attempted – a million 10,000 times smaller than an atomic nucleus
- It's like trying to hear a song being hummed in a very, very noisy party

LIGO & Gravitational waves-

- The LIGO is a giant L-shaped instrument. Each arm of the

'L' is 4 km long.

- Two laser pulses are shot through each arm at the same time, and they bounce off a mirror at the end to return to the vertex. A detector checks whether the pulses return at the same time.
- When a gravitational wave passes through the detector, the pulses are slightly out of time.
- Researchers use this and other signals to detect, record, and study gravitational waves
- **Gravitational waves are emitted by very massive objects in the universe** in extreme environments, such as when black holes collide.
- Just as light emitted by an object can be used to probe its electromagnetic properties, **gravitational waves can be used to probe the gravitational features of the source.**
- **While two LIGOs can study gravitational waves,** a third observatory is required to better triangulate the location of a source in the sky.
- A more ideal setup requires four observatories to record the same wave. **To this end, researchers are setting up and upgrading detectors in Italy and Japan.**