Fast Radio Bursts

For Prelims: Fast Radio Bursts (FRBs), Radio Frequency Emissions, Deep Space, Neutron stars, Laser Interferometer Gravitational-wave Observatory (LIGO), Laser Interferometer Space Antenna.

For Mains: Fusion of neutron stars and emission of Fast Radio Bursts (FRBs).

Source: TH

Why in the News?

Recently, scientists are trying to understand a new aspect of **Fast Radio Bursts (FRBs)**, which are **mysterious radio signals** coming from **distant galaxies.**

- **Laser Interferometer Space Antenna (LISA),** which is scheduled to launch in the early 2030s, will aid in studying **FRBs and mysterious radio signals.**

What are Fast Radio Bursts (FRBs)?

- **Fast Radio Bursts (FRBs)** are **powerful and brief bursts** of **radio frequency emissions** originating from **deep space.** These mysterious and intense signals last **only milliseconds** but release an amount of energy comparable to **hundreds of millions of suns.**
- **Astronomers** have proposed that **magnetars,** a type of **neutron star** formed from the remnants of **exploding stars**, could be a probable origin for FRBs.
- The **rotation of magnetars is comparatively slowe**r than that of other neutron stars.
- **Neutron stars** are formed when a massive star collapses. The very central region of the **core collapses, crushing** together every **proton** and **electron** into a neutron. These newly-created neutrons can stop the collapse, leaving behind a neutron star.
- A magnetar possesses a **magnetic field** over a **thousand times stronger** than that of other **neutron stars,** and it is a **trillion times** more powerful than **Earth's magnetic field.**

How are Neutron Stars Involved in the Genesis of FRBs?

- The occurrence of **FRBs** might result from the **collision of two neutron stars.**
- The collision could generate two distinct signals**: gravitational waves**, which cause **ripples in space-time,** and **FRBs.**
    - **Neutron star mergers** have been known to be accompanied by **electromagnetic counterparts** in the past.
- The **Laser Interferometer Gravitational-wave Observatory (LIGO)** in the US and the **Virgo instrument** in Italy made a **groundbreaking observation** by **detecting** gravitational waves from the **collision of two neutron stars** for the first time in 2015.

What is Laser Interferometer Space Antenna (LISA)?

- LISA is a planned **space-based gravitational wave observatory** led by the European Space Agency (ESA) **and** National Aeronautics and Space Administration (NASA).
- **LISA** is designed to **detect and observe gravitational waves** by measuring the minute changes in the distance between **three spacecraft** in a triangular formation, caused by the **passage of gravitational waves** through space.
- This **space-based observatory** is anticipated to provide valuable insights into cosmic events, such as the **mergers of massive** black holes and other astrophysical phenomena, contributing to our understanding of the universe.

What is LIGO?

- **About:**
  - **LIGO** stands for **Laser Interferometer Gravitational-Wave Observatory.**
  - It is a groundbreaking observatory designed to detect and study **gravitational waves.**
  - It is providing a new way to explore the **universe** by observing the **ripples in space-time** caused by events such as the collision of black holes or neutron stars.
- **First Detection of Gravitational Waves:**
  - The **LIGO** in the **US first detected gravitational waves** in **2015**, which led to a **Nobel Prize in Physics in 2017.**
    - These gravitational waves were produced by the **merger of two black holes,** which were about 29 and 36 times the mass of the Sun, 1.3 billion years ago.
    - **Black hole mergers** are the source of some of the strongest **gravitational waves**.

Conclusion

Scientists are investigating Fast Radio Bursts (FRBs), brief and powerful signals from distant galaxies. Magnetars, dense remnants of exploded stars, are proposed sources. Neutron star collisions may generate both FRBs and gravitational waves, as observed by LIGO and Virgo. The upcoming Laser Interferometer Space Antenna (LISA) aims to deepen our understanding of cosmic phenomena.

UPSC Civil Services Examination, Previous Year Questions (PYQs)

Q. Recently, scientists observed the merger of giant 'blackholes' billions of light-years away from the Earth. What is the significance of this observation? (2019)

(a) 'Higgs boson particles' were detected.
(b) 'Gravitational waves' were detected.
(c) Possibility of intergalactic space travel through 'wormhole' was confirmed.
(d) It enabled the scientists to understand 'singularity'

Ans: (b)

Exp:

- Every few minutes a pair of black holes smash into each other. These cataclysms release ripples in the fabric of space time known as 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 catastrophic events such as colliding black holes, the collapse of supernovae, coalescing neutron stars or white dwarf stars, etc.
- Scientists have yet again detected gravitational waves produced by the merger of two light black holes about a billion light-years away from the Earth.
- It was recorded by Laser Interferometer Gravitational-Wave Observatory (LIGO).

- Therefore, option (b) is the correct answer.

Mains

Q. How does the Juno Mission of NASA help to understand the origin and evolution of the Earth?