XPoSat

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Why is in news? ISRO launches XPoSat: What is the mission and its significance?

Indian Space Research Organisation (ISRO) put its first polarimetry mission X-ray Polarimeter Satellite (XPoSat) in a **precise circular orbit of 650 km** on January 1 morning after a 21-minute flight.

XPoSat is the **world's second satellite-based mission** dedicated to **making X-ray polarimetry** measurements.

About XPoSat:

X-ray Polarimeter Satellite (XPoSat) is **India's maiden mission** dedicated to **analysing the polarisation of X-rays** emanating from bright celestial sources in the **medium frequency band**.

XPoSat comprises two payloads, including Indian X-ray Polarimeter (**POLIX**) and X-ray Spectroscopy and Timing (**XSPECT**).

They have been **built by Raman Research Institute and UR Rao Satellite Centre**, both located in Bengaluru.

The spacecraft is designated for **observation from low earth orbit** (~ 650 km, low inclination of ~ 6 degree).

It has an **estimated mission life of about five years** during which XPoSat will observe sources that emit polarised X-rays.

The observations will be done **when the magnetars or neutron stars** (they are highly magnetic and display a wide array of X-ray activity) **are in transit through the Earth's shadow**, for instance, during the eclipse period.

Two scientific payloads onboard XPoSat:

POLIX:

It is the **world's first instrument** designed to **operate in the medium X-ray** of 8 to 30 kilo electron Volt (keV) energy band.

It comprises a collimator, which is the key component to filter light originating from bright sources in the field of view.

Moreover, there is a scatterer consisting of **four X-ray proportional counter detectors** (that prevent the trapped light from escaping).

It will observe a few tens of astronomical sources. It was conceived, designed, and built at RRI.

XSPECT:

It is designed to **conduct fast timing and high spectroscopic resolution** in a soft X-ray energy band (0.8-15 keV).

It will observe a variety of sources like X-ray pulsars, black hole binaries, low-magnetic field neutron stars, active galactic nuclei or AGNs (a compact region at the centre of a galaxy that emits a significant amount of energy across the electromagnetic spectrum) and magnetars.

Significance of XPoSat:

Till now, astronomers have largely used and depended on spectroscopic, imaging and timing–based data obtained from either ground-based telescopes or satellite-based missions from the optical to the radio frequency band of the electromagnetic spectrum.

Polarisation of celestial sources was done **either in the optical or radio bands**.

XPoSat, however, will be a **game-changer** and facilitate X-ray polarisation measurements **possible from bright sources, that too, in the medium energy band** (8-30 keV) energy range – which has **never been attempted ever before.**

The XPoSat team has identified **several tens of sources radiating X-rays**.

XPoSat will observe two kinds of sources — **persistent sources** (targeted and known sources) and **transient sources** (pulsars, active galactic nuclei, magnetars).

Out in space, X-rays get **polarised due to multiple causes**.

For example, X-rays when subject to strong magnetic fields or due to the interactions with material present around black holes. So, by studying the polarised X-rays emanating from excellent sources like magnetars, black holes and their surrounding environments, and neutron stars, scientists can probe the nature of the radiations and the multitudes of processes involved in the generation of these radiations.

POLIX will undertake important measurements like the degree and angle of polarisation of X-ray photons from the environment surrounding black holes, neutron stars, and other such cosmic entities.

These two additional parameters, along with the spectrographic, timing and imaging data, will aid researchers to overall improve the present understanding of the celestial bodies and ultimately unravel some of the unknown mysteries of the Universe.

Need for the study of Polarisation of X-rays:

X-rays comprise electric and magnetic waves that are constantly in motion. Being sinusoidal waves, they do not follow a patterned direction of motion.

Whereas, a polarised X-ray is both organised and has two waves vibrating in the same direction.

When magnetars or black holes emit X-rays, they encounter a wide variety of materials in the Universe.

As X-rays pass through the thick cloud of materials, the electric component of the X-ray emits a photon in a changed direction, as it has now undergone scattering.

In the process, the new photon has got polarised in a direction perpendicular to the plane formed between the original and scattered photon.

The polarisation measurements – **angular and degree of polarisation** – are believed to **provide clues about the bright X-ray emitting sources** the nature of these radiations and the complex process they undergo.

XPoSat compare with X-ray experiments or missions globally:

Missions on **X-ray polarisation measurements** have been a handful, the world over. Some like **HX-POL and XL-Calibur** have been **balloon-based and short-duration experiments** by NASA and collaborators.

Indian astronomers, using **AstroSat** – India's first astronomy-based space missions launched in September 2015 — performed timing and broadband spectroscopy of X-ray sources but no polarisation studies were performed.

The **lack of development of highly sensitive and precise instruments** makes missions for polarisation measurements of X-rays extremely challenging, thus fewer missions have been attempted so far.

In 2021, NASA launched **Imaging X-ray Polarimetry Explorer (IXPE).** It has been designed to operate and perform X-ray polarisation measurements within the soft X-ray band (2 to 8 keV energy band).

Besides complementing IXPE, XPoSat's payload POLIX will **offer an expanded observational energy band**, as it is designated to perform X-ray polarisation in the medium X-ray band (8 to 30keV).