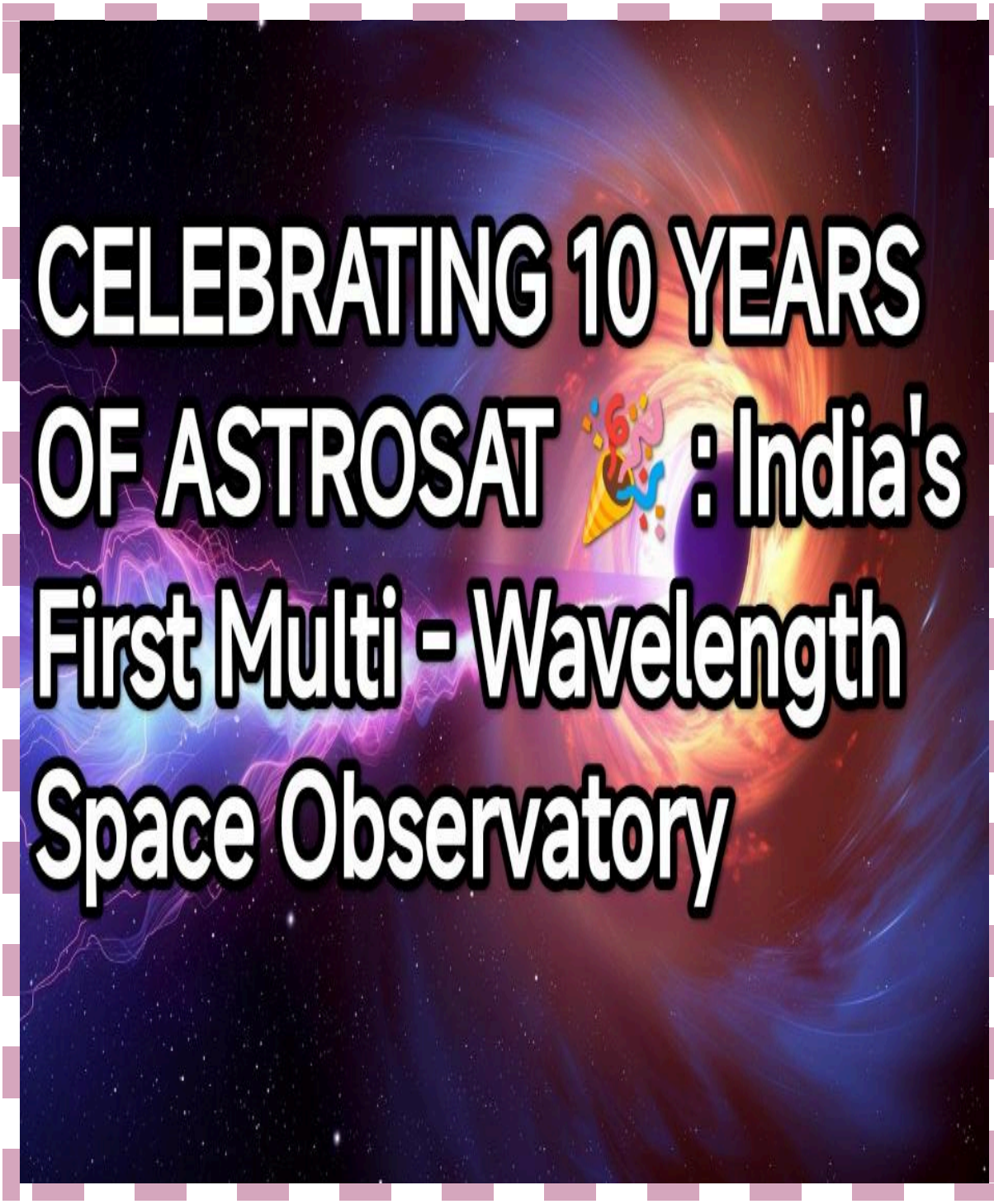
CELEBRATING 10 YEARS
OF ASTROSAT : India's
First Multi - Wavelength
Space Observatory

INTRODUCTION

- India has achieved remarkable achievements in the field of Space Science and technology in the past decades.
- Developed by the *Indian Space Research Organisation (ISRO),* AstroSat is India's first dedicated astronomical object which was placed in orbit on *28 September, 2015* through the assistance of *PSLV C-30* launch vehicle .
- The satellite has a very high colour resolution and is capable of studying the ultraviolet (UV), visible and high energy X- rays regions simultaneously.
- Despite a design period of 5 years it has completed a *decade* in service and has made many important achievements.
- Its contribution has given India a new identity on the Global stage of ancient science.

HISTORICAL BACKGROUND

The Indian Space Research program was launched in the 1960s. Initially, its primary objective was to utilize satellite technology for development purposes but astronomy and space sciences experiments were also conducted in parallel.

Tata Institute Of Fundamental Research (TIFR), Hyderabad :

It developed a balloon project vision facility sending instruments to altitude up to 42 kms to study cosmic rays and X- rays between 1967 - 1980s , several balloon based experiments provided India with significant results in x-ray astronomy.
Its smaller experiments began to be added to larger satellites, such as the Gamma ray burst (GRB) detector on the SROSS series satellite in 1987.

The Indian X-ray Astronomy Experiment (IXAE) :

It was installed on the IRS P-3 satellite launched by PSLV in 1996.
It operated for nearly 5 years, studying more than 20 celestial stars.
IXAE's success gave Indian scientists their own self vision and confidence that India could build an advanced astronomical laboratory on its own soil.
The confidence later became the basis for the concept for development of the AstroSat.

CONCEPT AND DEVELOPMENT OF ASTROSAT

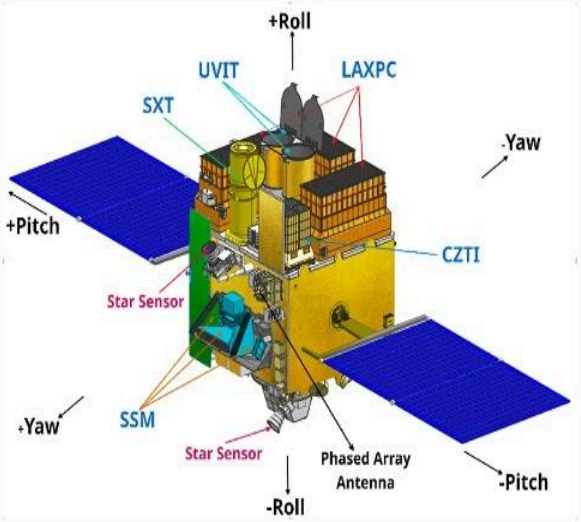

Fig: Image showing AstroSat spacecraft with various payloads.

In the 1990s , when missions like the Hubble Space Telescope, Chandra X-ray Observatory and XMM Newton were becoming operational in the world,the Indian astronomers also realised that India needed its *own dedicated Antriksh Observatory*. After the core discussions, it was decided that India should develop a multi- wavelength telescope to enable simultaneous and interconnected study of celestial bodies at different wavelengths and therefore through this way, the ASTROSAT project was born.

MISSION PROFILE :

- The AstroSat mission profile involves a dedicated Indian multi- wavelength space observatory launched in 2015 into a 650 km orbit, capable of observing cosmic sources simultaneously from UV to hard X-rays.
- Its *objectives* are to understand high energy astrophysical phenomena, to study every astro minor astrophysical phenomena and also to study neutron stars and black holes, to observe star forming regions, detect new X-Ray sources and perform deep-field surveys in the UV band.
- The satellite managed by ISRO's mission control collects data from its five scientific payloads and beams it to the ground station for processing, archiving and distribution by the Indian Space Science Data Centre (ISSDC).

MISSION OVERVIEW :

- ☐ Launch :- September 28, 2015 by PSLV C-30 rocket from Sriharikota, India.
- ☐ Orbit :- A 650 km Orbit with 6°inclination.
- ☐ Mass :- ~1515 kg
- ☐ Lifespan :- the minimum expected operational life was supposed to be of five years, which was successfully completed by September 2020 (but still active for more than 10 years as per the data of 28 September, 2025).
- ☐ Mission Control :- managed by ISRO'S Mission Operation Complex (MOX).

AstroSat : Key Instruments And Payloads

Five major scientific instruments are installed till date on AstroSat.

- ❖ **Ultraviolet Imaging Telescope (UVIT)** :-
  - ➔ It was Developed by Inter University Centre For Astronomy And Astrophysics (IUCAA), Pune.
  - ➔ Two telescopes with a diameter of 380 mm.
  - ➔ Study of ultraviolet and visible light wavelength with a maximum resolution of 1.5 arc seconds.
- ❖ **Large Area X-ray Proportional Counter (IAXPC)** :-
  - ➔ It has been developed by TIFR.
  - ➔ With an area of influence from 8000 square centimetres.
  - ➔ 2-80 KeV energy range.
- ❖ **Cadmium Zinc Telluride (CZTI)** :-
  - ➔ It has been developed by TIFR.
  - ➔ Study of energy ranges between 20-100 KeV X-rays.
  - ➔ Special capacity for Gamma-rays burst (GRB) and polarity mapping.
- ❖ **Soft X-Ray Telescope (SXT)** :-
  - ➔ It was also developed by TIFR.
  - ➔ With an energy range of 0.3-8 KeV spectral studies.
- ❖ **Scanning Sky Monitor (SSM)** :-
  - ➔ It was developed by ISRO for detection and monitoring of permanent and transient celestial events.

MAJOR SCIENTIFIC CONTRIBUTIONS

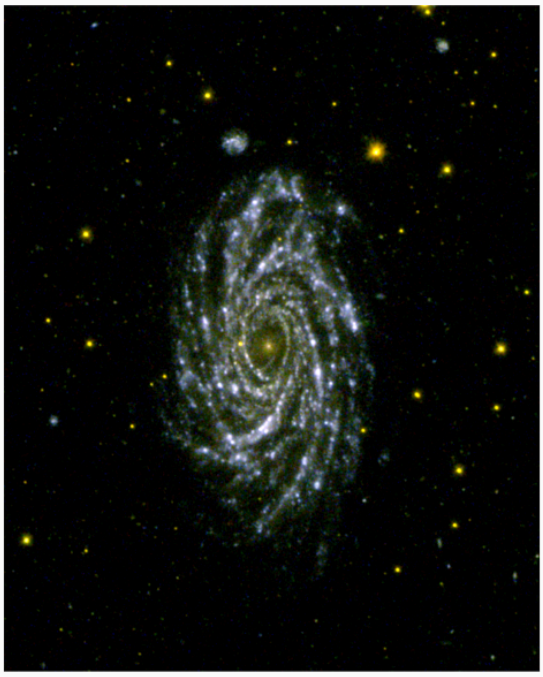

Figure 1: NGC 2336 a barred spiral galaxy 100 million light years away as seen by AstroSat UVIT

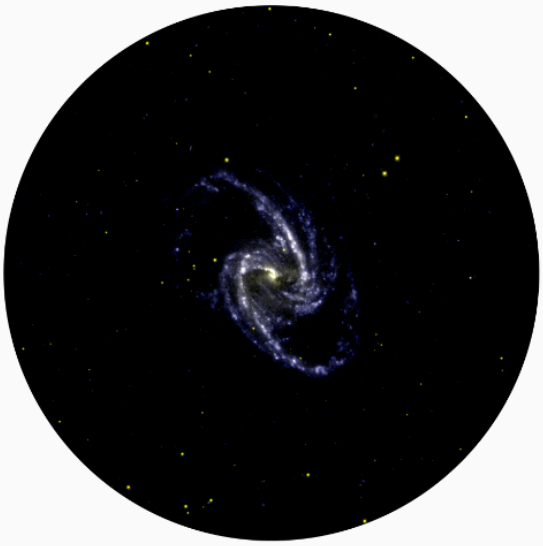

Figure 2: NGC1365 as seen by AstroSat UVIT is also known as Fornax propeller galaxy is a double barred galaxy at a distance of 56 million light years away.

1. AstroSat has made several important discoveries over the past decades.
2. The detection of ultraviolet photons from a distance of 9.3 billion light years, one of the most distant UV discoveries till date.
3. A thorough survey of the *Andromeda galaxy (M-31)* and a UV cataloging of over 75,000 stars.
4. The discovery of X-Ray polarity from the Crab-Pulsar, which provided the new foundation for the theoretical models.
5. The study of the polarity of *Gamma rays burst (GRB)* which shed light on the nature of these explosions.
6. The discovery of star formation in Jellyfish Galaxy which provides insight into the process of gas accretion.
7. It helps to understand UV and x-ray observations of the OG-287 blazer shed light on the role of protons.
8. Study the *Black Hole Binary System 4U-1637*, the black hole was found rotating at almost the maximum possible speeds.

IMPACT ON THE INDIAN SPACE SCIENCE

- AstroSat gave India a respected recognition and place in the global astronomy communities.
- It trained Indian scientists in cutting-edge equipment and data analysis.
- This mission is paving the way for even more advanced observations like *Extrapolar Metre Satellite (XpoSat)* in the future.
- Astrosat's impact on Indian space science has been profound, establishing India's capability in multi-wavelength astronomy enabling new discoveries in cosmic phenomena like black holes and supernovae, fostering a generation of astronomers, and significantly bolstering ISRO's global reputation in complex space science missions according to sources.
- This dedicated space observatory, operating in the X-ray, optical and UV bands, has facilitated simultaneous observations of celestial bodies and contributed to over 275 peer reviewed publications, positioning India as a key player in the field of space based economy.

Key Impacts

India's First Dedicated Astronomy

Mission : AstroSat is India's first multi-wavelength space observatory, enabling it to conduct independent, high-quality astronomical research.

Multi-Wavelength Capability : It allows simultaneous observations across UV, visible, and X-ray wavelengths, providing a
comprehensive view of celestial objects and phenomena, a unique feature not previously available from a single Indian satellite.

Advancement of Cosmic Understanding :
The mission's data offers insights into black holes , supernovae and galaxies contributing to a global understanding of the universe and enabling the study of matter under extreme conditions.

Enhanced Research & Global Collaboration : AstroSat has stimulated research activity for both Indian and international astronomers, with observations being utilized by thousands of registered users from many countries.

Technological Prowess And Reputation : The mission demonstrates India's advanced capabilities in developing and managing complex space science missions, strengthening ISRO's global image and reinforcing its reputation for low-cost, high - impact projects.

Scientific Discoveries and Publications : AstroSat has resulted in significant discoveries, such as the detection of UV light from distant galaxies and X-ray polarization from cosmic sources, leading to hundreds of scientific papers and positioning India as a key player in space based astronomy.

Inspiration for Future Scientists : The success of the mission also inspired interest among the young scientists and students, further cultivating the field of space science in India.

INTERNATIONAL COLLABORATION

- ★ AstroSat is an example not only of India but also of global corporations.
- ★ The *Canadian Space Agency* and The *University of Leicester (UK),* assisted in instrumental development.
- ★ Nearly *2000 scientists* from more than *57 countries* used the associate data.
- ★ The scientific use of AstroSat from the US to Afghanistan demonstrated its genuine International relevance.

FUTURE PROSPECTS

- ➢ AstroSat is still fully active and is expected to be discovered in the coming years .More light will be shed on the galaxy - availability, black hole physics and gamma-raybusters.
- ➢ New Indian Missions such as Aditya - L1, XpoSat, will build on the AstroSat experiments.
- ➢ AstroSat continues to operate and generate scientific data, but it's future prospects are focused on AstroSat-2, which will offer advanced capabilities in areas like gravitational wave reaction and IR astronomy, building on AstroSat's legacy. While AstroSat itself holds promise for continued operations beyond its initial design life, the emphasis is shifting towards next - generation observatories to enhance India's contribution to global astrophysics.

The Future : AstroSat - 2 & Beyond .....

1. **Advanced Capabilities**: The proposed AstroSat-2 is envisioned to incorporate next - generation science and engineering, including the detection of gravitational wave counterparts, X-ray polarization of gamma-ray bursts (GRBs), and the deployment of infrared (IR) telescopes.
2. **Formation Flying** : future possibilities include formation flying with multiple spacecraft (AstroSat 2A, 2B) to achieve enhanced observational capabilities.
3. **Successor Missions** : AstroSat's success paves the way for future Indian missions, such as the recently launched XpoSat (X-ray Polarimeter Satellite), which focuses on studying X-ray polarization, continuing AstroSat's scientific contributions.
4. **Broader Vision** : India's space program aims for next - generation observatories for infrared and gravitational waves studies, expanding beyond AstroSat's multi-wavelength approach to explore different frontiers of Astro physics.

Conclusion

- The last 10 years of AstroSat have demonstrated that India can play a leading role not only in space applications but also in space explorations.
- This mission is a testament to the self - confidence , technical powers and global corporation of Indian sciences.
- AstroSat's achievements will certainly inspire scientists of the future generations and provide a new dimension to India's astronomical research.
- In essence, AstroSat's "conclusion" is not just an end but a new beginning, marking a significant advancement in India's capabilities and its enduring contribution to astrophysical research worldwide.

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