Astrosat: a telescope on a satellite

The study of cosmic rays and radiation processes can be performed by measuring the emission of rays over the entire electromagnetic spectrum. Since 1971, space-based astronomy research projects have increased with the introduction of the first X-ray satellite in Uhuru (X-ray Explorer Satellite). The IUE satellite with UV spectroscopic capability has contributed immensely in understanding the atmospheres of stars and the environment of galaxies. Besides this, X-ray imaging by *Chandra* and the high spectral sensitivity of XMM-Newton have produced spectacular X-ray images and spectra of a range of objects in 0.1–10 keV (ref. 1).

India will soon launch its first dedicated astronomy satellite, Astrosat for space exploration. This satellite is meant especially for studying cosmic rays and will have diverse scientific goals. In addition to simultaneous multiwavelength monitoring of variable sources, it will also carry out studies on different classes of galactic and extragalactic sources using the scanning Sky Monitor.

The total mass of Astrosat is 1600 kg including 868 kg of scientific instruments. It is a three-axis stabilized satellite with orientation manoeuvres and attitude control performed using the reaction wheels and magnetic torquers (a device which helps orients a spacecraft and manage angular momentum on-board) which have inputs from three gyroscopes (a device for monitoring and maintaining the orientation on the basis of angular momentum) and two star sensors. A storage device of 120 GB capacity will be used for on-board storage of data.

The uniqueness of the satellite is due to its wide spectral coverage, extending over soft and hard X-ray regions, visible and ultraviolet regions. It is capable of observing the target source over various spectral bands with four co-aligned instruments simultaneously. Some of the important scientific objectives of the satellite include – ultraviolet imaging studies of nearby and distinct galaxies and to study the details of nuclear activity and associated star formation in the inner regions of galaxies; measuring the magnetic fields of neutron stars by detection and studies of cyclotron lines in the spectra of X-ray pulsars; broad-band X-ray spectroscopic studies from 0.3 to 100 keV for X-ray binaries, supernova remnants, stellar coronae, etc. Multiwavelength studies of different types of cosmic sources over a wide spectral band are important for discriminating between various models of radiation processes in the sources[1].

The satellite will have different payloads. They are: (1) Large area X-ray proportional counters, which are high-pressure X-ray proportional counters. (2) Cadmium zinc telluride images, which consists of a detector array with high detection efficiency close to 100% up to 100 keV, as well as superior energy resolution and suitable for the study of emission in X-ray spectra. (3) Soft X-ray imaging telescope (SXT), which will cover the energy range 0.3–8.0 keV and provide energy resolution of 2% at 6 keV for good quality spectroscopy. (4) Scanning sky monitor, with detectors mounted on a rotating platform in orthogonal position to cover a large part of the sky and with an energy range 2–10 keV. (5) Ultraviolet imaging telescope, with two similar co-aligned telescopes covering near-UV, far-UV and visible bands[2].

The satellite is a collaborative effort of the Tata Institute of Fundamental Research, ISRO Satellite Centre, Indian Institute of Astrophysics, Raman Research Institute, Inter-University Centre for Astronomy and Astrophysics and Physical Research Laboratory, all of which are involved in the development of hardware for this mission. In addition, several centres of ISRO are involved in the designing of components and subsystems and several other institutes are involved in developing software for the mission. The Canadian Space Agency is also involved in the making of this satellite[3].

The mission will help improve the understanding of radiation processes and the environment vicinity of the central compact objects in Seyfert galaxies and quasars. It will also study periodic and aperiodic time variability for all classes of X-ray and UV sources. Energy spectra of all classes of X-ray sources will be measured by Astrosat over 0.5–100 keV from simultaneous observations with three X-ray instruments. Magnetic field strength of the X-ray pulsars will be measured through detection of cyclotron absorption lines. SXT will carry out spectroscopic studies of hot, thin, collisional plasmas in galaxies, clusters of galaxies, stellar coronae and supernova remnants in accreting white dwarfs, neutron stars, black holes, active galactic nuclei and quasars[1].

The satellite will also be a powerful tool to probe the astronomical processes and environments of different astronomical sources. Astrosat is expected to be launched soon from Shriharikota launching station.

1. Agarwal, P. C., *Adv. Space Res.*, 2006, **38**, 2989–2994.
2. Manuchanda, R. K., ASI Conference Series, 2011, vol. 3, pp. 53–63.
3. www.meghnad.iucaa.ernet.in/~astrosat/

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