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REVIEW OF ORBITAL TELESCOPES & THEIR POSSIBLE DEVELOPMENTS

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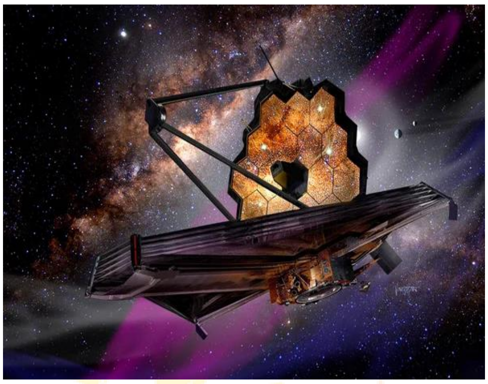
Abstract : The following paper is a review of orbital telescopes with respect to their characteristics, functions, and scientific features. With this review paper, 15 orbital telescopes are described according to the instrument composition, orbital configuration, mission objectives, and peculiarities of each. These include the design concept, operational concept, and major findings pertaining to some world-famous space-based observatories: the James Webb Space Telescope, Hubble Space Telescope, and the Chandra X-ray Observatory. These are state of the art telescopes placed in low Earth orbit and at Lagrange points, replete with advanced mirror technologies, instrumentation, and sophisticated multi-wavelength imaging and spectroscopic capabilities. Due to their important contributions, our understanding of key astronomical phenomena, including galaxy formation, black hole dynamics, and exoplanetary systems, has been transformed. The present study underlines the intimate and sustained need for innovation in space telescope technologies so that advance-making through these devices may continue unabated in the field of astronomical research.

INTRODUCTION

Since the first space-based observatories launched, orbital telescopes have reshaped our view of space. Unlike ground based telescopes, the orbital ones operate beyond Earth's atmosphere and hence avoid issues such as atmospheric distortion, weather conditions, and light pollution by providing a clear uninterruptible view of space. They further revolutionized the study of the starry sky and Which significantly expanded our knowledge about the universe. Early successes like launching the Hubble Space Telescope in 1990 revolutionized astronomy. Hubble's capability to observe visible, ultraviolet, and near-infrared light enabled ground-breaking insights into the age of the universe, the formation of galaxies, and the enigmas of dark energy. The successes underlined how vital such orbital telescopes would be in advancing space science and proved the necessity of consistent investment in developing orbital telescopes for the continued growth of space science. Where the search for answers about the beginning of the universe-and simultaneously, the hunt for exoplanets with possible habitability becomes ever more insistent, so does the need for even more sophisticated orbital telescopes. Modern missions, such as the James Webb Space Telescope, reflect several decades of advances in research, engineering, and international cooperation that further new frontiers in optical, infrared, and spectroscopic performance. Meanwhile, emerging technologies allied to adaptive optics, modular designs, and artificial intelligence are reconsidering the performance of any future telescopes. The paper reviews orbital telescopes: the principle, advances in technology, problems arising during operations, new trends, and the potential of new-generation design in responding to open scientific questions. Through the analysis carried out during the evolution of the subject, the review underlines their mission lifetimes, their capability to perceive a wide range of wavelengths, and their revolutionary discoveries about the universe.

Literature Review

I. JSWT



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The James Webb Space Telescope (JWST) is a groundbreaking infrared observatory designed to observe light from 0.6 to 28 micrometres, allowing it to investigate the origins and evolution of galaxies, stars, and planetary systems. With its 6.5-meter segmented mirror, JWST operates in the stable L2 orbit, 1.5 million kilometres from Earth, where it avoids interference from Earth's heat and light. Key instruments like Near-Infrared Camera (NIRCam), Near-Infrared Spectrograph (NIRSpe), Mid-Infrared Instrument (MIRI), and Near-Infrared Imager and Slit-less Spectrograph (NIRISS) enable the telescope to capture intricate details through imaging and spectroscopy. A critical component of JWST's design is its advanced cooling system, necessary for infrared observations. To reduce interference from its own heat, JWST uses a five-layer sunshield that blocks sunlight and radiates heat away, helping to maintain temperatures below -233°C (-388°F). Additionally, its Mid-Infrared Instrument (MIRI) requires even colder conditions, around -266°C (-447°F), achieved through an electrically powered cryocooler. This cooling allows JWST to detect faint heat signatures from distant galaxies and exoplanets that would otherwise be invisible. The James Webb Space Telescope (JWST) features several key instruments designed for infrared observations. **NIRCam (Near Infrared Camera)** captures images in the near-infrared spectrum (0.6 to 5 microns), playing a vital role in studying distant galaxies and star formation. **NIRSpec (Near Infrared Spectrograph)** conducts spectroscopy in the near-infrared, enabling scientists to analyse the composition and properties of celestial objects. **NIRISS (Near Infrared Imager and Slit-less Spectrograph)** offers wide-field imaging and slit-less spectroscopy (0.8 to 5 microns), focusing on exoplanets and their atmospheres. Finally, **MIRI (Mid-Infrared Instrument)** operates in the mid-infrared range (5 to 28 microns), crucial for observing cooler objects and studying star formation and planetary systems. Together, these instruments enhance our understanding of the universe.

II. HUBBLE

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The Hubble Space Telescope, or HST, is a classic observatory that was designed to acquire images and spectra at relatively high resolution over a very wide wavelength range-from about 100 nm in the ultraviolet down to 1,700 nm in the near-infrared. Its mission is to explore the fundamental questions about the universe, such as the nature of dark matter and dark energy, the formation and evolution of galaxies, stars and planetary systems, and the dynamics of celestial phenomena over long periods of time. Hubble orbits the Earth at an altitude of around 547 kilometers or 340 miles, above atmospheric distortion and light pollution, allowing for clearer, observation. The HST is an instrument with a 2.4-meter (7.9-foot) aperture based on the classic reflecting telescope design. Light from objects of interest is collected in the case of a primary mirror, and corrective optics then focus the light into sharp, high-quality images. Its telescope is equipped with a range of scientific instruments on board, ranging from which to observe different wavelength regimes, including, for instance, Wide Field Camera 3 (WFC3), COS, and STIS. Such information is then fed back to Earth via high-bandwidth communication systems for detailed analysis and long-duration observations of selected targets, sometimes for days or even weeks. The Hubble spacecraft itself consists of a 2.4-meter optical telescope assembly, or OTA, and two larger cylindrical sections. The equipment section contains the main housing of the spacecraft with its subsystems of power management, logic, and reaction control; the scientific instruments are housed in the aft shroud section along with the RSUs and attitude control systems. Attitude control is provided by a combination of reaction wheels, along with a combination of RSUs, FGSs, and FHSTs to accurately point the telescope. It has two enormous rotatable solar arrays that also power six onboard batteries to provide electricity during orbital nights. The spacecraft's thermal environment was both controlled with passive as well as active systems such that the stability of its optics and instruments was ensured. The capability of the telescope to achieve high-resolution, long-term observations for many years made the telescope one of the most influential in history with considerable amounts of our understanding of the universe.

III. CHANDRA X-RAY

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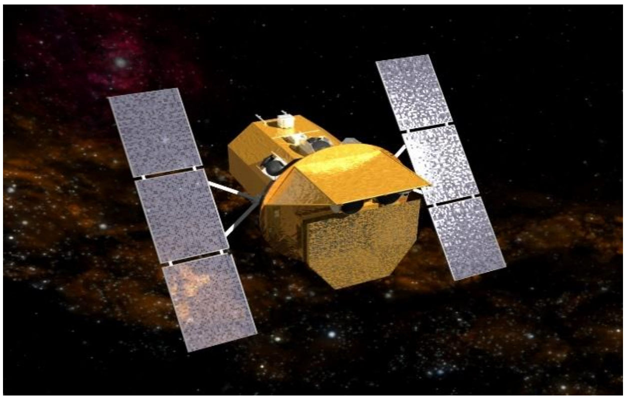
The Chandra X-ray Observatory covers high-energy astrophysics, sensitive to X-rays in the range of about 0.1 to 10 keV. Its main mission is to observe X-ray emissions from astronomical sources, furthering our knowledge about how galaxies, black holes, neutron stars, leftovers from supernovae, and the nature of dark matter and dark energy create and evolve. Chandra operates in an orbit that is highly elliptical, providing a low background of X-rays from Earth and allowing for long observing times; it spends much time outside the Earth's shadow. It has a large aperture of 1.2 meters and, with an optical design featuring nested, curved mirrors, achieves high angular resolution on detailed imaging. Equipped with advanced instruments such as the Advanced CCD Imaging Spectrometer and the High Energy Transmission Grating, Chandra is designed to provide unprecedented detail in the study of X-ray sources. Data from the spacecraft are telemetered back to Earth on a high-bandwidth communication system. This allows for lengthy observations prolonged views of the sky essential to the investigation of transient events and other comprehensive astrophysical studies. The Chandra was taken along with and deployed by the Space Shuttle Columbia into a low Earth orbit as NASA's Space Transportation System mission STS-93. About 8 hours after launch, Chandra was deployed at an altitude of about 240 km (130 nautical miles). A two-stage solid-fuel rocket booster, developed by Boeing Company Defence and Space Group of Seattle, Washington, for the US Air Force, called the Inertial Upper Stage (IUS), launched the Chandra flight system into a highly elliptical transfer orbit at this time. Following launch, over the course of several days, Chandra's TRW-built Internal Propulsion System (IPS) placed the observatory into its initial operation orbit with a 140-Mm (87,000-nautical-mile) apogee and a 10-Mm (6,200-nautical-mile) perigee and with a 28.5° initial inclination. The highly elliptical orbit of Chandra, with a period of 63.5 hours, yields a high observing efficiency. The fraction of the sky occulted by the Earth is small over most of the orbital period, as is the fraction of the time when the detector backgrounds are high as the Observatory dips into Earth's radiation belts. Observations can be useful for up to more than 70% of the time and may be uninterrupted for periods in excess of 2 days. The specified design lifetime of the mission is 5 years, but the only consumable (fuel for manoeuvres) is sized to permit operation for in excess of 10 years. The orbit will be stable for decades.

IV. SWIFT X-RAY



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The Swift X-ray telescope is placed in the orbit and is meant for observing cosmic events, including supernova remnants, neutron stars, and black holes, by detecting X-rays emitted in the range of 0.1 to 100 keV. The main objective of the Swift telescope is to explore the high-energy universe, studying cosmic structures, dark matter, and transient events like GRBs. To avoid interference from Earth's atmosphere, Swift is placed in a low Earth orbit or higher. The telescope relies on modern optical designs, such as the Wolter telescopes, to focus X-rays efficiently and has instruments, such as CCDs and spectrometers, with excellent accuracy in measurement and data detail. The high-bandwidth communication systems transmit the data back to Earth, enabling long-term monitoring as well as focused studies of transient events. It carries three of the key instruments: a Burst Alert Telescope (BAT) to sense GRBs and to position them within a few arcminutes, an Ultraviolet/Optical Telescope with a sensitivity of up to 24th magnitude and 0.3 arcsecond positional accuracy, and the X-ray Telescope for high-resolution X-ray imaging. These instruments operate together as a multiwavelength observatory able to rapidly determine the position of GRBs to a precision of better than 1-2 minutes and measure their light curves and redshifts. The XRT is mounted on an Optical Bench Interface Flange that forms the foundation for the bulk of the telescope structural support. The supporting structure accommodates the mirror module, camera, electron deflector and other important components of the telescope. The body of the telescope itself forms a carbon fiber and cyanate ester composite, lightweight tube with a diameter of 508 mm. All the components were carefully designed to minimize thermal expansion so that the alignment of the telescope remains stable in space. An aluminium-foil vapor barrier inside lines the tube against contamination by outgassing. The rear end carries the Focal Plane Camera Assembly, while the forward section carries the mirrors, the door assembly, and the star trackers. The internal volume of the tube is vented to space through a baffled vent. A single-shot door assembly covers the X-ray mirrors at the telescope's front end to protect them during launch and ground operations. Manufactured by Strays, the door was opened some two weeks after launch so that the spacecraft could outgas before exposing the sensitive mirrors to space. Combining advanced instruments with precise engineering, Swift makes it possible to do cutting-edge studies of transient high-energy events in a way to help scientists explore the most extreme and energetic processes in the universe.

V. FERMI GAMMA-RAY

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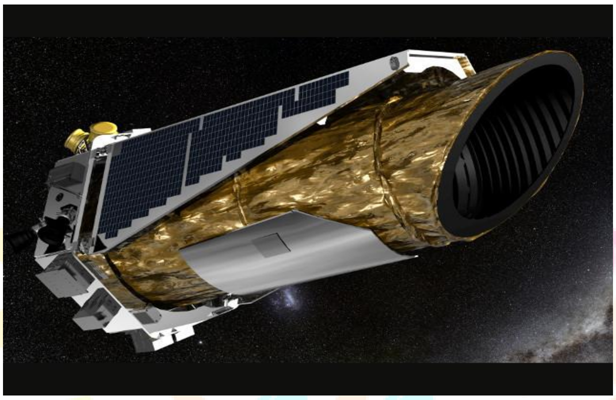
The Fermi Gamma-ray Space Telescope detects gamma rays in the range of 8 keV to 300 GeV; it studies high-energy cosmic events produced by black holes, neutron stars, and gamma-ray bursts. In a low Earth orbit of ~550 km, this facility will scan the entire sky every 3 hours. The major instruments on Fermi include the Large Area Telescope for broad gamma-ray coverage and the Gamma-ray Burst Monitor. TDRSS transmits data back, and, while the design was for a 5-year mission, Fermi has been on for over a decade now, sending back steady views of the high-energy universe. TDRSS comprises a network of communications satellites operated by NASA, which provides nearly continuous communication between low Earth orbit space stations, such as the Fermi Gamma-ray Space Telescope, and ground stations on the ground. The employment of TDRSS allows satellites to relay data and receive commands from ground control almost without break; this becomes rather critical in scientific applications related to real-time monitoring and data relay. Missions supported by the TDRSS include scientific observation, human spaceflight, and Earth imaging. The LAT, aboard the Fermi Gamma-ray Space Telescope, recently made its most unprecedented detail of the gamma-ray sky cataloguing thousands of sources that include active galactic nuclei, pulsars, and supernova remnants. It discovered new populations of gamma-ray pulsars and captured gamma-ray bursts that allow more insight into these powerful cosmic explosions. LAT observations have also set stringent limits on dark sector interactions, studied cosmic rays, and illuminated for the first time one of the most poorly understood components of the universe the extragalactic background light, probing the history of star formation. Observing AGN variability with the LAT has furthered our understanding of supermassive black holes, as an essential tool in high-energy astrophysics.

VI. KEPLER



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The Kepler Space Telescope was designed to detect Earth-sized exoplanets. It observed visible light (430-890 nm) to monitor over 150,000 stars for periodic dips in brightness caused by transiting planets. Kepler orbited the Sun in an Earth-trailing orbit, providing a continuous view without Earth’s interference. Its 0.95-meter aperture and wide field of view allowed it to capture light with a specialized photometer containing 42 CCDs. Data was sent monthly to Earth, with Kepler operating for nearly 9 years (2009-2018), vastly exceeding its planned 3.5-year mission and discovering thousands of planets. The design and scientific aims of the Kepler mission are highlighting its ambitious goal to find Earth-sized exoplanets within habitable zones of distant stars. The paper discusses Kepler's technical approach, such as its photometer and wide field of view, which allow for continuous observation of thousands of stars to detect the slight dimming caused by transiting planets. It predicts Kepler's potential to reveal hundreds of Earth-like planets if they are common, providing a statistical foundation for estimating how many stars host planets with life-supporting conditions. Additionally, it invites the scientific community to participate in data analysis, emphasizing the mission’s collaborative approach.

VII. XMM-Newton

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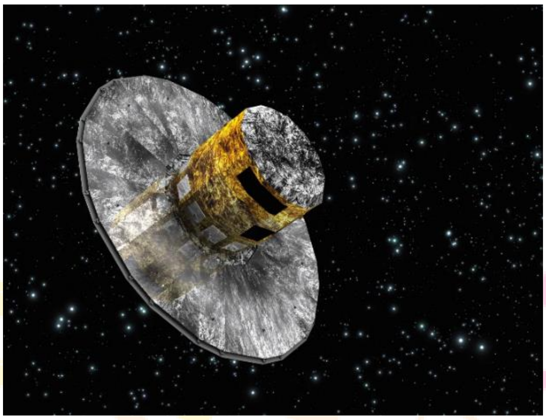
XMM-Newton is an ESA space-based observatory that was launched on December 10, 1999. It covers the X-rays in a range of 0.1 up to 12 keV. Its aims are to study the formation and evolution of galaxies, stars, black holes, and neutron stars, together with the investigation of high-energy phenomena such as supernovae remains and active nuclei of galaxies. Located in a highly elliptical orbit around Earth with an altitude ranging from 7,000 to 114,000 kilometres, XMM-Newton is designed with three telescopes in tandem that boast a total collecting area of 13,500 cm². Its Wolter type I optical design focuses X-rays onto advanced detectors using nested mirrors. Its advanced detectors include the European Photon Imaging Camera, better known as EPIC, and the Reflective Grating Spectrometer known as RGS. The data are transmitted back to Earth by a high-frequency radio link; observation times range from several hours to several days, depending on the required detail for a given astronomical source. The research paper "XMM-Newton Observatory: The Spacecraft and Operations & Astrophysics" by Jansen et al. outlines the significance of the XMM-Newton observatory when mentioning its contribution in terms of astrophysics. In designing the spacecraft used, advanced features of the European Photon Imaging Camera EPIC and Reflective Grating Spectrometer RGS resulted in high-resolution X-ray imagery and spectroscopy. Key findings that have been learned through the XMM-Newton mission include insights into the nature of black holes, the dynamics of galaxy clusters, and the processes driving cosmic X-ray sources. The observatory provided critical data regarding supernova remnants and active galactic nuclei, enhancing our knowledge about high-energy phenomena within the universe. The paper also covers operational aspects, such as the successful management of data acquisition and processing that has enabled extensive collaborative scientific research. In general, emphasis is given to how XMM-Newton has played a leading role so far in the improvement of our knowledge regarding the X-ray universe and has influenced various theories of astrophysics.

VIII. Gaia



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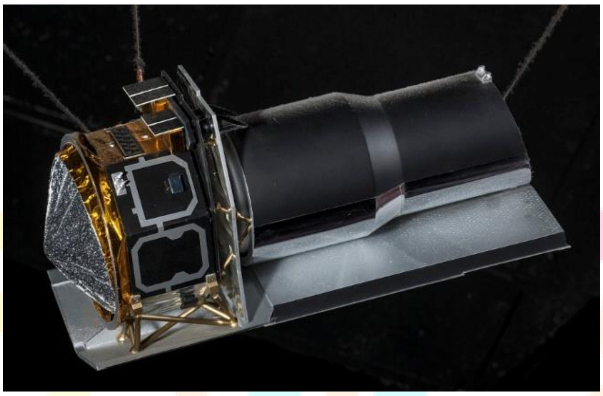
Gia is a Cornerstone Mission in ESA's Science Program the ESA science program developed the Gaia optical space telescope as a cornerstone mission. Conceived in 2006, this spacecraft design evolved from an interferometric principle to direct imaging. Both were built by European industry, while the contributions of the scientific community were brought to data processing through the international DPAC organization, founded in 2007, responsible for the overall data processing and scientific exploitation of the mission. Gaia was launched on 19 December 2013 and reached its operational position near the second Lagrange point of the Sun-Earth-Moon system only a few weeks later. The commissioning phase of the spacecraft and payload ended on 19 July 2014, officially beginning its five-year primary mission. It had spent four weeks scanning ecliptic poles before entering its full-sky scanning mode. The paper revisits the scientific objectives of the mission and provides a general overview of the spacecraft design, focusing its attention on the payload module performance crucial for the success of this mission. Gaia is carrying two identical three-mirror anastigmatic telescopes with apertures of 1.45 m and 0.50 m aligned at a basic angle of 106.5° and mounted on a quasi-octagonal optical bench with a diameter of 3 meters. The optical bench, made up of 17 brazed segments, all of the telescope mirrors, of sintered silicon carbide provides, for its high specific strength and thermal conductivity, excellent passive thermoelastic stability-major contributor to meet the scientific objectives set for this mission.

IX. Spektr-R

IMG: 09

The report presents a review of the Spektr-R onboard control system design (Radio Astron) and outlines a method for attitude determination and achieving the pointing precision of the radio telescope during observing sessions. The needed orientation accuracy has been provided by the complex of information from an otoscopic instrument and the Astro sensors with filtering measurement noise. Stabilization precision achieved during the operation of the spacecraft is presented. Launching the Spektr-R spacecraft into a highly elliptical orbit on 18 July 2011 marked the beginning of a new era in performing astrophysical research from Russia and international cooperation. Spektr-R carried a radio telescope with a 10-meter-diameter antenna. This radio telescope formed a radio interferometer with several ground-based telescopes, having a very long baseline of more than 300000 km. Therefore, the angular resolution of the Spektr-R telescope was 30 times better than that of its predecessors.

X. Spitzer



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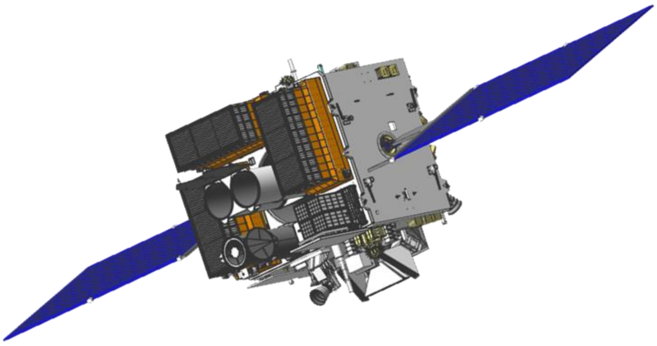
The National Aeronautics and Space Administration's (NASA) Spitzer Space Telescope, launched on August 25, 2003, is a groundbreaking infrared observatory designed to address some of the most fundamental questions about the cosmos. Spitzer orbits the Sun in an Earth-trailing orbit, which minimizes the thermal interference from Earth, allowing for highly sensitive measurements. Its primary scientific objectives include studying the origins of the universe, investigating the formation and evolution of galaxies, examining the birth and development of stars and planetary systems, and understanding the chemical processes that drive cosmic evolution. At the heart of Spitzer is its Cryogenic Telescope Assembly, which includes an 85-centimeter Ritchey-Chrétien telescope made from beryllium, a material chosen for its exceptional thermal stability. To achieve its extraordinary sensitivity, the telescope operates at extremely low temperatures, cooled cryogenically to as low as 5.5 Kelvin (-267.65°C). This cooling is essential to prevent the telescope's own heat from interfering with its infrared observations. Spitzer's scientific payload consists of three cryogenically cooled instruments that cover a broad wavelength range from 3 to 180 microns. These instruments are equipped with advanced large-format detector arrays, enabling the telescope to perform high-resolution imaging and spectroscopy. This capability allows Spitzer to observe phenomena that are invisible to optical telescopes, such as the heat radiated by distant exoplanets, the dust-enshrouded regions of star formation, and the faint glow from galaxies in the early universe. Spitzer's sensitivity represents a significant leap over previous infrared missions, enabling it to detect and study celestial objects with unparalleled detail. Its contributions have included the discovery of exoplanets and their atmospheric compositions, the mapping of star-forming regions in the Milky Way, and the observation of distant galaxies that offer glimpses into the universe's infancy. As one of NASA's Great Observatories, Spitzer has fundamentally advanced our understanding of the infrared universe, providing a crucial bridge to future missions like the James Webb Space Telescope.

XI. AstroSat



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AstroSat is India's first space-based Ultraviolet (UV) and X-ray astronomy observatory. The satellite was launched on a Polar Satellite Launch Vehicle by the Indian Space Research Organisation on 28 September 2015 from Sriharikota Range, north of Chennai, on the eastern coast of India. AstroSat carries five scientific instruments and one auxiliary instrument. Four of these instruments are co-aligned telescopes and detectors fixed on the satellite's common deck to observe stars and galaxies in near- and far-UV wavelengths and a broad range of X-ray energies (0.3–80 keV) simultaneously. The fifth instrument comprises three X-ray detectors mounted on a rotating platform on a side oriented 90 degrees from the others to scan the sky for X-ray transients. The auxiliary instrument monitors the charged particle environment in the satellite's path.The Polar Satellite Launch Vehicle placed AstroSat into an orbit with a 6-degree inclination and an altitude of 650 km on 28 September 2015. The scientific payloads weigh 855 kg, while the satellite's total launch weight was 1513 kg. The twin solar panels, made of triple junction solar cells, are oriented toward the Sun to generate a maximum power of 2.2 kW. Each panel measures 1.4 m x 1.8 m, is 20 mm thick, and can rotate independently of the satellite around its pitch axis. After injection into orbit, the panels were deployed, and two backup Li-ion batteries with a 36 Ah capacity provide power when the solar panels operate below full efficiency. A power management system ensures power distribution to the payload..

XII. HALCA

IMG: 12

In February 1997, the Institute of Space and Astronautical Science of Japan launched a satellite named HALCA using its new M-V rocket. HALCA became the world’s first space-based Very Long Baseline Interferometry (VLBI) satellite by successfully performing a series of engineering experiments, including deploying an 8-meter diameter parabolic antenna, achieving precise attitude control of the spacecraft, transferring phase reference signals, enabling high data-rate telemetry, operating as a single-dish telescope, and performing interferometry with ground-based radio telescopes. Following the engineering experiments, HALCA began scientific operations under the VLBI Space Observatory Program (VSOP), a collaborative effort involving multiple organizations and radio telescopes worldwide. Space VLBI, the concept of extending Earth-based VLBI into space by placing a radio telescope in orbit, aims to produce high-resolution images of celestial radio sources by forming extremely long baselines, unconstrained by Earth's size. Key observation targets include active galactic nuclei, quasars, and maser sources.HALCA orbits in an elliptical path with an apogee of 21,400 km, a perigee of 560 km, and an inclination angle of 31 degrees. A critical technical achievement for space VLBI was establishing the reference signal transfer to the orbiting spacecraft. HALCA uses a frequency of 15.3 GHz for phase transfer, as the Ku-band is less affected by ionospheric scintillation, ensuring coherence.

XIII. INTEGRAL

IMG: 13

The International Gamma-Ray Astrophysics Laboratory (INTEGRAL), a space telescope launched by the European Space Agency (ESA) in 2002, is dedicated to observing gamma rays with energies up to 8 MeV. Its mission focuses on imaging and spectroscopy of cosmic sources, enabling the study of some of the universe's most extreme phenomena, including black holes, neutron stars, and gamma-ray bursts the most energetic explosions ever observed. INTEGRAL's scientific payload consists of two main gamma-ray telescopes, SPI (Spectrometer on INTEGRAL) it Delivers precise measurements of gamma-ray energies, and BIS (Imager on Board the INTEGRAL Satellite) Provides detailed imaging of gamma-ray sources. IBIS offers superior spatial resolution compared to earlier gamma-ray instruments, with an angular resolution of 12 arcminutes and an energy resolution of 8–9% within the 0.1–1 MeV range. The telescope operates in a highly elliptical orbit, varying from approximately 9,000 km to 153,000 km above Earth. This trajectory allows it to cover a significant portion of the sky, making it ideal for investigating high-energy phenomena such as gamma-ray bursts, supernovae, and black holes. With an orbital inclination of about 51.5 degrees, INTEGRAL completes one orbit around Earth every three days, optimizing its observation of the gamma-ray universe.

XIV. WISE

IMG: 14

The Wide-field Infrared Survey Explorer (WISE) is a NASA mission that will map the whole sky in infrared light with far greater sensitivity than any previous survey. This new mission will be about 1,000 times more sensitive than its forerunner, the Infrared Astronomical Satellite (IRAS), using four infrared bands between 3.4 and 22 microns. The main objectives of this mission are as follows: Detecting the most luminous galaxies in the universe. Identifying the nearest stars to the Sun. Mapping the majority of the main belt asteroids larger than 3 km in diameter. The spacecraft carries a 40-cm telescope featuring detectors made from HgCdTe and Si to image the celestial objects in four infrared wavelengths at 3.4, 4.6, 12, and 22 microns with highly detailed observations at 5 arcseconds of angular resolution. The FOV of the camera is 47 arcminutes by 47 arcminutes. Because the camera orbits Earth, it captures new snapshots every 8.8 seconds. WISE does follow a Sun-synchronous orbit in a manner that ensures it maps the sky completely; its effective scanning strategy makes it quite capable of accomplishing a full-sky survey. Scheduled to launch in mid-2008, WISE will take infrared astronomy to the next level in adding crucial information for the follow-up missions like James Webb Space Telescope and will complement the investigation into the universe at thermal infrared spectrum. The mission takes advantage of the very low infrared background of space and the new and advanced large-format infrared detector arrays to achieve unprecedented sensitivity and angular resolution. The altitude of the WISE spacecraft is 285 cm, the width is 200 cm, and its depth is 173 cm. The total mass of the spacecraft is 661 kg. It operates at a power consumption of 301 watts, supported by solar panels capable of generating over 500 watts. The 40 cm telescope is housed within a solid-hydrogen-cooled cryostat. The total mass of the cryostat, telescope, and camera combined is 347 kg; 15.7 kg of solid hydrogen is taken on board at launch to cool the mission instruments.

XV. CGRO

IMG: 15

The Compton Gamma Ray Observatory (CGRO) was a space-based observatory that observed high-energy cosmic sources from April 5, 1991, to June 4, 2000. In operation over eight years, the observatory was set in low Earth orbit at an altitude of 450 km to avoid the problems of the Van Allen radiation belt. It was deorbited on June 4, 2000. At 16,300 kilograms, it was the heaviest astrophysical payload launched at the time. The CGRO carried a payload of four major instruments: OSSE, COMPTEL, EGRET, and BATSE, capable of detecting gamma rays in an unprecedentedly wide range of energies from 20 keV to 30 GeV. Its interests included the study of gamma-ray bursts; pulsars; black holes; and active galaxies, all representatives of an array of high-energy processes around the universe. The discoveries involved new kinds of gamma-ray sources and brought far-reaching insights into the behaviour of highly energetic particles in space. The contributions this observatory made helped show the way for further gamma-ray research and continue to provide an influence on missions such as the Fermi Gamma-ray Space Telescope mission, expanding our knowledge of the high-energy universe.

CONCLUSION & FUTURE SCOPE

In general, major design and operational decisions such as decisions about mirror assemblies, aperture size, and orbit are driven by the observational goals. Thus, for high-resolution observation, optical and infrared space telescopes such as Hubble and JWST use optimal designs for the mirrors, whereas X-ray and gamma-ray space telescopes rely on quite a number of techniques, each involving grazing-incidence mirrors or state of the art detectors. Larger apertures, such as the 6.5-meter mirror of JWST, increase light-gathering power and thereby improve the detection of faint objects. Choice of orbit (in particular, lower Earth orbit, L2, heliocentric orbit) ensures long-term operational stability. Long observation times together with high-bandwidth data transmission both achieved with JWST and even Hubble have massively improved our knowledge of the universe. In contrast, earlier missions, such as Kepler, had much-reduced data capability. Overall, the specific design of each one of these telescopes will have a maximum scientific return. Space telescopes such as JWST, Hubble, and X-ray Chandra make use of advanced instruments that include detectors in the infrared region, spectrometers, and high-resolution cameras. Other telescopes are CGRO and Gaia among others that are equipped with photometers and optical monitors. These tools, put together, allow for various detailed observations of astronomy.

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