# अन्तरिक्ष भारत

# SPACE INDIA

भारतीय अन्तरिक्ष अनुसंधान संगठन

Indian Space Research Organisation

जनवरी-जून **2009** January–June

# The Indian Space Programme

The space activities in the country were initiated with the setting up of Indian National Committee for Space Research (INCOSPAR) in 1962. In the same year, the work on Thumba Equatorial Rocket Launching Station (TERLS), near Thiruvananthapuram, was also started. The Indian space programme was institutionalised in November 1969 with the formation of Indian Space Research Organisation (ISRO). The Government of India constituted the Space Commission and established the Department of Space (DOS) in June 1972 and brought ISRO under DOS in September 1972.

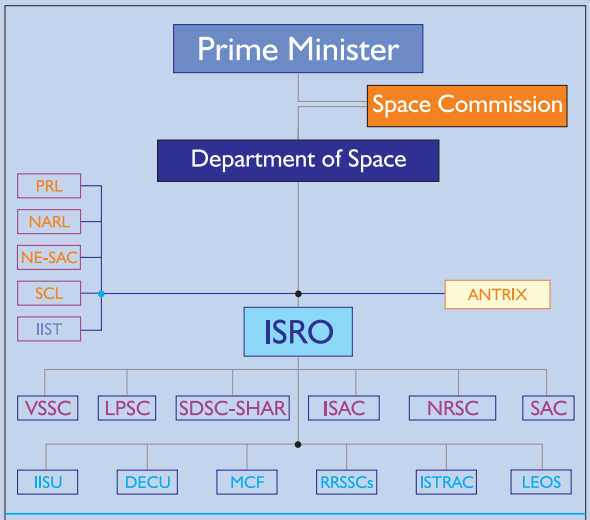
Department of Space (DOS) has the primary responsibility of promoting development of space science, technology and applications towards achieving self reliance and assisting in all round development of the nation. Towards this, DOS has evolved the following programmes:

- Indian National Satellite (INSAT) programme for telecommunications, TV broadcasting, meteorology, developmental education, etc.
- Remote Sensing programme for the application of satellite imagery for various developmental purposes.
- Indigenous capability for design and development of spacecraft and associated technologies for communications, resources survey and space sciences.
- Design and development of launch vehicles with indigenous technology for access to space and orbiting INSAT, IRS spacecraft and space science missions.
- Research and development in space sciences and technologies as well as application programme for national development.

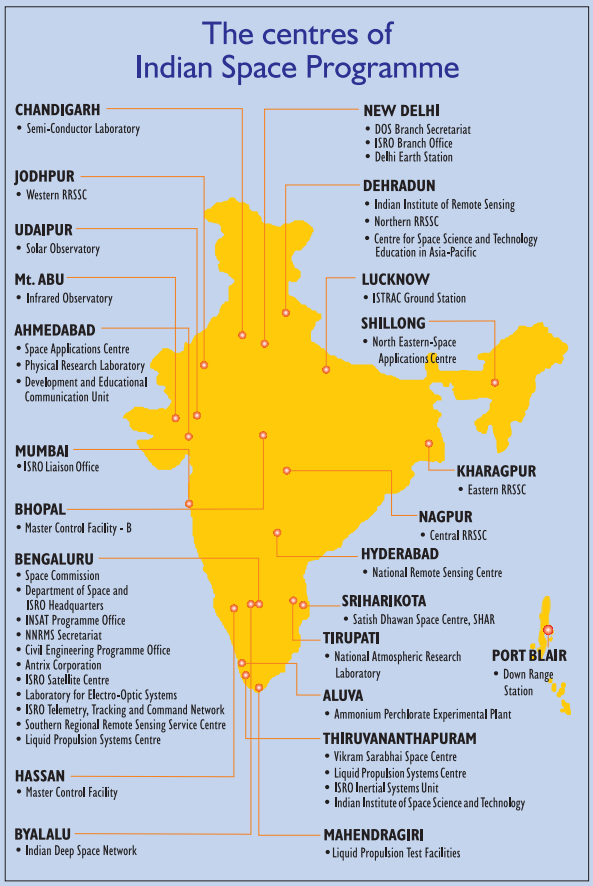
The Space Commission formulates the policies and oversees the implementation of the Indian space programme to promote the development and application of space science and technology for the socio-economic benefit of the country. DOS implements these programmes through, mainly, Indian Space Research Organisation (ISRO), Physical Research Laboratory (PRL), National Atmospheric Research Laboratory (NARL), North Eastern-Space Applications Centre (NE-SAC) and Semi-Conductor Laboratory (SCL). The Antrix Corporation, established in 1992 as a government owned company, markets the space products and services.

Both the DOS and ISRO Headquarters are located at Bengaluru. The development activities are carried out at the Centres and Units spread over the country.

So far, 53 Indian Satellite Missions, and 28 Launches from Sriharikota have been conducted.




**NRSC:** National Remote Sensing Centre, **PRL:** Physical Research Laboratory, **NARL:** National Atmospheric Research Laboratory, **NE-SAC:** North Eastern Space Applications Centre, **SCL:** Semi-Conductor Laboratory, **ISRO:** Indian Space Research Organisation, **Antrix:** Antrix Corporation Limited, **VSSC:** Vikram Sarabhai Space Centre, **LPSC:** Liquid Propulsion Systems Centre, **SDSC:** Satish Dhawan Space Centre, **ISAC:** ISRO Satellite Centre, **SAC:** Space Applications Centre, **IISU:** ISRO Inertial Systems Unit, **DECU:** Development and Educational Communication Unit, **MCF:** Master Control Facility, **RRSSCs:** Regional Remote Sensing Service Centres, **ISTRAC:** ISRO Telemetry, Tracking and Command Network, **LEOS:** Laboratory for Electro-optic Systems, **IIST:** Indian Institute of Space Science and Technology



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**Cover Page:** *The Nozzle End Segment of S200 booster being positioned in the vacuum chamber at Solid Propellant Plant*



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# World-Class Solid Propellant Plant Commissioned at Satish Dhawan Space Centre SHAR

The Solid Propellant Plant (SPP) at Satish Dhawan Space Centre (SDSC) SHAR, set up for manufacturing S200 solid boosters of GSLV Mk-III, was commissioned on December 18, 2008 with the successful casting of Head-End Segment (HES). Subsequently, in February 2009, the Nozzle-End-Segment (NES) and in April 2009 the Middle Segment (MS) were also processed. Thus, processing of all the three segments for the first static test of S200 booster has been completed. The S200 booster segments with 3.2 m dia. stand as the second largest of their kind in the world.

Some of the solid propellant plants in the world had faced teething problems and some of the large size segments were rejected due to processing glitches.

*Propellant Slurry being transferred to master hopper*

Thus, processing of such large solid propellant booster segments without any hitch in the maiden attempt itself is a commendable achievement by the SPP team. This testifies to the professional maturity of the team in planning, establishing and operationalising the plant.

All the three segments are now undergoing various post-cure operations like propellant trimming, inhibition and non-destructive testing (NDT). Preliminary NDT of HES and NES shows that the segments are in good condition. Evaluation of mechanical, interface and ballistic properties of HES and NES has been completed and results are well within the specifications. Viscosity values of final mix slurry were made available on-line throughout the programme. Information pertaining to the overall programme, including the total number of final mix batches processed, total number of batches made at each station, unloading time of each batch at respective stations, etc., was also displayed *in-situ* in the mixing control room.

**SPP and its constituent facilities**

SPP has 53 buildings spread over 6 Sq Km area, interconnected with roads of 18 Km length. All the non-scritical operations and plant maintenance are taken care by operation and maintenance contractor, M/s Premier Explosives Limited. Automation and remote operation with built-in safety features in most of the facilities enable processing of large quantity of propellant (around 100 tons) within 24 Hrs. The annual capacity of the plant is to produce 900 ton of solid

propellant required for 12 segments (delivery of four S200 boosters). Of the three segments of S200, the middle segment carries maximum propellant (about 98 tons).

The major constituent facilities of SPP are:

- Hardware Insulation and Lining
- Raw Materials Storage and Preparation
- Propellant Mixing Stations and Pre-mix storage
- Casting and Curing.
- Bowl Cleaning and Bowl Preparation
- Propellant Machining
- Segment Inhibition and Tilting
- Non-destructive Testing
- Integrated Sample Processing
- Analytical and Physical Testing Lab
- Segment Storage Magazine
- Material Handling and Maintenance
- Electrical Sub-stations and Standby DG Stations
- Fire Fighting and Protection System

*Middle segment being loaded on to the transporter*

**State-of-the-art facilities**

Though the propellant processing technology adapted at SPROB (which produces S139 boosters for PSLV and GSLV) and SPP is more or less same, the quantity of propellant produced and the size of segments handled in SPP are three times more than that processed by SPROB. As large quantities of raw materials are to be handled for processing propellant for S200 segments, a need was felt to adopt bulk packing for storage and handling of major raw materials. Ammonium Perchlorate constituting 68% of solid propellant is being received from APEP, Aluva (VSSC) in flexible intermediate bulk containers (FIBC) of 1000 kg capacity as against the old practice of 40 kg drums to minimise the number of containers handled during storage and processing. Liquid ingredients, namely, HTPB resin and plasticizer DOA, are received and stored in large sized tankers of 12 ton/8 ton capacity. Required quantity of these ingredients are transferred and weighed into bins using pneumatically operated double diaphragm pumps in closed loop batch weighing system.

SPP has five mixing stations. Of them, four will be in operation during final mixing. The fifth station will be contingent hot standby to meet the requirement of uninterrupted casting 100 tons of propellant within 24 hours. The casting facility is designed for continuous casting with two transfer cars to receive the bowls, tilt and transfer the propellant slurry into the master hopper which feeds the slurry to segment hardware. All operations in mixing and casting facilities are fully automated using the state-of-the-art PLC systems to avoid manual errors in operation. Integrated Sample Processing Facility (ISPF) carries out propellant mixing, casting, decoring, end trimming and inhibition

*Middle segment being tranported to Curing Facility*

of Agni motors for ballistic evaluation and cartons for the evaluation of mechanical/physical/interface properties. Radiographic inspection of segments takes place in horizontal attitude along the segment length using PLC programmable floor based LINAC handling system and film positioning system, without any manual intervention.

SPP has set-up a centralised data acquisition and control system in major operational areas, namely, raw material preparation, propellant mixing and propellant casting. Import systems like AP grinder, vertical mixer, Vertical Turning Mill (VTM) and linear accelerator are indigenised.

**Built-in Safety**

This plant is equipped with a modern fire fighting system comprising of four pumps of 410 cubic metres per hour capacity each, 2460 cubic meters of water storage, 17 km length of outdoor piping (80 NB to 600 NB) spread over the entire plant and fitted with 154 hydrant points. Eleven deluge systems and four sprinkler systems are provided in areas where propellant is processed.

With the twin objective of meeting the stringent safety requirements and reducing the manpower, the following 'process automations' are introduced in the plant:

- Blasting, degreasing and resin lining of S200 hardware
- Raw material feeding, bowl lid lifting and slurry spill collection in propellant mixing
- Slurry feeding, continuous casting, segment handling with (grab) tackle, bowl cleaning
- Agni motor decoring and Agni/carton trimming

All the facilities of SPP have undergone rigorous test and evaluation (T&E) process by expert committees proving their intended performance. These facilities were evaluated by three levels of safety committees.

*SPP Casting Building*

Successful commissioning of this world-class solid propellant plant and successful realisation of all the three segments for S200 booster are the significant milestones in the progress of 'SHAR Facilities for GSLV Mk-III' (SFG) project.

# New Microorganisms Discovered in the Stratosphere

Three new species of bacteria, which are not found on Earth and which are highly resistant to ultra-violet (UV) radiation, have been discovered in the upper stratosphere by Indian scientists. One of the new species has been named as *Janibacter hoylei*, after the Distinguished Astrophysicist Fred Hoyle, the second as *Bacillus isronensis* recognising the contribution of ISRO in the balloon experiments which led to its discovery and the third as *Bacillus aryabhata* after India's celebrated ancient astronomer Aryabhata and also the first satellite of ISRO.

The experiment was conducted using a 26.7 million cubic feet balloon carrying a 459 kg scientific payload soaked in 38 kg of liquid Neon, which was flown from the National Balloon Facility in Hyderabad, operated by the Tata Institute of Fundamental Research (TIFR). The payload consisted of a cryosampler containing sixteen evacuated and sterilised stainless steel probes. Throughout the flight, the probes remained immersed in liquid Neon to create a cryopump effect. These cylinders, after collecting air samples from different heights ranging from 20km to 410km, were

*Balloon experiment being readied for launch*

*Gondola carrying the payload*

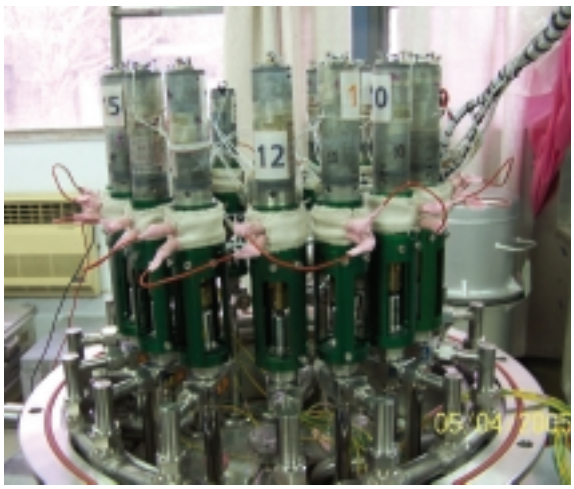
parachuted down and safely retrieved. These samples were analysed by scientists at the Centre for Cellular and Molecular Biology, Hyderabad as well as the National Centre for Cell Science (NCCS), Pune for independent examination, ensuring that both laboratories followed similar protocols to achieve homogeneity of procedure and interpretation.

## *The Analytical Findings are Summarised as Follows:*

In all, 12 bacterial and six fungal colonies were detected, nine of which, based on 16S RNA gene sequence, showed greater than 98% similarity with reported known species on earth. Three bacterial colonies, namely, PVAS-1, B3 W22 and B8 W22 were, however, totally new species. All the three newly identified species had significantly higher UV resistance compared to their nearest phylogenetic neighbours. Of the above, PVAS-1, identified as a member of the genus Janibacter, has been named *Janibacter hoylei. sp. nov.* The second new species B3 W22 was named as *Bacillus isronensis sp.nov.* and the third new species *B8 W22 as Bacillus aryabhata*.

Precautionary measures and controls operating in this experiment inspire confidence that these species were picked up in the stratosphere. *While the present study does not conclusively establish the extra-terrestrial origin of microorganisms, it does provide positive encouragement to continue the work in our quest to explore the origin of life.*

This multi-institutional effort had Jayant Narlikar from the Inter-University Centre for Astronomy and Astrophysics, Pune as Principal Investigator and veteran Scientists U R Rao from ISRO and P M Bhargava from Anveshna supported as mentors of the experiment. S Shivaji from CCMB and Yogesh Shouche from NCCS were the biology experts and Ravi Manchanda from TIFR was in charge of the balloon facility. C B S Dutt was the Project Director from ISRO who was in charge of preparing and operating the complex payload.



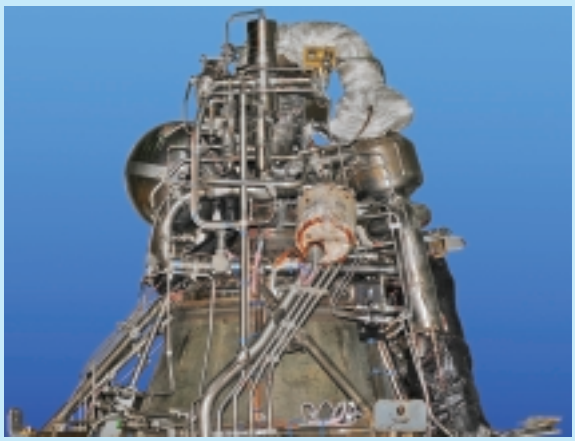
*The Cryosampler Payload*

This was the second such experiment conducted by ISRO, the first one being in 2001. Even though the first experiment had yielded positive results, it was decided to repeat the experiment by exercising extra care to ensure that it was totally free from any terrestrial contamination.

# Flight Acceptance Hot Test of Indigenous Cryogenic Engine Successful

ISRO has crossed yet another major milestone by successfully conducting the Flight Acceptance Hot Test of the Indigenous Cryogenic Engine at Liquid Propulsion Systems Centre's (LPSC) Mahendragiri facilities on December 18, 2008. This Cryogenic Engine is identified for the first indigenously developed Cryogenic Stage to be used in the next Geosynchronous Satellite Launch Vehicle mission (GSLV -D3).

The indigenous cryogenic engine develops a thrust of 73 kilo Newtons (kN) in vacuum with a specific impulse of 454 seconds and provides a payload capability of 2200 Kg to Geosynchronous Transfer Orbit (GTO) for GSLV. The Engine works on 'Staged Combustion Cycle' with an integrated turbopump running at around 42,000 rotations per minute (rpm). It is also equipped with two steering engines developing a thrust of 2 kN each to enable three-axis control of the launch vehicle during the mission. Another unique feature of this engine is the closed loop control of both thrust and mixture ratio, which ensures optimum propellant utilisation for the mission.



*Indigenous Cryo Engine*

The hot test was carried out for a planned duration of 200 seconds during which the engine was operated in the nominal and 13% uprated thrust regimes. All the propulsion parameters during the test were found satisfactory and closely matched with predictions.

The Cryogenic Engine will be further integrated with propellant tanks, stage structures and associated feed lines to realise the first fully integrated indigenous flight Cryogenic Stage by the middle of 2009.

*Flight Acceptance Hot test in progress*

# BSX 2008:

## Asia's First Focused Exhibition on Space Technologies, Products and Equipments held at Bengaluru

In the backdrop of India's successful Moon mission "Chandrayan-1", the maiden *Bengaluru Space Expo 2008*, a three day mega event organised by Antrix Corporation Limited, Confederation of Indian Industry (CII) and Indian Space Research Organisation (ISRO), was successfully concluded on the December 1, 2008 at Bengaluru, Karnataka state, India.

*BSX'2008* - Asia is first focused exhibition on Space technologies, products and equipments, received encouraging response from the industry with over 100 exhibitors from seven countries. Bengaluru Space Expo (BSX) 2008, spread across three thousand sq mtrs, was the Asia's first focused Space exhibition and attracted participation from countries like Denmark, France, Hong Kong, Italy, Malaysia, Singapore, UK and USA. The exhibition successfully achieved its aim at developing multilateral and bilateral trade relations with the attendance of high-level overseas delegations from over fifteen countries. This


*A view of the ANTRIX/ISRO Pavilion at BSX 2008*

event also became the ideal platform for showcasing the Indian space capabilities to the world.

The inauguration of the maiden show was done by Dr G Madhavan Nair, Chairman, ISRO along with Mr Ashok Soota, Past President, CII and Chairman and Managing Director, Mind Tree Ltd, Mr Vinay Despande, Past Chairman, CII Karnataka and Chairman and CEO, Encore Software Ltd and Mr K R Sridhara Murthi, Managing Director, Antrix Corporation Limited.

Around 2500 visited the exhibition which included over 1850 business visitors and 175 students from the renowned Space Institutes of the country. Overseas delegations from 15 countries – Austria, Brunei, France, Israel, Japan, Kazakhstan, Malaysia, Netherlands, Russia, Peru, Sudan, UK, Ukraine, and USA – attended BSX 2008 and conducted successful business meetings. During the three days, the event generated 352 business enquiries, in addition to a number of instant orders booked by visiting delegations.

A concurrent two-day International Conference "World Space-Biz" was also organised to deliberate on the commercialisation of space. The 'World Space - Biz' provided a platform for international and domestic space industry, space agencies, academia and scientific community, vendors and suppliers to discuss and deliberate upon future commercial prospects for international space industry in general and Asian region in particular, including issues ssuch as access to space, space commercialisation, risk management, space adventure and exploration. *World Space Biz 2008* recorded the attendance some of the eminent Space personalities like Mr Jean-Yves Le Gall, President, Arianespace, Mr Paul Brown Kenyon, MEASAT, Mr Vladimir Gershenzon, Vice-President, Scanex, Russia, Mr Neil Stevens, Vice-sPresident from Marsh Space Projects and many senior scientists of ISRO.

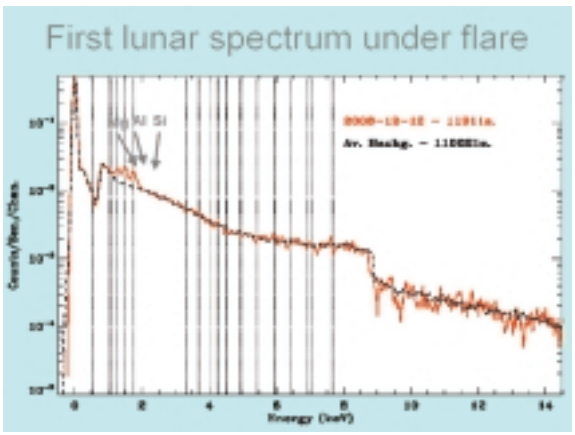
*A Panoramic view of BSX 2008 Exhibition Hall*

# Chandrayaan-1 Mission Update

**C1XS Catches First Glimpse of X-rays from the Moon**

The Imaging X-ray Spectrometer, one of the 11 payloads onboard Chandrayaan-1 spacecraft, jointly developed by the Indian Space Research Organisation (ISRO) and UK's Rutherford Appleton Laboratory, successfully detected the first X-ray signature from the Moon. This is the first step in its mission to reveal the origin and evolution of the Moon by mapping its surface composition. It may be recalled that Chandrayaan-1 spacecraft was launched from Satish Dhawan Space Centre, Sriharikota on October 22, 2008 and entered the lunar orbit on November 8, 2008.

In orbit around the Moon, Chandrayaan-1 Imaging X-ray Spectrometer (C1XS) detected the X-ray signal from a region near the Apollo landing sites on December 12, 2008 at 02:36 UT. The solar flare that caused the X-ray fluorescence was exceedingly weak, approximately 20 times smaller than the minimum the C1XS was designed to detect. The X-ray camera collected 3 minutes of data from the Moon just as the flare started and the camera finished its observation. C1XS depends on radiation from the Sun to activate the detection of X-rays. Though the minimum in solar activity was expected to end in early 2008, however, solar activity is yet to reach the anticipated increase. With the highly sensitive C1XS instrument, it has been possible to detect the-X rays.




*Plot generated from CIXS data showing the presence of diffrent elements*

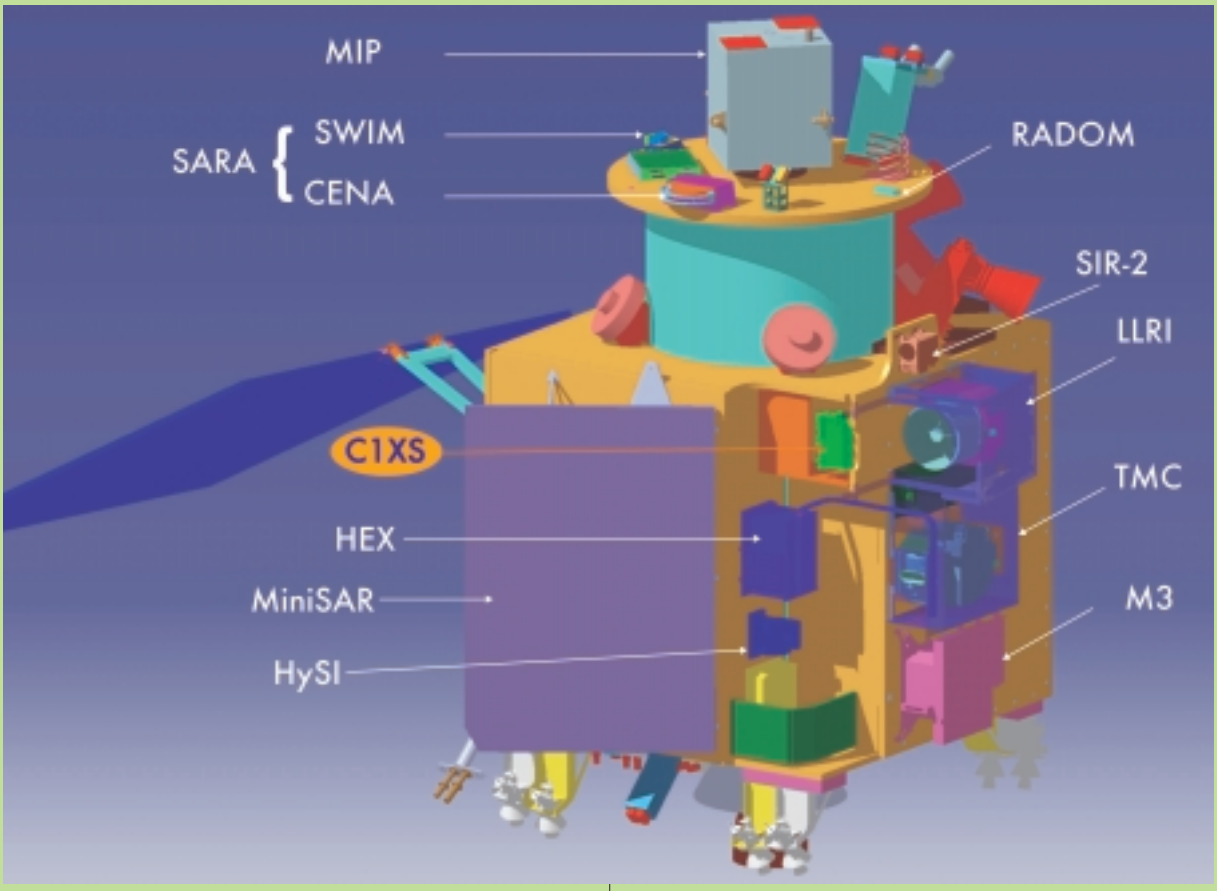
The camera - C1XS (pronounced "kicks") – was designed and built at Space Science and Technology Department at the Rutherford Appleton Laboratory in collaboration with Indian Space Research Organisation (ISRO). It is an X-Ray Spectrometer that uses X-rays to map the surface composition of the Moon and will help scientists to understand its origin and evolution, as well as quantifying the mineral resources that exist there.

Chandrayaan-1 is the first lunar mission of ISRO and also the first mission with international partners. It was designed to orbit the Moon at an altitude of 100 km and carries 11 scientific instruments including radar and particle detectors as well as instruments that will make observations in the visible, near infrared and soft and hard X-rays.

Dr G Madhavan Nair, Chairman, ISRO, said that the joint development and operationalisation of C1XS in Chandrayaan-1 between ISRO and RAL, UK is a major achievement. First signatures obtained from C1XS are highly encouraging.

**Chandrayaan-1's orbit raised**

After the successful completion of all the major mission objectives, the orbit of Chandrayaan-1 spacecraft, which was at a height of 100 km from the lunar surface since November 2008, was raised to 200 km. The orbit raising manoeuvres were carried out on May 19, 2009. The spacecraft in this higher altitude will enable further studies on orbit perturbations, gravitational field variation of the Moon and also enable imaging lunar surface with a wider swath.





Chandrayaan-1 spacecraft launched from Satish Dhawan Space Centre SHAR, Sriharikota on October 22, 2008 by PSLV-C11, was inserted into lunar orbit on November 8, 2008. In the succeeding seven months, all the 11 payloads onboard Chandrayaan-1 spacecraft were operationalised successfully and excellent quality data was received. The scientific community from India and other participating international agencies are analysing the data and already several interesting results have been obtained.

Chandrayaan-1 spacecraft operations are being carried out from the Satellite Control Centre (SCC) of ISRO Telemetry, Tracking and Command Network (ISTRAC) at Bengaluru and Indian Deep Space Network (IDSN) at Byalalu near Bangalore. The science data from Chandrayaan-1 is being archived and disseminated from Indian Space Science Data Centre (ISSDC), also located at Byalalu.

# ISRO's Workshop on the Design of Antenna and Radar Systems held at Bengaluru

A two-day national workshop on Design of Antenna and Radar Systems – DARS 2009 - was organised by ISRO Telemetry, Tracking and Command Network (ISTRAC) at its Mission Operations Complex in Peenya, Bengaluru, during February 13-14, 2009.

Indian Space Research Organisation (ISRO), in association with several organisations like Bharat Electronics, Electronic Corporation of India Limited, Bhabha Atomic Research Centre and many private agencies, has been instrumental in the design and development of various types of antenna and radar systems, meeting the needs of aerospace agencies in the country. The recent success of India's first mission to moon – Chandrayaan-1 – and the role played by the Indian Deep Space Network with its 32 m antenna of ISTRAC, has generated tremendous enthusiasm among the antenna and radar community in the country. This workshop was an effort to bring together designers, engineers and scientists across ISRO and other organisations in the field to share their experiences, current practices as well as future concepts to build state-of-the-art antenna and radar systems.

Padma Vibhushan Dr G Madhavan Nair, Chairman, ISRO/Secretary, Department of Space, inaugurated the workshop and presided over its inaugural function. Mr R Aravamudan, Former Director, ISRO Satellite Centre (ISAC), Bengaluru, who pioneered the development of radars in ISRO, was the Guest of Honour. Mr S K Shivakumar, Director, ISTRAC, welcomed the gathering and Mr G R Hathwar, Chairman-DARS 2009 Organising Committee, spoke on the theme of the workshop. Chairman, ISRO released the proceedings of the national workshop. Mr Aravamudan unveiled the souvenir brought out during the occasion and Mr S K Shivakumar released the compendium of antennas of various ISTRAC network stations.


*Dignitaries during the release of the proceedings*

In his inaugural address, Dr Madhavan Nair appreciated the organisers for conducting the workshop in the backdrop of the recent success of Chandrayaan-1. In his keynote address, Mr Aravamudan traced the development and establishment of radars for tracking launch vehicles over the past four decades, which continue to provide support for launch vehicle missions. During the function, Mr Aravamudan was presented with a "Life Time Achievement Award" by Dr Madhavan Nair for his contribution to ISRO during his illustrious career of 34 years. Dr Madhavan Nair was also felicitated on being conferred with Padma Vibhushan Award by the Government of India during the 2009 Republic Day Celebrations. Mr B Sambasiva Rao, General Manager, ISTRAC, proposed the vote of thanks.

About 250 delegates including 65 students from various prestigious technical institutions as well as experts participated during the two-day workshop and 65 high quality technical papers from India and abroad were presented. Besides, six invited lectures were delivered on the current state of technology in the field of antenna and radar systems.

# PSLV-C12 Successfully Launches RISAT-2 and ANUSAT Satellites

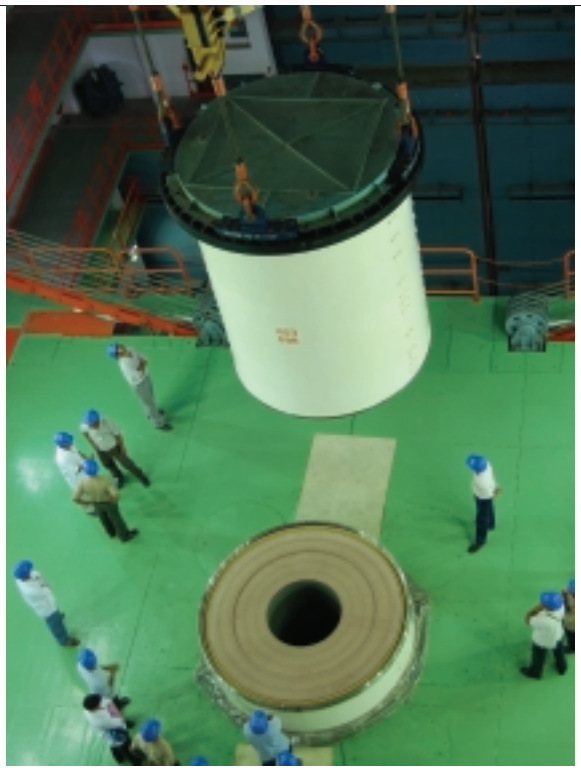
In its fifteenth mission carried out from Satish Dhawan Space Centre SHAR (SDSC SHAR), Sriharikota on April 20, 2009, ISROs Polar Satellite Launch Vehicle (PSLV-C12) successfully placed two satellites - RISAT-2 and ANUSAT - in the desired orbit.

RISAT-2 is a Radar Imaging Satellite with the capability to take images of the earth during day and night as well as cloudy conditions. At the time of launch, RISAT-2 weighed about 300kg and was realised by ISRO in association with Israel Aerospace Industries. The satellite was placed in an orbit of 550km height with an inclination of 41deg to the equator and an orbital period of about 90 minutes. This satellite will enhance ISRO's capability for earth observation, especially during floods, cyclones, landslides and disaster management in a more effective way.

*A glaring view of PSLV-C12 lift-off*

The 44 metre tall PSLV-C12 weighing 230 ton was launched from the Second Launch Pad (SLP) at SDSC SHAR in the 'Core Alone' configuration without the use of six solid strap-ons. In this mission, in addition to RISAT-2, PSLV also carried A 40 kg micro satellite named ANUSAT, built by Anna University, Chennai. ANUSAT is the first experimental communication satellite built by an Indian University under the oversall guidance of ISRO and will demonstrate the technologies related to message store and forward operations.

Integration of PSLV for the C12 flight commenced at the Second Launch Pad in SDSC, SHAR on February 26, 2009. Following this, the first, second, third and fourth stages of the vehicle along



*PSLV-C12 first stage integration in process*

with the satellites were fully integrated. After a 48 hour countdown, the vehicle and the satellites successfully underwent various levels of functional checks at the launch centre.

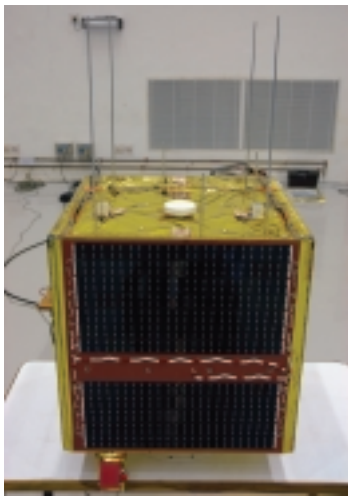
In this flight, PSLV carried the indigenously developed Advanced Mission Computers and Advanced Telemetry System, which guided the vehicle from lift-off till the injection of the two satellites in the desired orbit.

PSLV-C12 lifted off from the Second Launch Pad at 6:45 am IST (0115 UT) with the ignition of its first stage. The important flight events included the separation of the first stage, ignition of the second stage, separation of the payload fairing at about 115 km altitude after the vehicle had cleared the dense atmosphere, second stage separation, third stage ignition, third stage separation, fourth stage ignition and fourth stage cut-off.

The main payload, RISAT-2, was the first satellite to be separated in orbit at 1100 seconds after lift-off at an altitude of 550 km. About 60 seconds later, ANUSAT was separated.

*PSLV-C12 coming out of Vehicle Assembly Building*

With this successful launch, the versatility and the reliability of PSLV was proved again underscoring its importance as the workhorse launch vehicle of India. This was the fourteenth consecutive success for PSLV. In these launches, PSLV has placed a total of sixteen Indian satellites and sixteen foreign satellites into Polar, Geosynchronous Transfer and Low Earth Orbits. During its previous mission on October 22, 2008, PSLV had successfully launched Chandrayaan-1 spacecraft, which is now exploring the moon from lunar orbit.



*ANUSAT*

# International Conference on 'Megha-Tropiques' held at Bengaluru

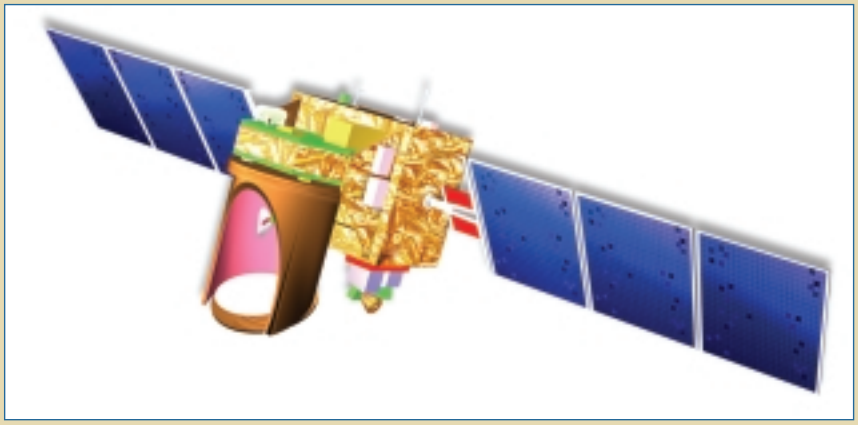
An International Conference on Megha-Tropiques Science and Applications was organised at Bengaluru during March 23-25, 2009 at Antariksh Bhavan, ISRO Headquarters, Bengaluru. This conference was attended by about 40 scientists of international agencies from France, UK, USA, Japan and Brazil besides 180 senior scientists from Indian R&D agencies, universities, etc. The conference deliberated on various aspects of Megha-Tropiques science and retrieval of various variables over tropical region. *Megha-Tropiques, one of the most advanced and complex tropical weather and climate monitoring satellites,* is a joint project of ISRO and the French Space agency CNES. The satellite is in its advanced stage of development and is scheduled for launch during 2009-10.

Megha-Tropiques has been conceived primarily to investigate the tropical regions as they receive maximum energy from the Sun than they radiate back into space. The excess energy received in the tropical region is utilised as a thermal engine and provides circulation in the atmosphere and oceans. This has substantial influence and is strongly linked to hydrological cycle, which immensely influences tropical convective systems. The stored energy through tropical rains is released in the form of latent heat while high humidity and thick clouds strongly affect the radiation budget. The complex processes between solar radiation, water vapour, clouds, precipitation and atmospheric motion determine the life cycle of convective systems and influence Indian monsoon in the tropical region.

The tropical convective system and its associated parameters are highly dynamic in nature and call for a high frequency observational platform through a low orbit satellite which is capable of providing information over the tropical region more frequently and on vertical structures on a daily basis. Towards this, Megha-Tropiques will be capable of studying cloud systems, radiation budget, water vapour profiles and temperature and humidity profiles in our troposphere on a more frequent basis.

Megha-Tropiques is one of the unique satellites to be launched into the space having multiple sensors in a single satellite and provides highly reliable parameters to understand global tropical weather and climate.

Megha-Tropiques carries four scientific payloads, of which Microwave Analysis and Detection of Rain and Atmospheric Structures (MADRAS), is a five frequency nine channel passive microwave radiometer. This instrument will provide estimation of rainfall, water vapour, liquid water, ice and surface wind speed in these systems. The second payload, Scanner for Radiative Budget (SCARAB), is a cross track scanning radiometer providing data on the radiative budget of tropical convective systems.



*An artist's concept of Megha-Tropiques*

The third, Sondeur Atmospherique du Profil d'humidite Intertropicale par Radiometrie (SAPHIR), is a multi-channel cross track millimeter wave humidity sounder for atmospheric profiling in the inter-tropical region. The fourth payload of Megha Tropiques is GPS Radio Occultation Sensor (GPS-ROS), which is capable of measuring water vapour and temperature profiles in the tropics.

Megha-Tropiques will be placed in a low inclination orbit of 20 deg which will facilitate high temporal re-visit capability over the tropical region. This orbit will enhance observational capability of the rapidly developing tropical systems and will enable monitoring of weather and climate over the entire tropical world.

The international conference on Megha-Tropiques held at Bengaluru was intended to deliberate on issues related to scientific retrieval and understanding of various parameters in tropical environment and their applications for enhanced interpretation on the evolution of tropical systems in the short term and climate in the long term. Additionally, the intention was that the international deliberations would culminate into directional pathways for improved tropical weather understanding and better forecasting ability.

# Antrix/ISRO and EADS Astrium Built Commercial Communication Satellite W2M Launched Successfully

A state of the art communication satellite, W2M, built by ISRO on a commercial basis in partnership with EADS-Astrium of Europe, was successfully launched on December 21, 2008 by the European Ariane-5 launch vehicle. The launch took place from the Guiana Space Centre at Kourou in French Guiana.

W2M project was undertaken in the context of an accord signed during the visit of the President of France on February 20, 2006, at New Delhi between Antrix Corporation Ltd., the commercial arm of the India's Department of Space and EADS Astrium to jointly build and deliver a communication satellite (W2M) to Eutelsat Communications, which is a global satellite communications provider based in Paris.

*W2M during one of the ground tests*

# Nation Honours Dr G Madhavan Nair

It was a proud moment for ISRO, when the nation conferred Padma Vibhushan to Dr G Madhavan Nair, Chairman ISRO. Dr Madhavan Nair was selected for the country's second highest civilian honour, on the occasion of the 60th Republic Day, for the significant role played by him in successfully realising Chandrayaan-1, India's first mission to Moon.

Dr Madhavan Nair has dedicated the award to the entire team of the Indian Space Research Organisation and believes that the national recognition has come because of ISRO's good work in recent years.

"...it is a great recognition at the national level. I owe it to the entire ISRO team who are behind me". He said. "I think ISRO has been doing very well in the last few years. If you take the last five years, we have completed something like 23 missions".

Dr Madhavan Nair has been earlier bestowed with the Padma Bhushan in 1998.

Space India is delightfully proud to congratulate Dr Madhavan Nair.

*Dr Madhavan Nair receiving Padma Vibhushan Award from the President of India, Mrs Pratibha Patil*

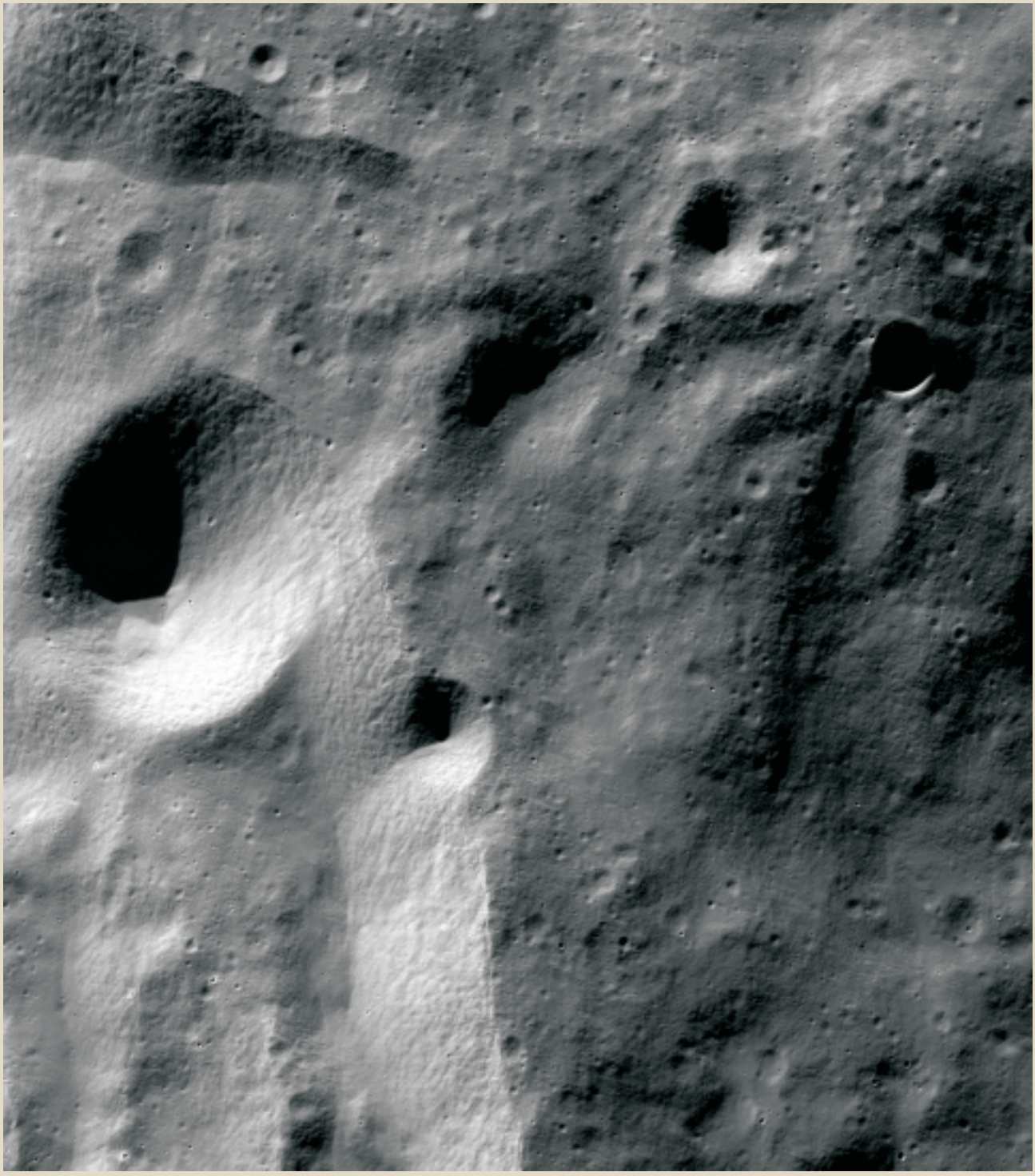


*Image sent by Chandrayaan-1's Terrain Mapping Camera showing details of the South polar region of the moon*