SPACE EXPLORATION IN INDIA

Synopsis: In ancient India astronomical and mathematical knowledge was highly advanced. The world owes the invention of zero and decimal system to India. Vedic literature and Epics are full of significant space-references. The 17th century observatories in the country were equipped with highly accurate instruments which presuppose such observatories in the past as well. Modern Indian space research is late yet very significant. India has made rapid progress in the launch of satellites, space vehicles etc. ISRO has a very ambitious space programme including development of GLSV engines. It is committed to application for peaceful purposes.

In ancient India, astronomy and mathematics were remarkably developed. It produced great astronomers and mathematicians like Varahamihira, Aryabhatta, and Bhaskara etc. They contributed a lot to knowledge of heavenly bodies. Their calculations were accurate and reliable. They know that the earth revolved around the sun on its axis. They could forecast eclipses with accuracy. Their astronomical knowledge was deep and of far-reaching consequences. The 17thcentury observatories of Jaipur, Delhi etc, constructed on a big scale were equipped with very accurate instruments .These suggests that there were their counterparts In ancient days as well. Zero and decimal system of numerals were invented by the ancient Indian Scientists and mathematicians. Indians were the first to understand the mathematical implications of zero and infinity. These are the very foundations on which modern space research and exploration is said to be based.

Vedic literature is full of significant references to ‘antariksha’ and ‘askasha’ the intermediate space between heaven and earth, the atmosphere, the sky, the open space, vacuity, the either etc. In the Ramayana Rama travels in an aerial chariot called ‘Pushpaka’ from Lanka to Ayodhya. Ravana having abducted Sita travels through skies. Similarly, the Mahabharata is replete with space-stories and adventures. There is an interesting anecdote in the Mahabharata which wonderfully allegorically. Bhima, physically the most powerful of the 5 Pandava princes, caught hold of an elephant by one of its feet and swirling hurled it into the space and it never fell on earth.

India’s modern space research and exploration is somewhat belated and yet significant. India now ranks sixth after the U.S., Russia, France, Japan and China in the world, and second in the developing countries in the matter of satellite launching into low earth orbit. India made a modest beginning in 1963

with the launch of Rohini sounding rockets. Since then, Indian scientists produced the world's most advanced remote sensing satellite IRS-1C which was successfully put into Orbit afloat a Russian rocket on December 28, 1995. It is equipped with the panchromatic camera (PAN) which will send pictures of the earth with a resolution of 6 meters, the highest available today in the world. India's third indigenous satellite INSAT-2C was launched from Kourou, French Guyana by the Ariane Rocket. It carries KU band transponders meant for telecommunication. Recently on March 21, 1996 the PSLV-D3 (Polar Satellite Launch Vehicle) successfully launched IRSP-3 (Indian Remote Sensing Satellite) from Sriharikota. The launch placed the 930 Kg IRS-P3 into a near-polar sun-synchronous orbit. The 2nd Indian remote sensing satellite IRS-1A was launched in March 1988 and IRS-1B in August 1991. The first satellite in the IRS series IRS-1A, launched in March 1988 had successfully completed its designed life of 3 years and continued to provide operational service even as it entered its 6th year of operation.

The Indian space programme was started formally in 1972 when Space commission and Department of Space were established. The programme aims at providing space based service in areas of communication, meteorology, resources survey and management and, as integral to it, develop satellite, launch vehicles and associated made remarkable progress. As a result of these, the communication capabilities have been enhances, distance education in remote areas search and rescue system. Similarly, space remote sensing is providing vital inputs on agriculture, soil, forestry, land and water resources etc.

The Indian National Satellite (INSAT) is a multipurpose operational satellite system for communications, meteorological observations and date relay, direct satellite TV Broadcasting and radio programme distribution. The INSAT system was set up in 1983 with the successful commissioning of INSAT-1B abroad the U.S. Space Shuttle Challenger on August 30, INSAT-1D, the last in the series of the first generation INSAT Satellite was sent into space by the U.S. Delta Rocket on June, 12, 1990/ The indigenously build INSAT-2A was launched in July 1992 on broad the European launch vehicle, Ariane and was commissioned in August 1992. INSAT-2 series of satellites are more advanced and have one and a half times the capacity of INSAT-1 satellite, was hurried into space by Ariane Vehicle from Kourou on 23 July, 1993. And then INSAT-2C was sent into space by Ariane rocket from Kourou, French Guyana in 1995.

Besides the last 2 satellites of the second generation series INSAT-2D, scheduled for launch on May 29 from Kourou and INSAT-2E, the ISRO has plans to launch four satellites of the third generation during the current five year period.

Two of them will use procured launches and the remaining 2 the second generation Geo Synchronous Launch Vehicles (GSLV).

The second operations Indian Remote Sensing Satellite, IRS-1B was launched on 29 August, 1991. Before this IRS-1A was launched in March. On October 15, 1994, 870 kg remote sensing satellite IRSP-2 WAS LAUNCHED FROM Sriharikota by PSLV-D2. IRS-1C was launched by Russian Molniya Vehicle in 1995. IRS-1C and IRS-1D are second generation highly advanced satellites with much better spectral and spatial resolutions, more frequent revisits, stereo viewing and on board recording capabilities.

In spite of some setbacks the launch vehicle programme in India has made significant strides. The maiden venture in developing a satellite launch vehicle proved a failure as SLV-3 failed in August 1979. The second attempt of SLV, however, proved successful and it placed a 35 kg Rohini satellite in orbit. SLV-3 was successfully launched in 1983 and it transmitted more than 2,500 pictures home. The next 2 Augmented Satellite Launch Vehicles (ASLVS) sent into space in 1987 and 1988 also failed in their mission, but the launch of ASLV-D3 on 20 May, 1982 was a success which carried the stretched Rohini Satellite (SROSS-III). ASLV-D4 was successfully launched from Sriharikota placing into low earth orbit the SROSS-C2 satellite on May 4, 1994. PSLV – D2 was successfully launched on October 15, 1994 hurtling into polar synchronous orbit 870 kg remote sensing satellite IRS-P2. PSLV-D3 launched successfully the IRS-P3 on March 21, 1996.

The ISRO is determined to continue the use of its workhorse, the Polar Satellite Launch Vehicle (PSLV) for hurtling satellites in polar orbit. The five continued series of PSLV would launch IRS-ID, IRS-P4, IRS-P5, IRSP-6 besides an astronomical payload. However, the crowning glory of the current 5-years programme would be the realization of the Rs. 935 crore GSLV series of which developmental launch is expected this year (1997) end, using the cryogenic top stage engine acquired from Russia, 6 GSLV launches have been planned during the next five years. GSLV (Geo Synchronous Launch Vehicle) is capable of putting, 2,500 kg communication satellite into geo synchronous transfer orbit. It is a three stage Vehicle with 3.4 m diameter heat shield.

A major milestone targeted for period is the operationalisation of the GSLV in launching communication satellites. According to the current programme, the last 2 of the GSLV series would launch INSAT-3C and INSAT-3D. Though the ISRO’s vision for the decade 2000 to 2010 lays stress on promotion and development of space technology for application in socio-economic development, one of its important plans is to commercialise the

technology capability and space application potential in the global market in an attempt to harness the benefits accruing from the national space efforts.

It is an ambitious programme which the Western powers may not like to succeed. They are already at work through MCTR (Missile Technology Control Regime) to see Indian space development programme of developing cryogenic engine derailed. But the Indian scientists and technologies at ISRO and other allied departments seem determined that the development is an scheduled. India is committed to peaceful application of space technology, but it can also be used in augmenting national security measures if there is any external threat from across the borders. This technology can help us in producing Inter-Continental Ballistic Missiles (ICBM's) for launching conventional as well as nuclear warheads – a rare capability which only a few countries in the world possess.

Indian Space Research Organisation (ISRO) is responsible for the planning, execution and management of all space research and exploration activities. Space research and development activities are carried out at various centres and units of ISRO. Vikram Sarabhai Space Centre (VSSC), Thiruvanthapuram is the lead centre for launch vehicle development, ISRO Satellite Centre (ISAC) Banglore is responsible for design, fabrication, and testing and management of satellite system, Space Application Centre (SAC), Ahmedabad is ISRO's research and development centre for conceiving, organising, and building systems for practical applications of space technology. The main launch centre of SHAR Centre, Sriharikota (Andhra Pradesh). Liquid Propulsion System Centre (LPSC) is the main centre for development of liquid propulsion system with its facilities located at Thiruvananathpuram, Banglore and Mahendragiri (Tamil Nadu). ISRO Telemetry, Tracking and Command Network (ISTRAC) with its Sriharikota, Thiruvananathpuram, Banglore, Lucknow, Car Nicobar and Mauritius, provides telemetry , tracking and command (TTC) support for the launch vehicles and satellite missions. Master Control Facility at Hassam (Karnataka) is responsible for all post launch operation of INSAT satellites including orbital manoeuvres, station keeping and in-orbit operations on the spacecraft. Physical Research laboratory (PRL), Ahmedabad under Department of Space is the premier national centre for research in space and allied sciences.