

**India carves a unique place in space****\*K V Venkatasubramanian**

More than 53 summers ago, India had successfully put its first signature on space by launching the US-made 'Nike-Apache' two-stage sounding rocket (the first rocket) from Kerala's obscure fishing hamlet Thumba.

There were no buildings at the Thumba Equatorial Rocket Launching Station (TERLS) on Thiruvananthapuram's outskirts. The bishop's house doubled up as the Director's office, the ancient St. Mary Magdalene church building became the control room and naked eyes tracked the smoke plume on November 21, 1963. Bullock carts and bicycles carried rocket parts and payloads to the launch pad.

About 12 years later, in 1975, India launched its first-ever experimental satellite, Aryabhata, on a Russian rocket. Lacking infrastructure, scientists at the Indian Space Research Organisation (ISRO) in Bangalore converted even a toilet into a data receiving centre.

From taking its first baby steps in Thumba, the Indian space odyssey has traversed numerous landmarks. ISRO has emerged as a key player in global satellite launches and the manufacturing industry. The nation has earned global recognition for launching lunar probes, built satellites, for others too, ferried foreign satellites up and even succeeded in reaching Mars.

Through these decades, India's space programme has focused on national imperatives, and social and economic well-being of society—specifically in earth observation and application for management of natural resources in agriculture, water, fisheries, and watershed mapping and development. Space-based applications like tele-education and tele-medicine have enabled greater access to rural population to these basic needs.

Space exploration missions have surged ahead during the past three years. India's latest communication satellite GSAT-17 on board an Ariane 5 rocket lifted off from French Guiana on June 28. It will strengthen ISRO's current fleet of 17 operational telecom satellites and provide meteorological and satellite-based search and rescue services--earlier provided by the Indian National Satellite System (INSAT).

In a boost to Prime Minister Narendra Modi's vision to project India as a global low-cost provider of services in space, ISRO launched on June 23 the PSLV C38 carrying 712 kg Cartosat-2 satellite for earth observation and 30 other tiny satellites, several of them for European countries. This

was PSLV's 39th consecutively successful mission.

India entered the big league of space technology on June 5 this year with the launch of its most powerful, homegrown and heaviest-ever rocket---the Geosynchronous Satellite Launch Vehicle Mark-III (GSLV Mk-III D 1)--carrying GSAT-19 communication satellite. The high-tech 3,136 kg workhorse established ISRO's capability to transport four-tonne satellites and test a homegrown cryogenic engine, and also paved the way to send humans, one day, beyond Earth's atmosphere. Now, Indian communication satellites can be lofted into space from within the country. So far, only the USA, Russia, Europe, China and Japan have launched space satellites weighing 4,000 kg and more.

Earlier on May 5, India catapulted the first-ever South Asia Satellite (SAS) to boost communication and improve disaster links among its six neighbours--Afghanistan, Bangladesh, Bhutan, the Maldives, Nepal and Sri Lanka. Following the launch of the 2,230-kg GSAT-9, built by ISRO and funded entirely by India, on board the GSLV-F09 rocket, the prime minister had said the "unprecedented" development sent out a message that "even sky is not the limit when it comes to regional cooperation".

In February, India scripted a new chapter in the history of space exploration and grabbed world headlines by hurling 104 satellites, a record, including the Cartosat-2 series satellite, in one mission—aboard a Polar Satellite Launch Vehicle (PSLV C-37). The rocket carried payloads from six different countries. The master stroke established India as the launch service provider for small satellites.

These spectacular achievements have placed ISRO in a commanding position in the space race. The prime minister's soft spot for space and ISRO were reflected in a substantial 23 per cent increase in this year's budget allocation for the Department of Space.

In 2016, among the major achievements were the successful launching of the remote sensing satellite RESOURCESAT-2 in December, a record lobbing of 20 satellites in a single payload in June and three navigation satellites and the GSAT-18 communication satellite.

ISRO hoisted the GSAT-15 communication satellite and the Multi Wavelength Space Observator ASTROSAT in 2015. It also ground tested the indigenously developed high thrust cryogenic rocket engine. Besides, five satellites were launched in July by PSLV and the IRNSS-1D, the fourth satellite in the Indian Regional Navigation Satellite System (IRNSS), in March.

In December 2014, the communication satellite GSAT-16 was launched. PSLV hoisted the country's third navigation satellite IRNSS-1C in October and the second dedicated navigation satellite IRNSS-1B in April.

In the years ahead, ISRO scientists have a busy schedule. A series of satellite launches is in the works. In early 2018, the space agency will launch two lunar missions, Chandrayaan-2, an advanced version of Chandrayaan-1. The indigenous initiative comprises an orbiter, lander and

rover, which are expected to perform mineralogical and elemental studies of the lunar surface. The other is in collaboration with Team Indus, a group of space enthusiasts.

The next grand project is the scientific mission to the Sun for observing the solar corona (with a Coronagraph--a telescope), photosphere, chromosphere (Sun's three main outer layers) and solar wind. To be launched by PSLV-XL by 2020, Aditya-L1 satellite will probe why solar flares and solar winds disturb the communication network and electronics on earth.

Further, ISRO will return to Mars, probably during 2021-2022, with a second Mars Orbiter Mission (MOM) spacecraft, Mangalyaan 2. Come September 24, India's first-ever interplanetary robotic probe, Mangalyaan 1, still going strong, will celebrate three years of landing on the Red Planet. India had created history by becoming the first nation to enter the Mars orbit on a maiden mission--also the cheapest such mission till now.

For the first time, India will have a date with Venus, beyond 2020. The Venusian orbiter mission will study the planet's atmosphere.

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*Views expressed in the article are author's personal.*

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