




# India: The Space Phoenix Rising to Global Leadership

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**Abstract:** Phoenix is a mythical bird that rises from its own ashes. Today, Japan is often referred to as a Phoenix in terms of development. Despite the devastation caused by the nuclear attacks during World War II, it has emerged as one of the most developed and advanced countries in the world. The same can be said for India. Ancient India was home to renowned astronomers like Varahamihira, physicists like Rishi Kanad, mathematicians like Aryabhata, and aviators like Bharata Muni. We even had advanced spacecraft and propulsion technologies in ancient times. However, during the medieval period, India lost its prominence in space exploration due to various invasions, transformations of kingdoms, and natural calamities. Since gaining independence, India has demonstrated remarkable growth in the space sector. Therefore, it is not contradictory to refer to India as the Phoenix of the space industry. Just as flocks of birds have one leader (Nayak in Hindi) while flying in the sky, India is poised to become a Vishwanayak, guiding the world in the coming decades.

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## 1. Introduction

The celebration of Space Day each year reminds us of the legendary Dr. Vikram Sarabhai and his remarkable contributions, which have grown like a plant spreading its branches into various subsectors of space and bearing the fruit of success for numerous Indian space missions. Dr. Sarabhai was an assistant to Dr. Homi Bhabha at IISc Bangalore, and together they launched a balloon to investigate the properties of the atmosphere. From making that balloon to sending astronauts into space, the journey of the Indian space sector is both inspiring and fascinating. Later, ISRO had several chairmen who made significant contributions, but India truly began to rise during the era of Dr. APJ Abdul Kalam. This journey reminds me of Kalam Sir the most. Despite facing multiple challenges in life, he grew "wings of fire" and took India to new heights. India began to accelerate in space technology when Kalam Sir became President. He envisioned India 2020, and this article is inspired by his thoughts. That is why I have titled each section with the names of the books he authored. This article provides readers with insights into the history of the Indian space sector and the efforts to establish space organizations even before Independence. It also highlights a group of Indian and foreign scientists and their contributions to space technology.

This article begins with insights into the history of the Indian space sector and the efforts to establish a space organization even before independence. It also highlights several Indian and foreign scientists and their contributions to space technology. The first section, titled describes the key moments that led to the formation of a space organization in India, particularly in the period leading up to independence. The section the Indian

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astronauts, known as Vyomnauts, who, inspired by their Western counterparts, persevered despite numerous failures and incidents during space flights. To be recognized as one of the dominant powers in the world, advancements in the Indian defense sector are outlined in the section titled of Fire: The Rise of the Defense Sector. In space technology, India still lags in theoretical aspects of space science, as mentioned in the section Ladder: Igniting Passion for Space Research. The new era of Indian space exploration, which began a few years after the tenure of Dr. A.P.J. Abdul Kalam, has demonstrated remarkable achievements, as detailed in the section.

## 2. Turning Point in the Indian Space Sector

In the modern era, the rise of the space industry in India began even after independence. The inspiring stories of foreign pioneers in space science, such as Galileo, Copernicus, and Newton, along with modern figures like Einstein and Wernher von Braun, ignited a passion for space exploration among enthusiastic Indian students. Dr. Vikram Sarabhai and Dr. Homi Bhabha, inspired by Srinivasa Ramanujan, pursued their studies at Cambridge. Unfortunately, due to World War II, they had to return to India. Later, they collaborated with Sir C.V. Raman at the Indian Institute of Science (IISc) in Bangalore. These scientists, along with a young and curious Dr. A.P.J. Abdul Kalam and many others, established the Vikram Sarabhai Space Centre, which later evolved into the Indian Space Research Organisation (ISRO). Today, we witness India launching numerous satellites into space and setting records, but this journey began with the humble act of transporting a satellite on a bicycle. Aryabhata, India's first satellite, was launched shortly after independence.



**Figure-1 Indian Scientists Carrying Rocket Parts in a Cycle for Assembling [Image Courtesy: ISRO]**

## 3. Vyomnauts [Indian Astronauts] with wings of fire

Just as Russian astronauts are called Cosmonauts and Chinese astronauts are known as Taikonauts, Indian astronauts are called Vyomnauts. Rakesh Sharma became the first Indian to travel into space in collaboration with Russia's cosmonauts from ROSCOSMOS. Kalpana Chawla followed in his footsteps, venturing into space alongside NASA astronauts; unfortunately, she did not survive due to a tragic incident. India has long aspired to engage in manned missions, but foreign space agencies were initially reluctant to share their technologies. Today, however, India has developed its own re-entry vehicle, Gaganyaan, which has successfully completed flight tests. The country has also selected four astronauts for an upcoming crewed mission. This progress has led to collaborations with foreign startups, such as Axiom, working with ISRO to send astronauts into space in partnership with the Indian space agency. This situation validates the famous words of Dr. APJ Abdul Kalam: "Strength respects strength." Inspired by the bravery of Kalpana Chawla, who ventured into space through collaboration with foreign space agencies, several Indian women, including Anima Sable and Ms. Astha Kachha, have pursued training through these agencies.

## 4. Indomitable Spirit of India

India is not lagging behind in the defense sector either. The impetus for strengthening the defense sector and conducting India's nuclear tests stemmed from the country's defeat in the 1962 war against China. Dr. Vikram Sarabhai and Homi Bhabha laid the foundation for India's defense capabilities. The rise of the

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Indian space industry was further propelled by the contributions of Dr. APJ Abdul Kalam, who played a pivotal role in the development of numerous missiles, beginning with his DRDL project for a glider named Nandi. He subsequently joined the DRDO and later ISRO, where he significantly contributed to the development of missiles such as Agni, Akash, Nag, and Prithvi, among others. Dr. Kalam recognized the importance of nuclear energy and successfully managed India's first nuclear test in Pokhran without alerting any other country. This achievement prompted India's Prime Minister at the time to promote the slogan "Jai Jawan, Jai Kisan, Jai Vigyan," which gained immense popularity. In this manner, India conveyed a message of peace to the world. Dr. Kalam inspired the youth of India to pursue careers in space through his actions, speeches, and renowned books. Following in Dr. Kalam's footsteps, Satish Dhawan emerged as a key figure in the Indian space program, ultimately leading to India's success in becoming the first country to land on Mars on its first attempt. Aviation is also closely related to space exploration. Hindustan Aeronautics Limited, established in 1940, has now become the world's third-largest aircraft manufacturing industry. India has developed an advanced fighter jet called Tejas using indigenous technology and is currently manufacturing the Advanced Medium Combat Aircraft (AMCA) in collaboration with the DRDO and ADA. Previously, India relied on other countries for defense weapons. However, the Aatmanirbhar Bharat initiative launched by the new government has not only enabled India to export defense weapons to developing countries but has also empowered the nation to respond to threats through surgical strikes and airstrikes.

### **5. Ignorance Towards Theoretical Space Subjects and Indian Ignited Minds**

Recently, a post about Dr. Jayant Naraliker, an Indian cosmologist, was trending on social media due to his poor reception at Indian airports. We should not forget our space heroes. The theoretical fields of astronomy, astrophysics, and cosmology are all closely related to space. Unfortunately, these disciplines have not advanced as much in India compared to other areas of space science. We need to encourage our cosmologists and astrophysicists because Indian scientists have the potential to challenge the renowned theories of space proposed by world-famous scientists. Dr. Abhas Mitra has challenged the established theories of black holes, including those proposed by Stephen Hawking. Dr. Jayant Naraliker, a Cambridge scholar, popularized the Steady State Theory of Sir Fred Hoyle by dominating debates as Hoyle's assistant. He later authored many books on these subjects in accessible language to unravel the mysteries of the universe for everyone. He also established the Inter-University Centre for Astronomy and Astrophysics (IUCAA) in Pune to promote research in astronomy and astrophysics. To validate theories of space, mathematics is essential, as it is the language of the universe. The world still remembers the Indian genius Srinivasa Ramanujan, who was known as the man who understood infinity due to his contributions to mathematics, particularly in infinite series and more. Remarkably, he formulated these equations first, with their proofs following later, which is a reverse process compared to conventional methods.



**Figure-2 Astronauts Selected for Gaganyaan Mission [Image Courtesy: ISRO]**

### **6. Luminous Spark in the Indian Space Sector**

In the past, Indian students had to go abroad to pursue education in aerospace. However, today they are able to pursue it within India, thanks to the increased awareness among the population about space exploration. Dr. APJ Abdul Kalam, who served as the director of IIST (Indian Institute of Space Science and Technology), played a pivotal role in providing students with education specifically in space technology. He also initiated a journal in collaboration with the Aeronautical Society of India to support Indian researchers. Many students are now choosing to become scientists and earn money in rupees rather than in dollars, leading to a gradual decline in the trend of Non-Resident Indians (NRIs). I believe that, just as we educate future generations about our kings



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and freedom fighters, we should also include the stories of prominent figures in the Indian space sector in the curriculum.



**Figure-3 Space Station Proposed by ISRO (Left); and Gaganyaan Capsule (right) [Image Courtesy: India Today and ISRO]**

The former ISRO Chairman, Dr. K. Sivan, became a hero for all Indians through his relentless efforts, especially after facing near failures, to make India the first country to attempt a landing on the Moon's south pole. Although the Vikram Lander, part of the Chandrayaan mission, lost contact, breaking the hearts of every Indian space enthusiast, optimists rallied behind our scientists. India has astonished the world, including SpaceTech tycoon Elon Musk, due to ISRO's significantly lower budgets compared to Hollywood's space agencies. As a result, many international agencies prefer ISRO for launching their satellites because of its cost-effectiveness. Rockets like PSLV and GSLV have become as reliable as Sir Robert H. Goddard's Saturn V. India is poised to become a global leader by expanding its capabilities in advanced space missions, such as NISAR (a joint satellite project by ISRO and NASA), Shukrayaan, the Reusable Launch Vehicle Pushpak, successful tests of Scramjet technology, and many more. The spark ignited by inventions like the world's smallest satellite, 'KalamSat,' has led to numerous innovations, including the world's first semi-cryogenic rocket and the Vikram launcher, developed by startups like Agnikul and Skyroot Aerospace.

## 7. Conclusion

In my concluding remarks, I would like to offer some suggestions to the Indian government and all Indians: There is no doubt that India is making great strides in the space sector, but we are still lagging behind in the research sector. For years, our IITs did not rank among the top 100 institutions globally. However, some of them have recently begun to break this trend. Nevertheless, our education system should become more research-oriented, focusing less on rote memorization and more on innovation and critical thinking. Another critical area of concern is the lack of emphasis on theoretical sciences related to space. Our education in these subjects does not yet match the level of foreign institutions. Despite this, scientists like Dr. Jayant Narlikar and Dr. Abhas Mitra have made significant contributions. The universal language of mathematics is an exception to this; even though it is a theoretical subject, Indians have excelled in mathematics for centuries, contributing many groundbreaking theories to the world. If we further develop these sciences, we might produce the next Einstein, Newton, Stephen Hawking, Richard Feynman, Carl Sagan, or Neil deGrasse Tyson. One thing is certain: just as a flock of birds has a leader, India is on the path to becoming a guiding force for the world in the coming decades. Future generations will recognize India as a Vishwanayak, a global leader in the space sector.

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