Vivekananda International Foundation

Is Colonisation of Space Imminent?

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About the Author

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Is Colonisation of Space Imminent?

The futurist Arthur C. Clarke once said that every revolutionary idea passes through three phases, which can be characterised by the statements of its critics: 1) “It’ll never work – it is pure fantasy”; 2) “It might work, but it’s not worth doing”; 3) “I said it was a great idea all along.” [1] Today, the idea of space settlement lies somewhere at the cusp of phases two and three.

When we look around at the world today, it is not hard to see that we are going through a rather rough period with happenings like de-globalisation, increased greenhouse emissions, renewed arms race, wars, travel, overpopulation, wealth disparity, state sponsored terrorism, fake news to create cognitive effects on the masses, and climate changes that strike in many different ways causing enormous devastation in its wake. It is no surprise that the “doomsday” clock is just two minutes away from midnight for the second year running; something that never happened before. There is immense pressure on the earth’s resources due to rising aspirations and population growth. Some estimates suggest that the earth’s mineral resources, food, water and basic health care will be stretched much beyond limits by 2060 and create mass migration, instability, chaos and anarchy. The situation is accentuated by the fact that humanity is currently limited to one planet.

In such a scenario people are concerned about their survival and their children’s survival. It is speculated if technology coupled with advancement in space exploration will make available viable alternatives by way of settlements, minerals and energy resources.

The scientific community and some adventurous billionaires are thinking in terms of survival of human species and life forms through colonisation of space. Broadly speaking, space colonies could provide answer to these problems to a large extent, if we could solve the medical problems posed by microgravity and high levels of radiation to which the people would be exposed after leaving the protection of the Earth's atmosphere and if we could drastically reduce the cost of travel.[2]

The colonists would mine the Moon, asteroids and the minor planets and build beamed power satellites that would supplement or even replace power plants on the Earth. The colonists could also take advantage of the plentiful raw materials, unlimited solar power, vacuum, and microgravity in other ways to create products that we could not create while inside the cocoon of Earth's atmosphere and gravity. In addition to potentially replacing our current Earth-polluting industries, these colonies may also help our environment in other ways. Since the colonists would inhabit completely isolated man-made environments, they would refine our knowledge of the Earth's ecology.

But, there are various challenges for space colonisation and one hopes that the international community would co-operate and collectively find all-inclusive answers in a just and transparent manner. The human future could be prosperous for all people, not just the privileged few, if we develop the vast resources of space.

Time has arrived now for the world space community to evolve a space vision. Let me propose the 'World Space Vision 2050' that forms into three components - space exploration and current application missions, comprehensive space security and large-scale societal mission and low cost access to space."[3] *- APJ Abdul Kalam, former President of India*

Background/ Historical Perspective

Since the first satellite was ever fired into orbit, and humans realised that they may be able to travel through space, the idea to explore other worlds, and possibly live there, has been at the forefront of some people's attention. The moon landing, subsequent missions to Mars and other planets, and the technological advances in the modern age have made the prospect of colonising outer space a fascinating subject and a possibility. But, is that ever going to be a reality? Are humans actually trying to colonise outer space? Simple answer is YES and soon; some predict a beginning by the decade 2030-40, if all goes well.

This vision, which was purely science fiction for years and years, caught the imagination of the public in the Seventies, leading to the establishments of the organisations like:

- **The National Space Society** (NSS): An independent, non-profit, non-partisan educational membership organisation dedicated to the creation of a space-faring civilisation with the vision: "*People living and working in thriving communities beyond the Earth, and using the vast resources of space for the dramatic betterment of humanity*". The society supports manned space missions as well as unmanned space missions, by both the public (e.g., NASA, Russian Federal Space Agency and Japan Aerospace Exploration Agency) and the private sector (e.g., Ansari X Prize, Transformational Space, Scaled Composites, etc.) organisations.
- **The Alliance for Space Development:** A space advocacy organisation dedicated to influencing space policy towards the goal of permanent human settlements in space. Alliance is focused on the technological development that must precede a successful space settlement regardless of where that settlement is located. The primary goals of the Alliance are to elevate the growth of the space industry, reduce the cost of accessing space, and to clearly define space settlement as the reason for sending humans to space.
- **Space Frontier Foundation**: Founded in 1988, the Space Frontier Foundation is an organisation committed to realising the vision of a greatly expanded and permanent human presence in space. Space alone offers the resources necessary to ensure the survival and prosperity of our species for numerous generations to come. To realise this vision, the Foundation is fundamentally transforming the conception of space into a widely accessible frontier, ripe with opportunity.

Why Space – The Argument?

The destiny of any species, in theory, is to expand and explore. We have already made some early attempts at the stars, but there is still so much to learn and see. Expanding into space is the logical choice for that.

A single-planet species is severely limited in terms of long-term survival to any planetary event (like an asteroid strike), that could potentially eradicate the species. However, a colony on the moon, Mars, or some other planet would act as a backup plan, or a restart protocol for the species, like a reverse colonisation of Earth, should something catastrophic occur. There are, thus, physical, emotional and cultural reasons for looking at space. Some of these are described in the succeeding paragraphs.

Because Space Technologies Will Enrich Our Lives on Earth:

Our solar system is overflowing with resources, material, and potential colonies. The asteroids in our solar system, for example, are massive sources of valuable minerals in their purest form, which we are running out of on our planet. As our population continues to grow, our planet is simply not sustainable, so if we can find a way to live off-planet in sustainable habitats, then we could spread our species and continue to grow.

Energy generation is also a major factor, as the amount of solar energy that could be captured elsewhere in space is much more significant. As our energy demands increase, we would need to use any technology that we could, including setting up colonies/systems in outer space to snatch some of that precious sunshine. Japan, USA and China are leading the race of developing systems for generation of solar power in space and its transmission to earth base distribution centres using LASER or microwaves.

Outer space holds virtually limitless amounts of energy and raw materials such as Helium-3 on the Moon for clean fusion reactors. Further, heavy metals and volatile gases from the asteroids can be harvested for use on Earth and in space. Quality of life can be improved directly by using these resources and also indirectly by moving hazardous and polluting industries and/or their waste products off planet Earth.

Because We Need to Learn What is Out There:

It is human nature to learn more about our origins, our past, our fellow life forms, our environment, our limitations, and our possibilities for the future. Such explorations give our lives context and meaning.

Because We Need a Frontier:

Space is the ultimate, boundless frontier. No society has ever gone wrong betting on the frontier. Societies that have pushed their frontiers have prospered; those that have not done so have withered. The true purpose of spaceflights is in pursuance of human quest to conquer this frontier by sending people in space to live and work there and create new homes for humanity.

Because Space Will Inspire Our Best:

In 1913, recruiting crewmembers for his Antarctic expedition, explorer Earnest Shakleton placed the following newspaper ad: *"Men wanted for*

hazardous journey. Small wages. Bitter cold. Long months of complete darkness. Constant danger. Safe return doubtful. Honour and recognition in case of success." More than 5,000 men answered the call. They didn't do so because of bad employment prospects; they answered because they wanted to be a part of history. In exactly the same spirit, the Sputnik generation answered the challenge of space. The non-profit "Mars One Foundation" hopes to send teams of four space flyers on one-way Mars colony missions starting in 2023.[4] Its initial 19-week application window closed on August 31, 2018 with a final tally of 202,586 volunteers. The applicant pool is quite diverse with more than 140 countries represented. Nearly a quarter of the aspiring Mars colonists are from the United States. Ten percent of the applicants are Indians, the second largest group in the pool.

Because We Must:

The short answer to why we go into space is simply that "we must."

Staying at home, waiting to run out of resources or to be wiped out by the next asteroid strike or any other natural or man-made tragedy, is not really an option. We, humans have to find answers for the survival and propagation of species. It is simply alien to our human nature to look away from a great adventure and a challenge.

What Are the Options?

Our best options, based on the length of the trip from Earth, would be the Moon, Mars, the moons of Mars, near-Earth asteroids, Venus, Mercury, the asteroid belt, or simply our own planet's orbit.[5] These space settlements and lunar bases would act as stepping stones to settlements much further out that are quarantined from Earth by millions of kilometres of vacuum. Once the "motivation of species survival" is put front and centre, it becomes clear that a settlement in Low Earth Orbit (LEO), on the Moon, at L5, or on the Martian surface would not be nearly sufficient. What is needed ultimately is a large set of thriving communities distributed throughout the solar system.

To start with, Moon is an obvious choice, as it is the only thing outside of our planet that a human has stood on. It is also a short journey to Moon as compared to Earth's distance with other celestial bodies. Moon has a weaker gravitational pull, making it a better launch point for other missions. However, the Moon is also depleted in materials, has temperature extremes and very little protective atmosphere. The moon presents a major challenge for

agriculture as seen from the recent mission of growing crops by China on the dark side of the moon.[6] Out of six seeds, cotton was the first one to grow but sprouted cotton could not last for long due to freezing lunar night.

While there is evidence of water on Mars, there are also major arguments against it. There is practically no oxygen on Mars, survivability would depend on serious life support systems, and it is also a much longer trip to Mars than to the Moon.

Some of the major obstacles to space colonisation are the cost, the travel time, life support systems, resource availability, radiation exposure, communications, and psychological factors.

What we do know is that we are getting closer to being able to colonise space in some capacity, and with privately funded space programmes, travelling into space for tourism, exploration, or colonisation is beginning to seem like much more of a reality![7] If you believe the hype, it may happen in just a few decades. Elon Musk anticipates that SpaceX's BFR (big falcon rocket) would take its first handful of passengers to the Red Planet by 2024 — if everything goes according to plan. Mars One's crew, which would take up permanent residence on Mars, is slated to launch by 2031. NASA is aiming for a similar mission by 2033.

Idea of having space settlements is being pursued more aggressively in the last decade due to following considerations:-

- Earth's resources are finite, are under tremendous stress and are likely to deplete considerably by 2050-60.
- Climate change, rising population and aspirations of people in the underdeveloped and developing nations.
- Spectre of nuclear holocaust and resultant decimation of life and its means of sustainment.
- Possibility of massive asteroids/comets impacts and damage to life due to solar flares and increased radiation due to fast depletion of the ozone layer.
- Drastic reduction of cost due to the entry of private sector in space exploration and availability of advanced technologies.
- Having other colonies in places with less gravitational pull would provide ideal launch pads and make travelling between planets much cheaper and convenient.

- Space settlement offer the hope of long-term species survival that remaining on Earth does not.
- The odds against human survival are likely to diversify and increase with likely threats from genetically engineered killer viruses, possible robot revolt, epidemics and other horrors as yet undreamt of.
- Critical strategic importance of space for national security, development, communications, meteorology, entertainment, earth observation, navigation, ISR and so on.
- People are realising that the Earth is not such a commodious place. When viewed from the perspective of deep time, it starts to look more like a death trap, bedevilled by regular mass extinctions.[8]

In view of the arguments listed above, the humanity must come to grips with the problem that it is currently limited to one planet. Space settlements offer the hope of long-term species survival.[9] Hence, the need to abandon the fiction of Earth as our eternal and unchanging perfect home and the consequent need for space settlements.

The first key step toward space settlement would be ensuring a gapless transition from the existing International Space Station to commercially owned and operated LEO space stations.[10] Next step would be the development of the resources of the Moon and nearby asteroids leading to the creation of a self-sustaining "Earth-Moon economy". Once we have established an "Asteroid-Earth-Moon" economy, it would make available resources found in the region for projects ranging from the construction of solar power satellites to fuelling future Mars missions.

The Motivation and Challenges

Since time immemorial, outer space has captured the imaginations of people across the globe.[11] As a result, when outer space became a strategic domain and within the reach of superpowers like the US and the Soviet Union, the idea to colonise space started taking shape. Since then, many manned and unmanned missions to outer space have been sent in order to search for a new home for the inhabitants of Earth. The objectives of these missions have been to:

- Look for conditions which could support life; and
- See if life forms are present anywhere apart from earth.

A lot has been done in the pursuance of these objectives and even a cursory look at the space programmes, organisations, technology, legal frame work, host of experiments conducted to study the impact of space environment, exploitation of resources and studies conducted to establish colonies in space, and so on are clear pointers to indicate that colonisation of space seems imminent.

For the new space race, this decade could well play out the way the late 1990s and early 2000s did for the Internet: as a time of uncertainty, ebullient creativity and, ultimately, economic reality.

A space station is central in pursuance of these objectives.[12] (*A space station is a spacecraft capable of supporting crew members and is designed to remain in space for an extended period of time and for other spacecraft to dock.)*

Space stations, essentially, are research platforms, used to study the effects of long-term space flight on the human body as well as to provide platforms for greater number and length of scientific studies with other available space vehicles.[13] Each crew member stays aboard the station for weeks or months, but rarely more than a year. The duration record for a single spaceflight is 437.7 days, set by Valeriy Polyakov aboard Mir from 1994 to 1995. Space stations have also been used for both military and civilian purposes.[14] The last military-use space station was Salyut 5, which was used by the Almaz programme of the erstwhile Soviet Union in 1976 and 1977.

As of 2018, one fully functioning space station is in Earth orbit: the International Space Station (ISS); operational and permanently inhabited. China, Russia, the US, as well as few private companies are all planning to establish other stations in the coming decades.

The enabling components being the heavy launch capabilities, sensors, monitoring the environment for sustenance of life forms, discovery and mining of precious minerals and their commercial exploitation; mechanisms for energy creation and its transfer to earth, research in growing of agriculture products, manufacturing processes in micro gravity conditions, defence and security; communication infrastructure and so on. Technology has to find answers to these and that is precisely what is being done. It is a high risk and challenging job requiring large finance, international co-operation and an appropriate legal frame work.

The risks of space colonisation were debated about 50 years ago when the United Nations realised that space weaponisation could prove extremely dangerous to global security.[15] This ultimately led to the signing of the Outer Space Treaty in 1967. Simply put, the treaty emphasises that colonisation of outer space could only happen through cooperation among states and thus eliminates chances of conflict among states which could have otherwise arisen. It is believed that the international laws on outer space, as of date, have many checks and balances to ensure the safety and security of Earth.

However, with private players becoming increasingly interested in spending money on space missions and space colonisation, things could take a dramatic turn. The Outer Space Treaty and the international laws on space talk about nation-states and how to keep them in check, but there is no mention of private players. Everyone thought only nation-states would have the wherewithal and intentions to invest such huge amounts in space exploration. With the proliferation of private players, which is only likely to increase, it is hard to say what twists and turns lie in the politics of space colonisation in future.

The space age was born out of a race between governments, starting with the Sputnik moment.[16] What we are seeing in the last 5 to 10 years is this fomented competition between companies, and sometimes between governments and companies. With the involvement of private players, the world would see an accelerated change in the science, technology and politics of space exploration.

In the US today, several companies are looking very specifically at human spaceflight. The three that are perhaps furthest down the road are SpaceX, Blue Origin and Virgin Galactic. The main goals of all three companies are to reduce the cost of access to space – mainly through reuse of launchers and spacecraft and making space accessible to people who are not specially trained astronauts. One thing these companies have in common is the private passion of their chief executives. Branson of Virgin Atlantic has announced recently that he may be going to space by July this year. Space tourism, cheaper source of energy and asteroid mining for rare metals may act as catalysts for space colonisation.

Russia, on the other hand, pursued the goal of human spaceflight, with its incredibly successful Mir orbiting space station and its programme of flights to transfer cosmonauts and cargo backwards and forwards to Mir.[17]

There has been widespread speculation that the entry of China into the field was sufficient to introduce a fresh impetuous to the US space programme. China has a well-developed space programme and is currently working towards having a space station in orbit around the Earth by about 2020. A prototype, Tiangong-2, has been in space for almost a year, and was occupied by two astronauts (or "taikonauts") for a month.

A typical space station may weigh up to ten thousand tons making heavy launch capabilities as critical and essential requirements. Add to this the pay load for transportation of human beings and associated logistics and station house keeping. There has been a quantum improvement in the design and availability of heavy launch rockets particularly due to the entry of private companies.[18] In just over 15 years, SpaceX of Musk has muscled its way into spaceflight, a realm long dominated by space agencies like NASA and their main contractors, Lockheed Martin and Boeing. Blue origin, a company owned by Jeff Bizos of Amazon, Virgin Atlantic of Richard Branson and a slew of other entrepreneurs have followed with lighter-lift rockets.

Both SpaceX and Blue Origin are at work on rockets fit for human travel, on very different tracks. Bezos's company is working on its "New Glenn" rocket, larger than its current reusable New Shepard rocket, which is smaller than the Falcon 9 vehicles that SpaceX has turned into reliable shuttles for NASA cargo. Musk has set his eyes on a device even bigger than the Falcon Heavy: a rocket SpaceX calls the BFR (Big Falcon Rocket), which would take humans deep into space.

NASA is working on its own super rocket, called the SLS, which would be the most powerful ever designed, and is likely tool for a new space station or deep-space exploration. SpaceX and Blue Origin have made reusable rockets a reliable business for NASA and telecom companies, and are advertising at a fraction of the price of government rockets. SpaceX's Falcon 9 rockets operate at an average cost of about $60m per flight, and Falcon Heavy at a cost of $90m to $160m, depending on modifications. NASA estimates that its SLS would cost about $1bn or more per flight – the price of reliability and safety over reusability. EU is designing Orion, a heavy lift launch vehicle to replace space shuttle de-commissioned in 2011.[19] China, Russia, India and Japan are also involved in the design and manufacturing of heavy lift rockets.

Energy from Space

China, Russia, the US, Japan and the EU are all striving to make technological breakthroughs on space energy application.[20] Whoever obtains the technology first could occupy the future energy market. So it is of great strategic significance. Construction of a space solar power station would be a milestone for human utilisation of space resources. And it would promote technological progress in the fields of energy, electricity, materials and aerospace. United States and Japan have studied a space solar power station. Japan is leading in the development of wireless power transmission technology. The US and Russia have explored man-made moon, hoping it could bring convenience to night-time activities. In the 1990s, Russia carried out an experiment called Banner, testing the idea of using a mirror to reflect the sunlight to Earth. The mirror failed to unfold in space and the experiment was halted.[21] China is preparing to launch three artificial moons in space in 2022. Verification of launch, orbit injection, unfolding, illumination, adjust and control of the man-made moon would be completed by 2020. Additionally, China plans to complete the construction of "Artificial Sun" by end of 2019 and achieving an ion temperature of 100million degrees centigrade, which is one of the three challenges to reach the goal of harnessing the nuclear fusion. The other two challenges are containing the fusion within limited space in the long term and providing a high density profile. (*TOI March 5, 2019*)

Resources from Space: Potential and Legal Position

All told, there are over 1600 asteroids in Near-Earth space.[22] According to informed estimates, these contain a total of 2 trillion metric tons of water, which could be used for the sake of life support and manufacturing fuel for space missions. By tapping this abundant off-world resource, the associated costs of mounting missions to space can be reduced by 95%.

Much like SpaceX's ongoing development of reusable rockets and attempts to create reusable space planes (such as the Dream Chaser and the Sabre Engine), the goal here is to make space exploration not only affordable, but also lucrative.[23] Once that is achieved, the size and shape of space exploration would be limited only by our imaginations.

The resources of our solar system are almost unimaginably vast.[24] To get some idea of their magnitude, consider that just one of the thousands of catalogued Near Earth Asteroids (NEAs), 3354 Amun, is made of iron, nickel, cobalt and platinum-group metals with an estimated value of

$20 trillion dollars – about twice the Gross National Product of the United States! Another asteroid, "Davida", evaluated by a leading company, Planet Resources, is said to be worth $100 trillion or more. What we need to guard against is, the fact that while the leading space fairing nations have brought back hundreds of pounds of rocks from the Moon without litigation or objection, human nature dictates that there would be a greater fight in grabbing the resources which amount to hundreds of trillions of dollars.

Up to now, no agreements are in place for rich resources that may exist in space.[25] The Outer Space Treaty and the Moon Agreement allow private property rights for outer space natural resources once removed from the surface, subsurface or subsoil of the Moon and other celestial bodies in outer space. Thus, international space law is capable of managing newly emerging space mining activities, private space transportation, commercial space ports and commercial space stations/habitats/settlements. However, the current treaties which govern space exploration forbid governments from appropriating territories in space.

Exploring Asteroids: Resources and Mining

Asteroid mining is seen as a potential solution for resource depletion on Earth.[26] Over the next decade, demand for nickel and cobalt is projected to spike and outpace available supply as the production of electric-vehicle batteries, which use those metals, surges.

Osiris-Rex, a US National Aeronautics and Space Administration spacecraft, is on its way to a near-Earth asteroid to check out whether it would be viable for extracting water and minerals. It is expected to reach the asteroid, Bennu, in December, 2019, becoming the first US mission to retrieve a sample of an asteroid and return it to Earth.[27] Hayabusa 2, a satellite of Japan Aerospace Exploration Agency (JAXA) recently released a pair of robot rovers on an asteroid for survey in the world's first moving, robotic observation of an asteroid. Hayabusa2 will deploy an "impactor" next month that will explode above the asteroid, shooting a 2kg copper object to blast a small crater into the surface. From this crater, the probe will collect "fresh" materials unexposed to millennia of wind and radiation, hoping for answers to some fundamental questions about life and the universe, including whether elements from space helped give rise to life on Earth.

Given the numerous initiatives devoted to exploration and colonisation in both the public and private sectors, we assume that colonisation of

Moon/Mars will eventually occur, through either or both corporate and government efforts.[28] Economic motivations for developing the resources of space are growing, but humanity's spirit of adventure also cannot be discounted as a significant motivation for colonisation.

Defence and Security

Space assets are critical for the economic development and security of a nation. A recent trend, particularly amongst developed nations, is the possible weaponisation of space. Consequently, there is a drive for developing/acquiring anti-satellite weapons and corresponding organisation like the space command or a space agency chartered with the responsibility to protect these resources and prepare for combat in, through and from space. There has been a recent call for raising of a "space force". These are pointers that nations may go to war over the resources in space and bat for sovereignty of space colonies/settlements which seems imminent. International community will have to work together to formulate necessary resolutions and associated legal measures to stop this trend and reverse the same, if possible.

The Future of Space Colonisation – Terraforming or Space Habitats?

One of the best examples of man's quest to tame the unknown is the growing interest in space habitats.[29] The double-digit growth in the global space habitat market is testimony to how the human race is gearing towards changing its residential address– from planet Earth to outer Space.

Elon Musk, the founder of SpaceX and Tesla, has released new details of his vision to colonise parts of the solar system, including Mars, Jupiter's moon Europa and Saturn's moon Enceladus.[30] His plans – designed to make humans a multi-planetary species in case civilisation collapses – include launching flights to Mars as early as 2023. His paper proposes several interesting ways of trying to get to Mars and beyond – and he aims to build a "self-sustaining city" on the red planet. His idea of terraforming wherein humans could move around freely like on earth is an enormous challenge. Many experts have expressed reservation for its success. Another model of Bio-sphere seems to be gaining acceptance. Number of companies are working since 2014 on this approach for creating space habitats both for near earth orbits and deep space. Space biospheres, like the settlement in Antarctica, could also be accomplished within a reasonable timeframe – i.e. between 2030 and 2050 – which is simply not possible with terraforming.

Building colonies in space would require access to water, food, space, people, construction materials, energy, transportation, communications, life support, simulated gravity, radiation protection and capital investment.[31] The habitat would need pressurised environment for working and living space and be able to withstand the vagaries of nature by way of radiation, solar flares, extremes of temperature, micro-gravity, potential impacts from space debris, meteoroids, dust, etc.

India's Quest for Space Exploration

India's quest for space has been pioneered by the Indian Space Research Organisation (ISRO) set up in 1969 and today has an annual budget of about $ 1.4 billion.[32] The country has a constellation of 44 satellites in orbit and can launch up to four tons of communication satellites into geo-synchrous orbit. This gives India end-to-end capabilities in space technology from making its own satellites to launching its own rockets. India has even sent an Indian-made satellite Mangalyaan or the Mars Orbiter Mission all the way to the Mars travelling a distance of over 200 million kilometres; the country's first mission to Mars. It hit bull's eye when on September 24, 2014, Mangalyaan entered the orbit of Mars. India created global history by becoming the first country to reach the orbit of Mars on its maiden attempt, a fact that eluded global giants like USA and Russia. Made for a nominal mission life of 180 days, the Mangalyaan completed 1,000 days in orbit this year and continues to beam back data. Some of its images like those of the full disc of Mars are so good that they featured on the cover of the venerated National Geographic magazine. Early next year, India plans to hoist its second mission to the Moon, Chandrayaa-2, which would include hoisting its flag on the lunar surface on an indigenous rover.[33] Inter-planetary exploration missions are also planned for Venus and a re-visit to Mars is also on India's radar.[34]

India's space programme wants to go where no nation has gone before — to the south side of the moon. And once it gets there, it would study the potential for mining a source of waste-free nuclear energy that could be worth trillions of dollars. The Indian Space Research Organisation (ISRO) will launch a rover in October to explore virgin territory on the lunar surface and analyse crust samples for signs of water and Helium-3. The isotope, Helium-3, is limited on Earth. However, it is abundant on the Moon and theoretically it could meet global energy demands for 250 years if harnessed. The mission would solidify India's place among the fleet of explorers racing to the Moon, Mars, and beyond for scientific, commercial or military gains.

"*The countries which have the capacity to bring that resource from the moon to Earth will dictate the process, I don't want to be just a part of them, I want to lead them,'' K. Sivan, chairman of the Indian Space Research Organisation*.

More importantly, our first-ever manned space mission, Gaganyaan, in which a three-member crew will spend seven days in space in the LEO, is expected to lift off by 2022. There are talks of sending an Indian astronaut to the ISS for a short training mission in 2022. The governments of the US, China, India, Japan and Russia are competing with start-ups and billionaires Elon Musk, Jeff Bezos and Richard Branson to launch satellites, robotic landers, astronauts and tourists into the cosmos.

In the vastness of space, what makes us unique is our desire to know more about the universe we inhabit. So, our quest to reach the farthest corners of the cosmos should not stop. The fields of interplanetary travel, space colonisation and deep-space voyages have so much to offer. We could only improve and pick up the pace of space exploration.

Given the numerous initiatives devoted to space exploration and colonisation in both the public and private sectors, it is very likely that colonisation of Mars would eventually occur sooner than later, through either or both corporate and government efforts. Concurrently, some others may choose to developing settlements in the LEO. With the involvement of private sector and availability of enabling technologies, coupled with the sense of adventure and economic motivation, the pace is going to increase, but the size and shape of humanity's future in space is difficult to predict. Emphasis would be on space tourism, asteroid mining, development and transmission of energy, creation of habitats congenial for human stay, increased investment in R&D and innovation; establishing outposts on planetary bodies, with the goal of turning them into "new Earths". Between them, we can expect that humans will begin developing a degree of "space expertise" which will certainly come in handy when we start pushing the boundaries of exploration and colonisation even further.

India, with its well-developed space programme, must claim her rightful place and plan for space exploration, space station and establishing a habitat by involvement of the private sector and co-operation with like-minded nations like Japan and Israel. She must play a significant role internationally against weaponisation of space, ensuring that space does not become a battlefield, in developing a pragmatic model for sovereignty and re-visiting the

"World Space Vision 2050",[35] suggested by Dr APJ Abdul Kalam with its three components:-

- Space exploration and current application missions;
- Comprehensive space security and large-scale societal mission and
- Low cost access to space.

The goal should be utilisation of space technology to improve the quality of life and the concept should be "space for people".

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