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ABOUT US

WHITE BLACK LEGAL is an open access, peer-reviewed and refereed journal provided dedicated to express views on topical legal issues, thereby generating a cross current of ideas on emerging matters. This platform shall also ignite the initiative and desire of young law students to contribute in the field of law. The erudite response of legal luminaries shall be solicited to enable readers to explore challenges that lie before law makers, lawyers and the society at large, in the event of the ever changing social, economic and technological scenario.

With this thought, we hereby present to you

COSMIC KARMA: ROLE OF INDIAN COMPANIES IN SPACE DEBRIS AND TRAFFIC MANAGEMENT

AUTHORED BY - MUDIT VATS

In the vast, silent rung of space, every action carries a weight of consequence- a cosmic cause and effect that echoes the ancient Indian philosophy of karma. As humanity pushes the boundaries of disquisition, we leave behind a trail of discarded satellites, rocket fractions, and space junk, threatening the veritably unborn we seek among the stars. But where there is imbalance, there is also occasion for restoration. The concept of karma is inevitable, and managing space debris is a pivotal step towards guarding the sanctity of space and exploratory routeways (orbits).

Indian companies are not just participants in the space race; they are the stewards of a new cosmic order, where every satellite launch, every orbital manoeuvre, is guided by a responsibility to the macrocosm. From crafting innovative technologies to clear the cluttered orbits to developing sophisticated traffic management systems that ensure harmony among elysian bodies, these pioneers are balancing the scales of space debris and traffic with a karmic sense of duty. The Indian Space Industry is a remarkable integration of spirituality and technology. There have been multitudinous cases where the ISRO chief and his team visit temples and places of worship before the successful launch of satellites and other space objects. This blog delves into how India is applying the ancient principles of karma and science to modern-day space exploration, ensuring that our steps forward in the cosmos are mindful, sustainable, and in harmony with the universe.

The growing congestion in space, with thousands of satellites sharing orbits with defunct machines and fragments of past missions, presents a challenge that calls for both technological innovation and ethical responsibility. Indian companies are stepping up to ensure that our actions in space today do not create insurmountable obstacles for tomorrow.

The Rising Challenge of Space Debris

The growing presence of space debris is becoming a significant threat to the safety of satellites, space stations, and upcoming space missions. In the past sixty-seven years, human activities have led to a substantial increase in outer space pollution. Initially, it was believed that inactive satellites would disintegrate upon re-entering Earth's atmosphere. However India, a nation experiencing a burgeoning space industry, is familiar with these obstacles. The Indian Space Research Organisation (ISRO) has been a pioneer in space exploration and satellite launches for many years, playing a key role in both national pride and global scientific progress. However, India is committed to the task of preserving a clean and sustainable space environment, viewing it as a crucial duty based on the principle that space, like Earth, deserves to be treated with reverence and consideration.

The Spiritual-Scientific Synergy in Indian Space Missions

The Indian space sector uniquely combines spirituality and technology, where traditional knowledge often intersects with contemporary science. It is customary for ISRO leaders and their teams to visit temples and other sacred sites before major satellite launches to seek blessings for their missions. This practice reflects a strong belief in karma - the notion that every action leads to a result, suggesting that success in space relies on both technological skill and spiritual harmony.

This spiritual perspective also influences how Indian firms are addressing the challenges of space debris and traffic management. The idea of cosmic karma – ensuring our actions in space do not inflict damage – shapes many of the innovative solutions being crafted in India today.

Notable Space Debris Incidents and Accidents

The problem of space debris is not just a theoretical concern but has resulted in actual incidents and accidents. According to NASA, an average of one catalogued piece of debris has fallen back to Earth each day for the past 50 years, highlighting the critical need for better management of space debris. Below are some key events that have influenced our awareness of the dangers

associated with space debris: -¹

- In 1969, five sailors aboard a Japanese ship were hurt after space debris from a suspected soviet spacecraft hit the ship's deck.
- In 1978, the Soviet reconnaissance satellite Kosmos 954 re-entered the Earth's atmosphere above northwest Canada, spreading radioactive fragments across northern Canada, with some falling into the Great Slave Lake.
- By 1979, parts of Skylab fell over Australia, with some pieces landing in the vicinity of the Shire of Esperance. As a result, NASA was fined \$400 for littering by the local authorities.
- In 2002, a 6-year-old named Wu Jie was the first person to be hurt by space debris hitting him directly. He got a fractured toe and a swollen forehead when a large piece of aluminium from the outer shell of the Resource Second satellite hit him while he was sitting under a persimmon tree in China's Shaanxi province.
- In 2016, on November 2nd, the upper stage of Vega flight VV01, which had been launched on February 13, 2012, re-entered the atmosphere above the Indian state of Tamil Nadu. During the re-entry, a composite overwrapped pressure vessel managed to survive and was successfully retrieved.
- In 2024, a sizable piece of space debris with scorched marks was discovered on a Canadian farm. This 45-kilogram fragment, composed of carbon fibre and honeycomb structures, is believed to be part of the Axiom 3 Dragon spacecraft that re-entered the atmosphere over that region in February. The find has sparked speculation about the origins and fate of this intriguing celestial remnant.

These incidents illustrate that space debris poses a real threat to current and future space missions, as these incidents have demonstrated. It's a serious issue that demands our attention and action to ensure the safety of our space endeavours.

Innovations in Space Debris Removal: Global and Indian Efforts

The growing concern regarding space debris has prompted a range of innovative solutions and initiatives globally, with notable contributions from Indian organizations. These endeavours focus on promoting the safe and sustainable utilization of outer space. Below are some of the prominent

¹ space debris falls' (Wikipedia) <https://en.wikipedia.org/wiki/List_of_space_debris_fall_incidents>

innovations in the field of space debris removal.

Global Innovations:

- The ADRAS-J satellite, created by Astroscale, represents a significant advancement in the effort to eliminate space debris. This innovative satellite has effectively approached and captured images of a substantial piece of orbital waste surrounding Earth, demonstrating its proficiency in tracking and managing debris.
- The Active Debris Removal Vehicle (ADRV), engineered by NASA, is an advanced spacecraft that incorporates leading-edge control systems for executing precise manoeuvres aimed at capturing and removing substantial orbital debris. Its capture and release system significantly enhances automated rendezvous and docking abilities, thus promoting safe and efficient operations for debris removal.

Indian Innovations:

- The ISRO System for Safe and Sustainable Operations Management (IS40M), which was launched in 2022, reflects ISRO's comprehensive strategy aimed at securing space assets and fostering the sustainable use of outer space for national development purposes. This system plays a crucial role in monitoring objects that may threaten to collide with Indian satellites, thus enhancing the overall safety of space operations.
- Project Netra, initiated by the Indian Space Research Organisation (ISRO), serves as an advanced early warning system designed to identify space debris and various potential hazards to Indian satellites. This system possesses the ability to detect, monitor, and catalogue objects as diminutive as 10 centimetres, extending its operational range to 3,400 kilometres, thereby significantly contributing to India's overall space situational awareness.
- In the year 2022, ISRO executed 21 maneuvers aimed at avoiding potential collisions for its operational space assets. These maneuvers play a vital role in safeguarding against impacts with other celestial objects, thereby enhancing the safety and sustainability of India's space endeavors.
- The ISRO Space Situational Awareness (SSA) control centre, inaugurated in 2020, functions as the primary centre for all activities related to space situational awareness in

India. This facility plays a vital role in orchestrating initiatives aimed at ensuring safe and sustainable operations in outer space, underscoring ISRO's dedication to addressing the challenges posed by space debris.

The innovations emerging both globally and within India underscore the necessity of a collaborative and multifaceted strategy to tackle the escalating problem of space debris, thereby safeguarding space as a secure and accessible environment for future exploration and advancement.

Space Traffic Management

“Public and private space operators all agree on one thing: ‘satellite collisions are bad for business, and bad for space’.”²

And thus, due to the increasing competition in the global sphere and a fight for becoming a space superpower, there are numerous space exploration programs that are being executed, resulting in the issue of Space Traffic Management.

Currently, there are over 4,800 active satellites orbiting Earth, with representation from more than 40 countries. By 2030, nearly 25,000 additional satellites are expected to join them. Furthermore, space exploration is pushing new boundaries: ambitious space companies are launching space tourism initiatives and sending humans into space within the next while governments and military organizations are intensifying their activities in cislunar space—the area within the Earth-Moon radius—to take advantage of strategic orbital zones. As humans are expanding their frontiers in different arenas, the galaxy brings them the opportunity to establish the nation a global space power. While sustainable growth in this sector is beneficial, the development of hostile capabilities poses a risk to free and open access to space. A recent example occurred in November 2021, when a Russian anti-satellite (ASAT) test created over 1,500 fragments of debris.

The Ecosystem of STM:

The ecosystem of Space Traffic Management (STM) is becoming increasingly vital as more nations and private entities enter the space domain. With the growing number of satellite owners

² Space Traffic Management: Time for Action, www.atlanticcouncil.org/wp-content/uploads/2022/08/Space-traffic-management_time-for-action.pdf. Accessed 23 Aug. 2024.

and operators, the need for enhanced coordination and governance in space has become critical. Currently, there is no standardized system to regulate on-orbit behaviours across different operators, except for spectrum management, which the ITU handles. Each private entity—ranging from universities and research institutes to non-profits and commercial companies—is regulated by the licensing nation, leading to potentially diverse practices in space. This challenge could intensify as more nations launch government satellites and license private entities, further complicating the space environment.

In order to control space trash, avoid accidents, and guarantee safe operations, effective STM requires the establishment of international norms and cooperation. For example, the United States' role in leading global air traffic control standards provides a model for space, where frameworks like the U.S. Space Surveillance Network and global initiatives such as the Combined Space Operations Centre (CSpOC) work to monitor and coordinate space traffic. While unilateral efforts can establish a powerful global benchmark, addressing a worldwide challenge like Space Traffic Management (STM) necessitates multilateral dialogue. Achieving effective global Space Situational Awareness (SSA) is a crucial first step in developing any comprehensive STM framework.

The Collision Conundrum: Tackling Space Traffic in an Era of Rapid Expansion:

The likelihood of space collisions is expected to rise due to the increasing number of objects in low Earth orbit (LEO) and geostationary orbit (GEO), coupled with limited tracking capabilities. The situation may worsen if proposed small satellite constellations are launched, significantly increasing the number of objects requiring tracking and complicating space situational awareness (SSA) and collision avoidance. Industry experts highlight the need for more precise tracking to mitigate collision risks, especially with the deployment of multiple small satellites. Satellite owners and operators feel they need higher-quality information to make informed manoeuvring decisions. However, they often lack confidence in acting on U.S.-provided collision warnings because the process for calculating these warnings is unclear, with many referring to it as "black box processing." This scepticism is heightened by the nonstandard and nontransparent calculation methods. Additionally, some users view the U.S. Department of Defence (DoD) systems as outdated for the evolving space environment and believe the DoD is overworked and understaffed,

leading to further dissatisfaction. Russia has been promoting the idea of a global strategy for space traffic management (STM). This mechanism, to be operated by the United Nations Office of Outer Space Affairs, would aim to support global space traffic management initiatives.

Steering Through the Cosmos: India's Command in Space Traffic Management:

India has established itself as a prominent entity in the domain of space traffic management, largely due to the initiatives undertaken by the Indian Space Research Organisation (ISRO). Since the inception of its space program, India has successfully launched a total of 127 satellites, which encompass contributions from private sector entities and academic institutions. As of December 31, 2023, 51 of these satellites are actively functioning in low Earth orbit (LEO) and geosynchronous Earth orbit (GEO). Additionally, by the close of 2023, three deep space missions were operational: the Chandrayaan-3 Propulsion Module, Aditya-L1, and the Chandrayaan-2 Orbiter. The increasing congestion in outer space has led to a rise in collision avoidance manoeuvres (CAMs) for ISRO's Earth-orbiting satellites, a trend indicative of the growing challenges in space traffic management. In the recent developments, the dichotomy of public-private role also comes into consideration.

In 2023, ISRO conducted seven successful launches, placing a total of 5 Indian satellites, 46 foreign satellites, and 8 rocket bodies into orbit. Notably, the Chandrayaan-3 and Aditya-L1 missions faced no close encounters with other space objects during their respective phases. ISRO's commitment to the long-term sustainability (LTS) of outer space activities is reflected in its operational ISRO System for Safe and Sustainable Operations Management (IS4OM) since 2022, which safeguards India's space assets and ensures compliance with international guidelines.

India plays a crucial role in international space debris management forums, actively participating in organizations like the Inter-Agency Debris Coordination Committee (IADC), International Academy of Astronautics (IAA), International Astronautical Federation (IAF), International Organization for Standardization (ISO), and the UN Committee on the Peaceful Uses of Outer Space (UN-COPUOS). As a signatory to all major space treaties and the current chair of the UN working group on the Long-term Sustainability of Outer Space Activities, India underscores its commitment to space traffic management. ISRO's leadership in this field is further highlighted by

its chairmanship of the IADC for 2023-24, during which it will host the 42nd annual IADC meeting in April 2024.

Conclusion: Enhancing Space Traffic Coordination for Safer Orbits

India's ascendant role in the worldwide space domain is characterized by a focus on technological enhancement, ethical responsibility, and a strong appreciation for the cosmic environment. The guiding principle of karma underscores the notion that every action in space – spanning satellite launches to orbital manoeuvres – has significant and lasting repercussions. What is urgently needed is a stronger emphasis on **Space Traffic Coordination (STC)**. This approach, as evidenced by successful collaborations between operators in avoiding potential collisions, is crucial for maintaining the safety and sustainability of space activities.

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