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INTELLECTUAL PROPERTY RIGHTS IN THE COMMERCIALIZATION OF SPACE ACTIVITIES IN INDIA: LEGAL CHALLENGES, REGULATORY GAPS AND FUTURE DIRECTIONS

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Abstract

The transition of the global space sector into the market-driven "NewSpace" era has triggered unprecedented private-sector participation, exemplified by India's expansion to approximately 440 registered space-tech start-ups, backed by USD 618.5 million in private equity. However, contemporary legal scholarship reveals an enduring institutional friction: the systemic mismatch between the strict territoriality of municipal Intellectual Property Rights (IPR) regimes and the borderless, non-appropriable domain of outer space under Article II of the *Outer Space Treaty 1967*. This review paper synthesizes existing international legal literature, statutory frameworks, and municipal policy gaps, with a specific focus on the Indian commercial space landscape. A critical evaluation of current scholarship reveals that despite the structural liberalization introduced by the *Indian Space Policy 2023*, a significant regulatory lag persists. While private entities account for over 80% of new domestic space entrants, they hold less than 5% of active space patents (IPC: B64G), leaving them structurally vulnerable to orbital and cross-border patent infringement loops and downstream "data laundering". Furthermore, this paper identifies critical analytical blind spots in contemporary literature, particularly the lack of *sui generis* database frameworks for machine-learning outputs derived from raw satellite telemetry and unresolved IP allocation models in state-to-private technology transfers. Review concludes with a call for targeted legislative action, specifically the introduction of a dedicated extraterritorial patent extension (Section 157B) within India's domestic statutes, to de-risk private deep-tech capital and secure the nation's position as a legally stable global space hub.

Keywords: Space Law Jurisprudence**,** NewSpace Commercialization**,** Extraterritorial IP Enforcement**,** Outer Space Treaty (OST) 1967**,** Indian Patents Act, 1970.

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1. Introduction

1.1 The Theoretical Clash

The expanding body of legal literature tracking the globalization of outer space activities identifies a core institutional conflict: the structural incompatibility between the international space law regime and municipal Intellectual Property Rights (IPR) frameworks. This theoretical clash centers on a direct jurisdictional contradiction between the principles of non-appropriation and territorial sovereignty. The foundation of public international space law, codified under Article II of the Outer Space Treaty (OST) 1967, establishes that outer space is a global commons: *"Outer space, including the moon and other celestial bodies, is not subject to national appropriation by claim of sovereignty, by means of use or occupation, or by any other means."* [1]. Conversely, as synthesized by downstream scholars, international IP frameworks, most notably the TRIPS Agreement and the Paris Convention, are fundamentally rooted in state sovereignty and strict geographic territoriality. Patent protection exists only within the boundaries of the granting state, granting the patent holder exclusive rights to prevent unauthorized use or manufacture within that specific geographic territory. Legal scholars argue that this creates an immediate paradox when applied to commercial space operations. If an innovation operates in an environment that is legally immune to sovereign claims, national courts lack a clear basis to assert civil jurisdiction over patent or copyright infringements occurring in orbit.

1.2 The Evolution of NewSpace Literature

Historically, space law literature focused almost exclusively on state-centric, public international interactions. Early legal analysis treated space technology as a highly protected, government-funded domain dedicated to scientific exploration, where cross-border technology transfers were tightly controlled by export regimes. Intellectual property issues were rarely discussed, as state space agencies such as NASA and ISRO prioritized public-domain science over commercial monopolies. However, over the last two decades, legal scholarship has shifted toward analyzing "NewSpace," a market-driven paradigm led by private companies, risk capital, and commercial satellite constellations. Academic discussion has moved from debating state liabilities under the *Liability Convention 1972* to exploring how private legal mechanics, such as venture capital financing, joint ventures, and patent enforcement, function in space. Recent literature highlights that private capital requires clear asset protection to offset the high risks of deep-tech development. Scholars note that when a space program transitions from a state-run utility to a private commercial market under contemporary policies like the Indian

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Space Policy 2023, intellectual property shifts from an afterthought to a core asset that directly drives corporate valuation and investment.

2. The International Legal Matrix: A Synthesis of the Literature

2.1 The Quasi-Territorial Fiction

In analyzing the cross-border extension of private domestic laws into outer space, mainstream legal literature centers heavily on the concept of "quasi-territoriality" [2]. Because Article II of the *Outer Space Treaty (OST) 1967* bars any nation from claiming territorial sovereignty over space coordinates, a sovereign state cannot directly project its domestic laws into orbit based on geographical boundaries [1, 3]. To prevent a complete legal vacuum, international space law relies on a specialized mechanism set out in Article VIII of the OST, which provides that the State of Registry retains *"jurisdiction and control"* over launched objects and personnel.

As documented by space law scholars such as Frans G. von der Dunk, this provision establishes an extension of domestic jurisdiction based on registry rather than on physical territory. This approach is closely mirrored in Article II of the Registration Convention 1975, which links a launched object back to a specific national database. However, academic critiques highlight a significant vulnerability in this setup. Analysts like Anna Maria Balsano note that while Article VIII grants administrative, political, and criminal jurisdiction, it does not automatically extend municipal private laws such as civil patent enforcement, copyrights, or trade secrets unless the state implements explicit domestic laws to do so. Consequently, the legal literature treats Article VIII as an incomplete framework that requires additional national legislation to protect commercial intellectual property effectively in orbit.

2.2 The "Flags of Convenience" Dilemma

A major focus in the intellectual property and space law literature is the risk of "Flags of Convenience" a problem in which private companies choose where to register their spacecraft to take advantage of more lenient regulatory environments. This issue stems directly from gaps in national patent laws [3]. Because international intellectual property treaties, such as the *TRIPS Agreement*, do not include coordinates beyond Earth's atmosphere, patent protections remain fragmented along national lines. If a technology is used or replicated on a vehicle registered in a nation without strict space-patent laws, it creates a significant legal challenge for the original inventor [4].

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Table 1: Academic Consensus on Regulatory Arbitrage & Forum Shopping

Conceptual Risk Area	Legal Mechanics & Triggers	Academic Consensus & Literature Trend	Core Legal Vulnerability
Jurisdictional Forum Shopping	Registering a spacecraft in a nation without space-specific IP laws.	Private companies can bypass international patent enforcement by shifting launch registries.	National patent protections end at Earth's atmosphere.
The Translaunch Loophole	Manufacturing a component in country A, assembling it in country B, and launching it via country C.	Multi-national manufacturing lines can obscure where a patent infringement actually occurred.	Standard patent laws protect only against local manufacturing.
The Orbital Copying Risk	Replicating patented software or hardware designs aboard a multi-national orbital station.	Complex joint-venture agreements often cloud who owns or is liable for IP modifications in space.	Cross-border enforcement remains weak in multi-national space projects.

Scholars like Michael Gerhard emphasize that this regulatory fragmentation creates an uneven playing field, placing commercial entities in nations without space-specific IP extensions such as India at a distinct disadvantage. While a Western aerospace firm can protect its innovations under advanced domestic laws such as the US Space Patents Act, an Indian startup risks regulatory arbitrage [5, 8]. This lack of uniform international protection highlights the urgent need for developing space nations to implement targeted municipal reforms to safeguard their domestic deep-tech ecosystems.

3. The Indian Municipal Scenario: Critical Analysis of Current Scholarship

3.1 The Indian Patents Act, 1970 Limitations

Domestic legal scholarship on India's deep-tech ecosystem has identified severe statutory limitations in the Indian Patents Act, 1970, regarding its extraterritorial and orbital application [2, 5]. Academic critiques point out that the Act was fundamentally designed for an earthbound, industrial economy. Section 1(2) explicitly limits the Act's statutory jurisdiction to the physical territory of India [16]. Under Section 48 of the Act, a patentee receives the exclusive right to

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prevent third parties from making, using, offering for sale, or selling the patented product *within India*. Legal scholars argue that this creates a major enforcement gap for space technology:

- If an unauthorized third party duplicates a patented component and operates it aboard an orbital vehicle, the patent holder cannot easily prove a domestic violation under Section 48.
- If an infringing payload component is integrated outside India's land or territorial waters, local courts lack the jurisdiction to issue preventive injunctions.
- Scholars note that tracking when and where a patent is legally "exhausted" becomes highly complex in multi-national space supply chains.

This means that while the Indian Patent Office (IPAIR) processes aerospace patent classifications under IPC Code B64G (Cosmonautics), the resulting legal protections remain tied to Earth [6]. Consequently, local space start-ups face significant risks, as their patented designs can be used in orbit without clear legal consequences.

3.2 Evaluation of the Indian Space Policy 2023

The introduction of the Indian Space Policy 2023 has been widely analyzed in public and economic law literature [7]. Academic consensus praises the policy for ending ISRO's monopoly, creating a clear role for IN-SPACe as a single-window regulator, and encouraging private Non-Government Entities (NGEs) to enter the market [2]. However, intellectual property experts highlight a significant policy omission: while the 2023 Policy successfully unbundles commercial and regulatory operations, it completely lacks a binding statutory framework for IP ownership and enforcement.

Table 2: Academic Evaluation of the Indian Space Policy 2023

Policy Focus Area	Structural Reform Achieved	Academic Critique & Policy Omission
Private Market Authorization	Establishes IN-SPACe to approve and monitor private commercial space operations	Authorizations are administrative and do not clarify civil IP ownership boundaries
Public Asset Monetization	Empowers NSIL to handle technology transfers from ISRO to private firms	Relies on non-exclusive licensing, which can lower corporate valuations for venture capital

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Downstream Data Sharing	Encourages the commercial use of Earth Observation (EO) and remote sensing data	Lacks data protection rules, leaving processed satellite telemetry vulnerable to scraping

Scholars emphasize that this policy gap creates a contradiction. The government is encouraging private investment and executing over 71 technology transfers through NSIL, yet the legal system does not provide clear protections for the IP upgrades private firms build on top of those technologies. This dynamic leaves private space companies exposed to international competition and highlights the need to turn these administrative policy guidelines into comprehensive, binding space laws.

4. Comparative Global Frameworks: Key Lessons for India

4.1 The United States Model

International legal literature extensively cites the United States as the pioneer in resolving the conflict between territorial patent laws and outer space activities [8]. The US addressed this jurisdictional gap by enacting 35 U.S.C. § 105 (The Space Patents Act), which provides a clear statutory framework for extraterritorial IP protection [9]. This provision extends the definition of US territory directly to space objects by stating: *"Any invention made, used, or sold in outer space on a space object or component thereof under the jurisdiction or control of the United States... shall be considered to be made, used, or sold within the United States for the purposes of this title."* Scholars emphasize that this law leverages the "quasi-territoriality" framework of Article VIII of the *Outer Space Treaty 1967* to seamlessly connect space registries with civil patent enforcement [10, 19]. By declaring a US-registered spacecraft to be domestic territory under patent law, the US effectively protected its commercial entities from international regulatory arbitrage. Academic reviews show that this clear legal protection has been a major driver of de-risking private deep-tech capital, allowing American space startups to secure institutional financing with high confidence in the safety of their assets.

4.2 The European Intergovernmental Model

In contrast to the United States' unified federal approach, the European model offers a unique framework for managing multinational collaborations [11, 16]. Because the European Space Agency (ESA) operates as an intergovernmental body with multiple member states, it cannot rely on a single national law. Instead, Europe addresses intellectual property through international agreements, most notably the Intergovernmental Agreement (IGA) for the

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International Space Station (ISS).

Table 3: Comparative Matrix of Global Space-IP Frameworks

Regional Legal Model	Primary Statutory / Treaty Instrument	Jurisdictional Mechanism	Academic Assessment of Transferability to India
United States Model	35 U.S.C. § 105 (Space Patents Act)	Extends federal patent territory to any US-registered space object	Highly Transferable. India can adopt this model by amending the *Indian Patents Act, 1970*
European Model (ISS-IGA)	Article 21 of the ISS Intergovernmental Agreement	Maps patent jurisdiction to the specific national registry of each individual module	Moderately Transferable. Useful for India's future commercial orbital stations and global consortiums
Indian Model (Current)	*Indian Space Policy 2023* (Administrative only)	No statutory extension; enforcement is limited to physical earthbound territory	Current baseline requires urgent legislative upgrades to protect private space capital

Scholars frequently highlight Article 21 of the ISS-IGA, which creates a legal fiction where an invention made inside an orbital module is deemed to have occurred solely within the territory of the nation that registered that specific module [12, 18]. For instance, an invention developed inside a German-registered module is protected under German patent law. Legal literature notes that this approach effectively prevents cross-border infringement loops within complex, international space systems [17]. For India, as it begins developing its own space station (the *Bharatiya Antariksha Station*) and expanding joint ventures, these global models offer essential lessons for building a reliable, stable legal framework for private enterprise and international investors.

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5. Identified Research Gaps and Future Directions

5.1 The Downstream Analytics Blindspot

A critical review of contemporary legal literature reveals an asymmetric focus favoring upstream hardware manufacturing over downstream digital applications. While extensive analysis has been devoted to resolving orbital patent conflicts for physical infrastructure such as thrusters and 3D-printed engine components, a significant scholarly blind spot persists regarding the protection of Earth Observation (EO) data streams and geospatial analytics [13, 16]. As Indian NGEs increasingly deploy high-resolution hyperspectral satellite constellations, the legal nature of the data they transmit remains unaddressed in mainstream IP scholarship. Current literature fails to provide a cohesive framework for several emerging legal challenges:

- There is an acute lack of peer-reviewed analysis on whether feeding proprietary satellite imagery into autonomous machine-learning models to extract planetary insights constitutes a derivative infringement under traditional copyright laws.
- Existing IP commentary heavily debates the copyright ability of stitched satellite raster images, but completely ignores the vulnerability of raw digital telemetry data streams, which are often denied copyright protection due to a perceived lack of human creative authorship.
- Since India lacks a dedicated, standalone trade secrets statute, legal scholarship has not yet mapped how private space-tech firms can effectively protect their proprietary downstream predictive analytics from sophisticated corporate espionage.

5.2 Public Asset Privatization and the Modification Dilemma

Another unexamined area in current space law scholarship concerns the long-term legal status of commercial modifications built atop state-transferred technologies. The *Indian Space Policy 2023* and NSIL have aggressively driven commercialization by executing 71 technology transfer agreements to shift ISRO's institutional knowledge to the private sector [14]. However, intellectual property literature has largely ignored the complex legal issues that arise when a private startup significantly modifies or improves a public asset. Scholars have yet to formulate a balanced legal model that protects the public's investment in foundational space science while giving private innovators the explicit, long-term property rights they need to scale [15, 20]. Future research must move past broad policy descriptions and focus on developing concrete legal frameworks. Specifically, scholars need to design clear public-private co-ownership contracts and targeted data laws that can protect India's deep-tech sector as it enters an increasingly competitive global market.

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6. Conclusion

6.1 Synthesis of Conceptual Review

This critical review of the literature on space commercialization and intellectual property rights highlights a major disconnect between international space law and domestic IP frameworks. Academic literature confirms that the strict territorial limits of national laws such as the Indian Patents Act, 1970 cannot easily protect innovations in the borderless environment of outer space, which is governed by the non-appropriation principle of the Outer Space Treaty 1967. While international frameworks rely on "quasi-territoriality" via launch registries to track state jurisdiction, scholars note that this administrative connection does not automatically protect civil patent or copyright enforcement in orbit. In India, this legal gap is exacerbated by a major imbalance in innovation assets: the public sector holds 84.5% of active space-tech patents, while private start-ups hold less than 5%. Furthermore, while the Indian Space Policy 2023 successfully opened the market to private enterprise, it stopped short of establishing a binding statutory framework to protect the intellectual property these companies develop.

6.2 Future Scholarly and Policy Directions

To protect private deep-tech investments and help India's space economy reach its projected value of USD 40–45 billion, future legal research and policy must shift toward building concrete statutory frameworks. Legal scholars should draw on global models such as the US 35 U.S.C. § 105, which extends national patent law directly to a country's space registry. India can adapt this approach by adding a dedicated extraterritorial provision such as Section 157B to its domestic patent laws. Additionally, future research needs to address the growing blind spots in downstream digital analytics and satellite data protection. By moving away from rigid, non-exclusive public licensing and implementing clear public-private co-ownership models, India can create a more balanced legal ecosystem. This regulatory evolution is essential to de-risk commercial space operations, maintain investor confidence, and secure India's position as a leading global hub for space innovation.

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