PATENT GOVERNANCE IN OUTER SPACE: OWNERSHIP, ENFORCEMENT, AND LEGAL AMBIGUITIES

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ABSTRACT

The introduction of commercialization in the outer space has created a lot of legal confusion regarding regulation of intellectual property rights outside the earth. The international space law, specifically the Outer Space Treaty of 1967, has been conceived in the state-centred paradigm and offers very little guidance on the problems of patent ownership, jurisdiction, and enforcement in a field that is becoming more dominated by commercial entities, multinational cooperation, and AI-driven innovation. Although the Treaty prohibits the national claim of the outer space, it allows the states the assertion of jurisdiction over the registered objects and persons of space, thus creating the pseudo-terrestrial system having problems with the integration of cross-border and collaborative inventive action. The article reviews the failures of the current jurisdictional doctrines, such as functional control, the jurisdiction of the flags, and the modular sovereignty model of the use of space resources, further exploring how the soft-law instruments of Artemis Accords and national legislation on the use of space resources, unilateral systems, are contributing to the fragmentation of regulations and legal confusion. Specific much attention is paid to the obstacles posed by AI-based inventions and the absence of effective regulation tools when operating in a non-sovereign space. According to the article, the use of a territorial patent systems and a system of rights of the contract is insufficient to bring legal certainty in outer space. It suggests establishing a unified global system of space-related intellectual property, to be realised through increased coordination in the context of WIPO and UNCOPUOS, with additional support of specialised arbitration and international space patent index.

Keywords: Patent protection in Outer space, Outer Space Treaty, Global IP regime, Space Commercialisation, Harmonisation of National laws

INTRODUCTION

It has become one of the burning legal matters of the modern space era, the governance of intellectual property in outer space. This once confined domain of state actors governed by treaties of the Cold War era has now been an ecosystem comprised of private companies, multinational partnerships, technologies based on artificial intelligence, and long term business goals that stretch from the low Earth orbit up to the moon, Mars, and beyond. This shift has revealed underlying contradictions between traditional systems of territorial patent and the non-sovereign nature of the outer space in the international law.[1]

The original tools of the international space law especially the Outer Space Treaty of 1967 were written when no one could foresee or accommodate commercial innovation, a personal ownership and an international way of doing the businesses in space. Although the Treaty forbids a national seizing of outer space and, celestial bodies, it at the same time provides the jurisdiction and authority of the states concerning what is registered in space objects and personnel. As an approximation of maritime and aviation law, this quasi-territorial model has been operating in narrow scopes like the International Space Station, but is becoming a poor fit to the multinational, privately operated space settings[2].

With the increase in commercial activities into orbital manufacturing, utilisation of lunar resources and asteroid mining, legal ambiguity on patent ownership, law and enforcement has been heightened. Disjointed national policies, overlapping jurisdiction and lack of a central system of enforcement have posed a threat to innovation and investment. These are further complicated by the fact that AI-generated inventions have also appeared and put current definitions of inventorship and ownership to the test, as well as by the fact that the current systems of contractual governance cannot replace the open international law[3].

The paper is a critical discussion of the shortcomings of the current jurisdictional theories, such as the functional control and flag-state jurisdiction, as well as modern reactions such as the ISS regime, the Artemis Accords, and national space legislation. It suggests that the existing

[1] See Frans G. von der Dunk, *Space Law as a Branch of International Law*, in HANDBOOK OF SPACE LAW 1, 7–10 (Frans G. von der Dunk & Fabio Tronchetti eds., 2015).
[2] Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, Including the Moon and Other Celestial Bodies arts. II, VIII, Jan. 27, 1967, 18 U.S.T. 2410, 610 U.N.T.S. 205.
[3] See Ryan Abbott, *The Reasonable Robot: Artificial Intelligence and the Law* 109–15 (2020); see also *Thaler v. Comptroller-Gen. of Patents*, [2023] UKSC 49.

patchwork of territorial extensions, soft law tools and private ordering is inadequate in ensuring that there is legal certainty in space-based innovation. The article finally advocates the existence of a unified global system which is based on WIPO and UNCOPUOS systems, complemented by specialised arbitration, a worldwide space patent registration, to maintain patent system integrity and provide sustainable, equitable, and innovation-driven exploration off-Earth[4].

1. JURISDICTIONAL AMBIGUITIES IN OUTER SPACE

The recent controversies surrounding the outer space indicate a growing conflict between the historical laws of the earth and modern space operations. Although Article V of the Outer Space Treaty gives states rights and jurisdiction over objects that have been registered as space objects together with their crew membership, it can nullify when it pertains to multinational missions, joint ownerships, and AI-driven innovations. The traditional sources of jurisdiction such as nationality, flag-state principle, and functional control are not well-equipped to accommodate inventions that arise in international arenas of collaboration or unilaterally due to AI systems in space. The further decentralization of the state-centric legal system with the rising implications of the privatization and commercialization of orbital stations, lunar exploration, and the extraction of resources further undermines the further decentralization of the legal framework through the concept of contractual deals over the international one. Enforcement is even more challenging: courts and patent offices on Earth have no power outside of the planet, and it creates significant loopholes in terms of protection and justice. Without one coherent enforcement regime, cross-border cooperation and AI-generated innovation create significant uncertainty on the subject of patent ownership, law and efficient protection. These issues underscore the need to have a harmonised global system, redefined concept of inventiveness, certainty in rules of jurisdictions, and a specialised dispute-resolution systems in place to maintain outer space innovation[5].

[4] See International Space Station Intergovernmental Agreement art. 21, Jan. 29, 1998, T.I.A.S. No. 12927; Artemis Accords § 10 (2020); World Intellectual Property Organization, *WIPO Arbitration and Mediation Center Rules*.

[5] Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, Including the Moon and Other Celestial Bodies arts. I, II, VI, VIII, Jan. 27, 1967, 18 U.S.T. 2410, 610 U.N.T.S. 205; see also Frans G. von der Dunk, *International Space Law*, in HANDBOOK OF SPACE LAW 29, 55–62 (Frans G. von der Dunk & Fabio Tronchetti eds., 2015); Ryan Abbott, *The Reasonable Robot: Artificial Intelligence and the Law* 109–15 (2020).

Limits Of Extraterritorial Jurisdiction And Multi-State Conflicts In Space Innovation

The high rate of commercialisation and internationalisation of space operations has revealed the restriction of extension of the jurisdictional doctrine of the earth into space. Although the outer space regime Article VIII places the jurisdiction and control of its registered objects and personnel in space under the jurisdiction of the State of Registry, this quasi-territorialism strategy is weakly sustained in multinational missions, common platforms, and joint research facilities. The traditional foundations of jurisdiction, including nationality, principles of flag-states, or even functional dominance, were designed with an earth or sea in mind and are not very adaptable to inventions that are designed collaboratively on an international platform or autonomously under AI systems in orbit[6].

A very thinly-fitting solution is manifested through the International Space Station (ISS). According to the Intergovernmental Agreement (IGA) of 1998, each of the modules is considered to be the quasi-territory of the registering state, so that the national laws of patents could be applicable. The United States practiced this by 35 U.S.C. § 105 and other European partner states did the same by passing similar legislative extensions. The model is however only applicable in a closed, treaty-based environment in low earth orbit and cannot be extended to new missions outside of LEO such as lunar exploration projects and personal space stations[7].

Beyond the ISS there is very strong jurisdictional fragmentation. The European approach is harmonised but restrictive by implementing a patent scheme and new digital policies and focuses on the clarity of inventorship, data control and transparency. China adheres to a state-centric and strategically managed paradigm, whereby the authority is extended by having the strong governmental control over space operations and a strict control over technological products. Japanese innovation encourages public-private collaboration which is based on the high level of the contractual regulation and the system of nationwide licensing. India, in its turn, remains in the stage of shaping its space IP governance, where more and more frequently the authorisation is on the basis of ISRO, so as well as the domestic patent laws, but without

[6] Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, Including the Moon and Other Celestial Bodies, arts. VIII, I, II, VI, Jan. 27, 1967, 18 U.S.T. 2410, 610 U.N.T.S. 205; Frans G. von der Dunk, *International Space Law* 55–62 (2d ed. 2021).

[7] Intergovernmental Agreement on Space Station Cooperation, arts. 5, 21, Jan. 29, 1998, S. Treaty Doc. No. 105-38; 35 U.S.C. § 105 (2015); see also Ryan Abbott, *The Reasonable Robot: Artificial Intelligence and the Law* 109–15 (2020).

the explicit extraterritorial process of patent enforcement.[8]

Without having a homogeneous multilateral IP regime, multinational missions, as represented by the Artemis Accords, rely on bilateral agreements and on contracts between them to share ownership and inventorship. Such patchwork poses risks of forums shopping, conflicting claims, and flags of convenience in which space objects are incorporated in jursdictions by which the IP is less enforced. As a result, legal predictability in terms of the applied law, the right of ownership and patent protection in the context of the multi-state space collaboration has been proved to be elusive[9].

1.2 Private Commercial Operations, AI-Generated Inventions, and Cross-Jurisdictional Enforcement Gaps

Over the last few years, the increasing role of non-state actors and independent technologies has intensified the destabilisation of the state-centric legal system of the outer space. Although Article VI of the Outer Space Treaty requires states to grant and maintain unremitting surveillance of the activities of the private space, it provides no solid guideline on how such surveillance should be. This has since made regulatory arbitrage a possibility as it is in the case of the United States and Luxembourg who have passed domestic laws acknowledging individual rights to extract extra-terrestrial assets and also reject sovereignty assertions at the same time. These are patterns that undermine global enforcement and enhance the legal diffusion[10].

The inventions created by AI are even more challenging. The vast majority of patent systems, such as the United States, the European Union, Japan, China, and India, take human inventor, which was also affirmed by the rest of the world in the DABUS litigation. In this regard, the inventions that are independently produced by AI systems in space may end up unpatentable and companies will be forced to use trade secrets and contract protection instead of using actual intellectual-property rights. In the case of the creation of such inventions in orbit Article V of

[8] P. L. N. Rao, *Space Law and Intellectual Property Rights* 121–25 (2018); see also Y. H. Park, *Public-Private Collaboration in Japanese Space Law* 43–50 (2020).
[9] Artemis Accords, §§ 1, 9, Oct. 13, 2020, https://www.nasa.gov/specials/artemis-accords/index.html; Frans G. von der Dunk, *International Space Law*, supra note 1, at 59–61.
[10] Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, Including the Moon and Other Celestial Bodies, art. VI, Jan. 27, 1967, 18 U.S.T. 2410, 610 U.N.T.S. 205; see U.S. Commercial Space Launch Competitiveness Act, Pub. L. No. 114-90, § 403, 129 Stat. 704 (2015); Loi du Grand-Duché de Luxembourg du 20 juillet 2017 relative à l'exploration et à l'exploitation des ressources des corps célestes.

Article VIII is not very informative, especially in the multinational missions in which control is distributed and supervision dispersed[11].

The enforcement makes these challenges even more difficult. Where the jurisdiction may be theoretically defined, terrestrial courts do not have the practical capacity to assert patenting in space. Courts cannot confiscate satellites, make them park in space or issue injunctions above the surface of the earth. The use of arbitration, provided by organizations like WIPO, by the PCA Optional Rules to Space Activities and the like has become the dispute-resolution policy of choice since it can be enforced by the New York Convention. Arbitration, however, is only limited to inter partes cases and will not be valid to deal with patent validity or infringement by third parties, leaving the enforcement gap left in the hands of the public[12].

Without a single enforcement regime, the safety of space-based innovation is dependent on a significant level of contractual agreements and the watchfulness of states of registry. Such a shaky framework is a threat to the investor trust and technological advancement. Greater legal predictability in the long run will necessitate harmonised internationalisation, dispute-focused institutions, and perhaps a treaty-based system of space intellectual property, one which can locate harmony between individual innovation, AI agency, and the religion of the outer space being the property of all humanity.[13]

2. EMERGING LEGAL INTERPRETATIONS AND DOCTRINAL DEBATES

Legal tradition is being reviewed and adapted to the changing realities of outer space human activity that has evolved and become more complex and market-oriented. The antecedent structures, based on the sovereignty of territory and maritime analogy, are no longer as fit as they were at the time of the periphery of the outer space regulation. The missions nowadays concern individual businesses, multinational partnerships, and independent systems that function way subsequent to any sovereign district. This has in turn called to mind innovative conceptualizations of control and responsibility, in which territorial ownership is replaced by

[11] Thaler v. Commissioner of Patents [2022] FCA 879 (Austl.); Thaler v. Comptroller General of Patents [2021] EWHC 2569 (Pat) (Eng.); see Ryan Abbott, *The Reasonable Robot: Artificial Intelligence and the Law* 109–15 (2020).
[12] Permanent Court of Arbitration, *Optional Rules for Arbitration of Disputes Relating to Outer Space Activities* (2011); New York Convention on the Recognition and Enforcement of Foreign Arbitral Awards, June 10, 1958, 330 U.N.T.S. 3; see Frans G. von der Dunk, *International Space Law* 180–85 (2d ed. 2021).
[13] Id.; see also WIPO, *WIPO Arbitration and Mediation Center Rules and Practice for Space-Related IP Disputes* (2020), https://www.wipo.int/amc/en/rules/; see Outer Space Treaty, arts. I, II, VIII.

the functional authority where jurisdiction is vicarious based on the virtues of operative control or management of a space activity rather than bilateral possession of the underlying space activity considered to be regulated by ownership rights to a given land[14].

At the same time, the current discussion of flag-state registration and the growing need of specific lex spatialis supports the importance of the need to establish consistency and fairness in the regulation of space operation. In order to exercise the accountability of registering space objects under the national flags, it has gained some vulnerabilities like the provision of flags of convenience. A unified lex spatialis would create a more straightforward and fairer regime, setting up generally applicable principles of the data management, intellectual property, and business collaboration agreements in space. These new interpretations have become a new shift towards a more coherent and practical legal order that takes into consideration the peculiarities of the space and responsibility of people who enter the space[15].

2.1 Functional Control, Flag-State Jurisdiction, and the Limits of Territorial Analogies

Conventional international law is one that refers jurisdiction to territory. The collapse of such a linkage in the outer space is a case that Article II of the Outer Space Treaty (OST) expressly forbids national appropriation. In order to provide this gap, space law has integrated concepts of functional control and the analogue of flags-state, in which jurisdiction is exercised by the working control or by the nationality or by registration as opposed to geographic location. Based on maritime and aviation law space objects is equivalent to vessels on the high seas and must fall under the jurisdiction of their State of Registry according to Article since Article VIII of the OST and supposedly, Article VI obliges states to license and closely monitor the activities of their nationals in space. [16]

This pseudo-territorial system has enabled order and accountability and maintained the non-appropriation principle. A model such as the International Space Station (ISS) Intergovernmental Agreement, which considers each of the modules a quasi-territory of the

[14] Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, Including the Moon and Other Celestial Bodies, arts. I, II, VI, VIII, Jan. 27, 1967, 18 U.S.T. 2410, 610 U.N.T.S. 205; Frans G. von der Dunk, *International Space Law* 150–55 (2d ed. 2021)

[15] Id.; see also Intergovernmental Agreement on the International Space Station, art. 5, 21, Jan. 29, 1998, 37 I.L.M. 1457; Michael J. Listner, *The Future of Lex Spatialis and Outer Space Governance*, 52 J. Space L. 123, 130–32 (2026).

[16] Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, Including the Moon and Other Celestial Bodies, arts. I, II, VI, VIII, Jan. 27, 1967, 18 U.S.T. 2410, 610 U.N.T.S. 205; Frans G. von der Dunk, *International Space Law* 150–55 (2d ed. 2021).

state in which it is registered, is a good example of effective sovereign-imposed imitations. However, this is unlike the maritime law which is established under UNCLOS where the space law imposes no genuine linkage between the state of registry and space object. It has been this gap that has led to the rise of the so-called space flags of convenience allowing companies to fly spacecrafts under a state that regulates the sector with minimal scrutiny and subsequently undermines accountability. This problem is exacerbated by the Registration Convention of 1975, which sees the minimum of technical information, and leaves the issue of defining the registry standards in the mercy of the states in their entirety, as is seen by the registration ambiguities that have surrounded the satellites like NSS 6 and NSS 7[17].

The legal landscape has also been made difficult by operational exigencies. Resource extraction, mining, and safety-associated actions often demand the establishment of the temporary exclusion areas, which contributes to the loss of the line between legitimate utilization according to Article I and illicit expropriation according to Article II. States have reacted to this by pursuing a bifurcation approach in which they distinguish between non-appropriable celestial territory and mobile extracted resources. An example of such a strategy is the U.S. Commercial Space Launch Competitiveness Act (2015) and Luxembourg space law, which provides the right of property to extracted resources but expressly does not claim sovereignty. Even though functional control is flexible, its effectiveness depends on harmonised national supervision, transparency, and minimum international standards that are aimed at preventing regulatory arbitrage and misaligned liability under Articles VI, VII and XVIII of the OST[18].

2.2 The Case for a Lex Spatialis: Beyond Registration Toward a Unified Space Legal Regime

With the trend toward the space domain moving toward a permanent commercial presence and not exploration, the national analogies built of maritime and air law have been stretched to the farthest limits of conceptualization and practicality. The concept of lex rei sitae cannot hold in

[17] Id.; Intergovernmental Agreement on the International Space Station, arts. 5, 21, Jan. 29, 1998, 37 I.L.M. 1457; Convention on Registration of Objects Launched into Outer Space, Mar. 12, 1975, 28 U.S.T. 695, 1023 U.N.T.S. 15; see also NSS-6 and NSS-7 registration issues, United Nations Office for Outer Space Affairs, *Space Object Registry Reports*(2020).

[18] U.S. Commercial Space Launch Competitiveness Act, 51 U.S.C. §§ 50901–50923 (2015); Loi du Grand-Duché de Luxembourg du 20 juillet 2017 relative à l'exploration et à l'utilisation des ressources de l'espace; Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, arts. VI, VII, XVIII.

space properties that are mobile, non-territorial and ever-orbiting in nature. This in turn brings about severe doubt on matters of ownership, financing and enforcement, especially to investors and lenders who are unable to reclaim or foreclose space-based property. The growing acknowledgement of the necessity of Regulating Space autonomously is indicated by international programmes like the UNIDROIT Space Protocol as well as asset registration, financing and priority of interest[19].

An analogous situation is experienced with respect to intellectual property law. Patents are still strictly territorial, but the Article the State of Registry principle of Article decided on the inventions made or used in space renders a legal fiction of quasi-territoriality. Although this system can possibly work in small scale scenarios, e.g. the International Space Station, in multinational missions, bases on the Moon, and joint research stations, where different states might claim intersecting jurisdiction, the system breaks down. Without a cohesive space-IP regime, there is no certainty on inventorship, ownership, and enforcement and this discourages innovation, and private investment. Solutions to this phenomenon that are offered by WIPO such as a centralised space patent registry would help reduce duplication, make ownership clear and also improve legal predictability[20].

Such systemic inadequacies highlight the dire need to have a lex spatialis a spatial specific legal regime that is in line with the transnational, non-sovereignness and the technologically convoluted character of outer space. In such a structure, jurisdictional regulations, IP decisions, mechanism of financing and dispute-resolution mechanisms would be incorporated rather than adopting the isolated national legislation. Multinational missions, specialised arbitral mechanism and harmonised licensing standards Model Contract Clauses would further lower the conflict. Even soft-law tools like the Artemis Accords already contain emerging norms of responsible behaviour, resource use and transparency, and can be reformed into binding rules as time goes on. The development of a consistent lex spatialis is thus not only dogmatically desirable, but imperative to achieving that accountability, legal predictability, and to the long-

[19] UNIDROIT, *Space Assets Protocol to the Cape Town Convention* (2019); Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, Jan. 27, 1967, 18 U.S.T. 2410, 610 U.N.T.S. 205, arts. I–II; Frans G. von der Dunk, *International Space Law* 45–48 (2d ed. 2021).
[20] Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, art. VIII; Intergovernmental Agreement on the International Space Station, Jan. 29, 1998, 37 I.L.M. 1457, arts. 5, 21; WIPO, *Global Space Patent Registry Proposal* (2022).

term growth of human activity outside the Earth[21].

3. THE INTERNATIONAL SPACE STATION AND BEYOND: CASE STUDIES IN JURISDICTIONAL COMPLEXITY

The ever-growing human presence in outer space has given rise to jurisdictional issues that have never been witnessed before, with inter-state cooperation and individual businesses defying the boundaries of laws. The best practical example of how several countries can share common field and work in close collaboration through carefully designed agreements is the International Space Station (ISS). These projects are still evolving, as missions to the Moon continue following the Artemis Accords, and even further projects potentially including colonizing Mars and mining asteroids, the national laws, particularly the patent rights and intellectual property rights, become more complex. These trends are indicative of the necessity of adaptive governance structures and unveil the constraints of the agreements and treaties which were made in the past to serve an era of state-driven exploration. Understanding the jurisdictional dynamics of the ISS, the policy implications of the Artemis Accords, and the legal challenges that may arise with regard to interplanetary ventures will be able to give insight into the manner by which international space law will be required to adapt to the new stage of human expansion into space.[22]

3.1 Jurisdiction, Enforcement, and Patent Governance in Multinational and Orbital Platforms

The International Space Station (ISS) is the most intricate project of collaboration among the nations and a key experiment towards governing intellectual property (IP) in space. Articles 5 and 21 of the IGA contain the structure of a framework of modular jurisdiction, where each partner State, that is, the United States, Russia, European Partner States, Japan, and Canada, has jurisdiction and control over the space objects and personnel it registers. In a similar manner to the operationalisation of the Article 8 of the Outer Space Treaty (OST), granting jurisdiction

[21] Artemis Accords, Oct. 13, 2020, https://www.nasa.gov/specials/artemis-accords/index.html; Model Contract Clauses for International Space Missions, UNIDROIT (2020); Frans G. von der Dunk, *International Space Law* 200–210 (2d ed. 2021).

[22] Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, Jan. 27, 1967, 18 U.S.T. 2410, 610 U.N.T.S. 205; Intergovernmental Agreement on the International Space Station, Jan. 29, 1998, 37 I.L.M. 1457; Artemis Accords, Oct. 13, 2020, https://www.nasa.gov/specials/artemis-accords/index.html; Frans G. von der Dunk, *International Space Law* 145–150 (2d ed. 2021).

of States over registered space objects, the model understands the activities carried out within a specific module as the one carried out in the territory of the State of registration[23].

Though the United States adopted this framework in the Patents in Space Act, 35 U.S.C. SS 105, the United States law has extended its domestic patent law to U.S.-registered objects in space, and Germany has enacted similar ratification law, other members, including Japan, Canada, and the United Kingdom have not done similarly with statutory measures. This inappropriate application of the law results in a lack of certainty in the legislation, which affects the invention of the law and the performance of the individual operator. The exclusivity of patent rights as last provided in *Brown v. Duchesne*, confirmed in *Microsoft Corp. v. AT&T Corp*. goes on further to restrict the extraterritorial application of national patent protection legislation in the orbital marketplace[24].

The modular jurisdiction model fails in cases where an invention/infringements falls across modules. As an example, in a situation in which a patented process has been launched in the U.S. Destiny module, followed up in Japan in Kibo module and the Columbus module in Europe, there is no single choice-of-law rule that governs the patent regime to apply. Neither percentage and harmonised conflict of law regime nor lex stationis is created by the IGA (forcing patentees to initiate parallel litigation in more than one jurisdiction instead of one) or requiring uniform treatment across jurisdictions (serious concerns that have been raised in the context of *Voda v. Cordis Corp.* is on transnational patent enforcement.[25]

Add to these challenges is Article number 16 of the IGA where a broad Cross-Waiver of Liability is established between Partner States and their own so-called related entities such as the private contractors. The waiver will mean that despite its aim to restrict intergovernmental liability, they will protect the actions of the private actors against liability of patent infringements as it would result in a vacuum of non -liability. This is reminiscent of objections articulated on the ground in the earthly contexts as contractual immunities derail the level of IP enforcement as argued in *Dow Chemical v. Exxon Corp.*. This also poses an issue as far as enforcement of judgments interjurisdictionally is concerned because of the territoriality of the

[23] Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, Jan. 27, 1967, 18 U.S.T. 2410, 610 U.N.T.S. 205; Intergovernmental Agreement on the International Space Station, Jan. 29, 1998, 37 I.L.M. 1457.
[24] Patents in Space Act, 35 U.S.C. § 105 (2021); *Brown v. Duchesne*, 7 C.P. 51 (1857); *Microsoft Corp. v. AT&T Corp.*, 550 U.S. 437 (2007
[25] Intergovernmental Agreement on the International Space Station, Jan. 29, 1998, 37 I.L.M. 1457; *Voda v. Cordis Corp.*, 536 F.3d 1311 (Fed. Cir. 2008)

IP rights itself and the lack of a cohesive identification system, specifically in the United States where foreign IP judgments face review under the public policy/ jurisdictional doctrine[26].

To this reaction, researchers would support the creation of specific dispute resolution institutions, including a Space IP Arbitration Protocol or a specialised international space IP tribunal. Based on the aspiring Permanent Court of Arbitration Rules on Optional Dispute Resolution in Space-Related Disputes and the International Law Association's Draft Convention on the Settlement of Space Activities Disputes, further settlements need to coordinate the applicability of the law to intergalactic operations and clearly elude personal commercial IP charges under governmental liability cap to guarantee valuable defense of in-space invention[27].

3.2 Emerging Governance Challenges: Lunar Activities, Mars Settlements, and AI-Generated Inventions

The Artemis Accords are used to mark a shift towards a more inclusive but commercially focused space exploration system which focuses on the Moon and deep space. The Accords, which were launched in 2020 as a type of non-binding political pledges, are the additions to the treatment of the space regarding transparency, interoperability, and responsible behavior to the Outer Space Treaty (OST). The key element of the Accords is that the extraction and subsequent use of space resources should not be considered national appropriation under Article 2 of the OST a stance that is very unhelpful to the 1979 Moon Agreement in treating the lunar resources as common heritage of humanity.[28]

Section 9 of the Accords also establishes a notion of Safety Zones which is based on Article IX OST in order to avoid destructive interference. Nonetheless, the lack of a legal purposive definition of the concept of reasonableness has cast doubt on the event that such zones can degenerate into the de-facto property claims, which subverts the principle of non-appropriation. The Artemis Accords, in contrast to the International Space Station framework, do not offer a

[26] Intergovernmental Agreement on the International Space Station, Jan. 29, 1998, 37 I.L.M. 1457; *Dow Chem. Co. v. Exxon Corp.*, 31 F.3d 110 (3d Cir. 1986).
[27] Permanent Court of Arbitration, Optional Rules for Arbitration of Disputes Relating to Outer Space Activities (2011); International Law Association, Draft Convention on the Settlement of Space Activities Disputes (2014).
[28] Artemis Accords: Principles for Cooperation in the Civil Exploration and Use of the Moon, Mars, Comets, and Asteroids, Oct. 13, 2020; Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, art. II, Jan. 27, 1967, 18 U.S.T. 2410, 610 U.N.T.S. 205; Agreement Governing the Activities of States on the Moon and Other Celestial Bodies, Dec. 5, 1979, 1363 U.N.T.S. 3.

binding intellectual property (IP) regime, pushing the IP regulation in bilateral agreements. This uneven manner is connected to the indecision in *Eurospace v. European Commission* where different regulatory frameworks discourage individual investment.[29]

This disintegration is also exacerbated by geopolitical lines between Artemis coalition and the China -Russia led International Lunar Research Station (ILRS) with the risk of the formation of rival regimes of governance and incompatible technology. Based on this, the researchers propose the creation of a binding multilateral IP system with a multilateral institution like WIPO and the creation of the lex specialis spatial in order to provide control over priority rights and resource use.[30]

Such obstacles are increased in a future case of Mars colonies and asteroid mining. In domestic statutes, including those of the U.S. (Commercial Space Launch Competitiveness Act of 2015) or Luxembourg (Space Resources Law), there are statutes that allow the ownership of extracted resources by individuals without declaring sovereignty, which is justified by the need to comply with Article II of the OST but criticised as a consequence of the compromise of the principle of space resources as the province of all mankind. The ambiguity in the law is further increased by the fact that it is hard to apply the law in areas of interplanetary space, as Article 889 of Article VIII extends jurisdiction over them in theory but practically it is almost impossible to enforce the law.[31]

Things like structures and equipment on heavenly bodies could be owned with no breach of the principle of non-appropriation, however, the issue with inventorship and patentability are yet to be solved, especially those involving AI-created inventions. The rejection of the status of AI as an inventor in *Thaler v. Comptroller-General of Patents* and *USPTO v. Thaler* (DABUS case) demonstrates the deficiency of the existing patent regimes towards independent innovation in space. Mechanisms to resolve such gaps involve the introduction of international registries of space-mining rights of priority, customizable charters of governance to extraterrestrial settlements and intellectual-property protocols overseen by WIPO overseen by special arbitration clauses. It is on the basis of these reforms alone that space law can come to

[29] Artemis Accords, § 9; Outer Space Treaty, art. IX; *Eurospace AISBL v. European Commission*, Case T-883/16, ECLI:EU:T:2019:446.
[30] Frans G. von der Dunk, *International Space Law* 325–330 (2d ed. 2021); Ram S. Jakhu & Paul Stephen Dempsey, *Routledge Handbook of Space Law* 412–415 (2017).
[31] U.S. Commercial Space Launch Competitiveness Act, Pub. L. No. 114-90, 129 Stat. 704 (2015); Loi du 20 juillet 2017 sur l'exploration et l'utilisation des ressources de l'espace; Outer Space Treaty, arts. II, VIII

grips with the principles of the Outer Space Treaty and the realities of sustained human and commercial activity in the outer space.[32]

4.INSTITUTIONAL AND POLICY PROPOSALS FOR RESOLVING JURISDICTIONAL AMBIGUITIES

With the current trend of commercialisation and internationalisation of space activities, there has been a need to ensure that there are accurate enforceable legal frameworks, which would resolve the issue of ambiguity on jurisdiction. The outdated state-centric models do not fit well in dealing with a network of actors, such as state agencies, companies, and international partnerships that act beyond the planet. This is due to scholars and policy makers attempting to come up with institutional and policy changes to bring about harmony in the dispute resolution mechanisms and ensuring transparency in the space innovation. The core of these suggestions is the creation of coordinated international frameworks that are flexible enough to be free to the operations of the individual players, yet responsible to the laws of international law.[33]

The most promising solutions include expanding the mandate of WIPO and UNCOPUOS to include the intellectual-property regulation of space, and the creation of specially tailored arbitration procedures akin to those of Permanent Court of Arbitration. These can be supplemented with measures like a global patenting registry of space innovations and standardisation of private-contractual systems thus improving the issue of ownership and enforcement conflict. Together, all these actions will represent a dynamic vision of a cooperative and adaptive legal order that will facilitate equitable access, continued innovation, improved security, and clarification of the law as humanity goes deeper into space.[34]

4.1 International Harmonisation of Intellectual Property in Outer Space

The increased commercialisation of the outer space has revealed a critical lapse in the

[32] *Thaler v. Comptroller-General of Patents*, [2023] UKSC 49; *Thaler v. Vidal*, 43 F.4th 1207 (Fed. Cir. 2022); World Intellectual Property Organization, *WIPO Arbitration and Mediation Center Rules*; Permanent Court of Arbitration, Optional Rules for Arbitration of Disputes Relating to Outer Space Activities (2011).

[33] Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, arts. VI–VIII, Jan. 27, 1967, 18 U.S.T. 2410, 610 U.N.T.S. 205; Ram S. Jakhu, Paul Stephen Dempsey & Frans G. von der Dunk, *The Need for an Integrated Regulatory Regime for Space Activities*, 23 Annals Air & Space L. 247 (2018).

[34] World Intellectual Property Organization, *WIPO Arbitration and Mediation Center Rules*; Permanent Court of Arbitration, *Optional Rules for Arbitration of Disputes Relating to Outer Space Activities* (2011); United Nations Committee on the Peaceful Uses of Outer Space (UNCOPUOS), *Status of International Agreements Relating to Activities in Outer Space*, U.N. Doc. A/AC.105/1260 (2021).

international law of protection of intellectual property outside the earth. Intellectual property rights are territorial and exclusive unlike the Outer Space Treaty of 1967 (OST) which venerates that the outer space is not a sovereign territory but rather a non-sovereign field which can be utilized to the advantage of all mankind. The OST and the institutional structure of UNCOPUOS were created when space operations were mainly state-controlled and consequently the framework does not give any clear aspects of patents, copyrights or trademarks of any kind that could result due to a private or multinational space operations. With the increased investments by private corporations in orbital manufacturing, space tourism and space resource extraction, lacks predictable and enforceable IP protection jeopardizes the innovation and investor confidence.[35]

Other States have sought to fill this gap by applying the laws of national patent extraterritorially, under the so-called flag-state principle. It is worth noting that the U.S. space related inventions are treated similar to those made within U.S premises under 35 U.S.C. 105, with the International Space Station Intergovernmental Agreement (IGA) Article 21 assigning jurisdiction based on module registration. Nonetheless, these methods are still quite disparate and inadequate in future business operations of the privatized multinational infrastructure. Cases like *Decca Ltd.v. United States* and *Hughes Aircraft Co. v. United States* have indicated judicial reasoning that it is difficult to find infringement in the non-territorial context, since the old-fashioned tests of control and beneficial use cannot work with the space reality.[36]

To end this fragmentation, this paper suggests both international harmonisation in WIPO and UNCOPUOS and suggests a special WIPO Treaty on Extra-Terrestrial Intellectual Property. Based on the Patent Cooperation Treaty, such an arrangement could offer a single application regime, a commonised register, harmonised patentability regimes and mandatory licensing arrangements that are oriented towards the OST benefit-of-mankind principle. The resolutions could be achieved by specialised WIPO arbitration panels and enforcement targeted at the assets found on the planet. This is a pragmatic solution to an acceptable lex spatii to intellectual property by taking advantage of the technical expertise of WIPO instead of having a politically

[35] Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space arts. I–II, Jan. 27, 1967, 18 U.S.T. 2410, 610 U.N.T.S. 205; Frans G. von der Dunk, *International Space Law*, in Handbook of Space Law 29, 58–61 (Frans G. von der Dunk & Fabio Tronchetti eds., 2015).
[36] 35 U.S.C. § 105; Intergovernmental Agreement on the International Space Station art. 21, Jan. 29, 1998, 37 I.L.M. 1457; *Decca Ltd. v. United States*, 640 F.2d 1156 (Ct. Cl. 1980); *Hughes Aircraft Co. v. United States*, 534 F.2d 889 (Ct. Cl. 1976).

charged debate on sovereignty.[37]

4.2 Dispute Resolution and Enforcement Mechanisms for Space-Based IP

With the lack in the effectiveness of the territorial courts to resolve the intellectual property conflicts concerning the use of space, transnational arbitration has developed as one of the required tools of governance. What can be called an impartial framework, the Optional Rules of Arbitration of Disputes in Outer Space Activities, adopted by the Permanent Court of Arbitration in 2011, is a blend of the public international law and individual commercial arbitration. Arbitration allows the parties to choose the law to be applied, the persons to be used to arbitrate, and the adoption of confidential rules, whereas the enforceability is ensured by the New-York Convention of 1958. However, the PCA Rules have not been used effectively due to their lack of clear-cut answers on the validity of patents, violations, as well as technical secretiveness. It must also be reformed to explicitly include IP disputes, explicitly make rulings on invalidity of patents bind inter partes, and compel the establishment of expert panels, based on the example of practices of the WIPO Arbitration and Mediation Centre.[38]

In addition to dispute resolution, the article suggests that a Global Space Patent Registry (GSPR) should be established that is both managed by both the World Intellectual Property Organization (WIPO) and the United Nations Office for Outer Space Affairs (UNOOSA). Under such an arrangement, WIPO would review and issue patents as to space project activities, but UNOOSA would offload such rights to registered space objects, thus avoiding duplication and operating within criminal justice boundaries like the flags of handy issue. The GSPR would harmonise inventions used or made in outer space only, unlike the Patent Cooperation Treaty (PCT) which abolishes respect of pre-existing terrestrial patent regimes. It would be initially enforced on an arbitrational basis but then it would be advanced to a specialised Space Patent Court. Such a scheme would free incentives to innovation in harmony with the non-appropriation principle of the Outer Space Treaty (OST).[39]

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[37] Patent Cooperation Treaty, June 19, 1970, 28 U.S.T. 7645, 1160 U.N.T.S. 231; World Intell. Prop. Org., *WIPO Arbitration and Mediation Center Rules*; Ram S. Jakhu & Joseph N. Pelton, *Global Space Governance* 221–25 (2017).

[38] Permanent Court of Arbitration, *Optional Rules for Arbitration of Disputes Relating to Outer Space Activities* (2011); Convention on the Recognition and Enforcement of Foreign Arbitral Awards art. III, June 10, 1958, 21 U.S.T. 2517, 330 U.N.T.S. 3; World Intell. Prop. Org., *WIPO Arbitration and Mediation Center Rules*.

[39] World Intell. Prop. Org., *WIPO Intellectual Property Handbook* (2023); United Nations Office for Outer Space Affairs, *Register of Objects Launched into Outer Space*; Treaty on Principles Governing the Activities of

Temporary measures also include the need to use private contracts and licensing agreements. The joint development agreements, consortium arrangements and the licensing clauses help the parties distribute the background and foreground intellectual property, the governing law and to pre-select the arbitration forums. These involve the reduction of jurisdictional uncertainty and helps to avoid the gaps in national regimes, which can be demonstrated with the help of litigation where *Decca Ltd. v. United States* and *Hughes Aircraft Co. v. United States*. However, the solutions within the contract are only binding to the contracting parties, and lack in rem effect on the third parties. Based on this finding, as much as private ordering is flexible and immediate, it cannot be used to substitute a binding international intellectual-property regime.[40]

Combined, harmonised global standards, specialised arbitration systems, international patent registration, and closely designed contracts of the individual are the mighty pillars of a sustainable legal system of space innovation. Without these kinds of reforms, intellectual-protection in open space will continue to be rather unpredictable, piecemeal, and otherwise not substantial enough to sustain the next stage of human and commercial activity off the planet.[41]

CONCLUSION

Addressing the issues of jurisdictional ambiguity in the outer space world will require a dynamic and inclusive international legal framework that will be applicable in the intellectual property protection outside the borders of the earth. Even though international law has established some fundamental principles for the regulation of activities related to space, such as the Outer Space Treaty and the Registration Convention, these instruments fail to handle the intricate issues of the modern space activities, including commercial space missions, the use of orbital facilities, and AI-based inventions. The high level of development of technologies makes it possible that space activities will not be associated with national territories anymore, which makes the original model of jurisdiction founded on sovereign states quite insufficient.

The solution of these problems will mandate structural reform and doctrinal innovation which

States in the Exploration and Use of Outer Space art. II, Jan. 27, 1967, 18 U.S.T. 2410, 610 U.N.T.S. 205; Patent Cooperation Treaty, June 19, 1970, 28 U.S.T. 7645, 1160 U.N.T.S. 231.

[40] *Decca Ltd. v. United States*, 640 F.2d 1156 (Ct. Cl. 1980); *Hughes Aircraft Co. v. United States*, 534 F.2d 889 (Ct. Cl. 1976); Mark Sundahl, *The Use of Contracts in Regulating Commercial Space Activities*, 45 J. Space L. 1 (2021).

[41] Ram S. Jakhu & Joseph N. Pelton, *Global Space Governance: An International Study* 219–28 (2017); Frans G. von der Dunk, *Legal Aspects of Commercial Space Activities*, 86 Neb. L. Rev. 891 (2008).

includes the creation of such institutions as a WIPO-led Space Patent Registry or the extension of the mandate of UNCOPUOS to coordinate registration, dispute resolution and enforcement processes. In addition, these barriers would be greatly alleviated by the establishment of a special body of law, a lex spatialis, to harmonise in extra-terrestrial technologies inventorship, jurisdiction and enforcement of IP laws. In the absence of such international devices, superflexible transnational arbitration and private contractual systems cannot compete with the sophistication of the jurisdictional grey area. These individual procedures have to be consistent with the larger global agreement of protecting innovation and reasonable accessibility of space resources.

The shared vision and cooperation between the nations is the final reason why sustainable governance with intellectual property rights in outer space is possible. Clearly defined and universally accepted standards are urgently needed, and they will be necessary sooner or later, as the humankind will enter into ways of conducting its businesses on the Moon and Mars, and as the AI systems will become the makers of their own inventions. Without this degree of co-ordination, outer space runs the risk of being torn to business rags and tatters as rival jurisdictions and commercial interests run free. Space may only be preserved as a field of collective human accomplishment and equitable innovation by creating a modern, future-oriented legal framework in which technological development is balancing innovation with fairness, inclusiveness, and mutual benefit.