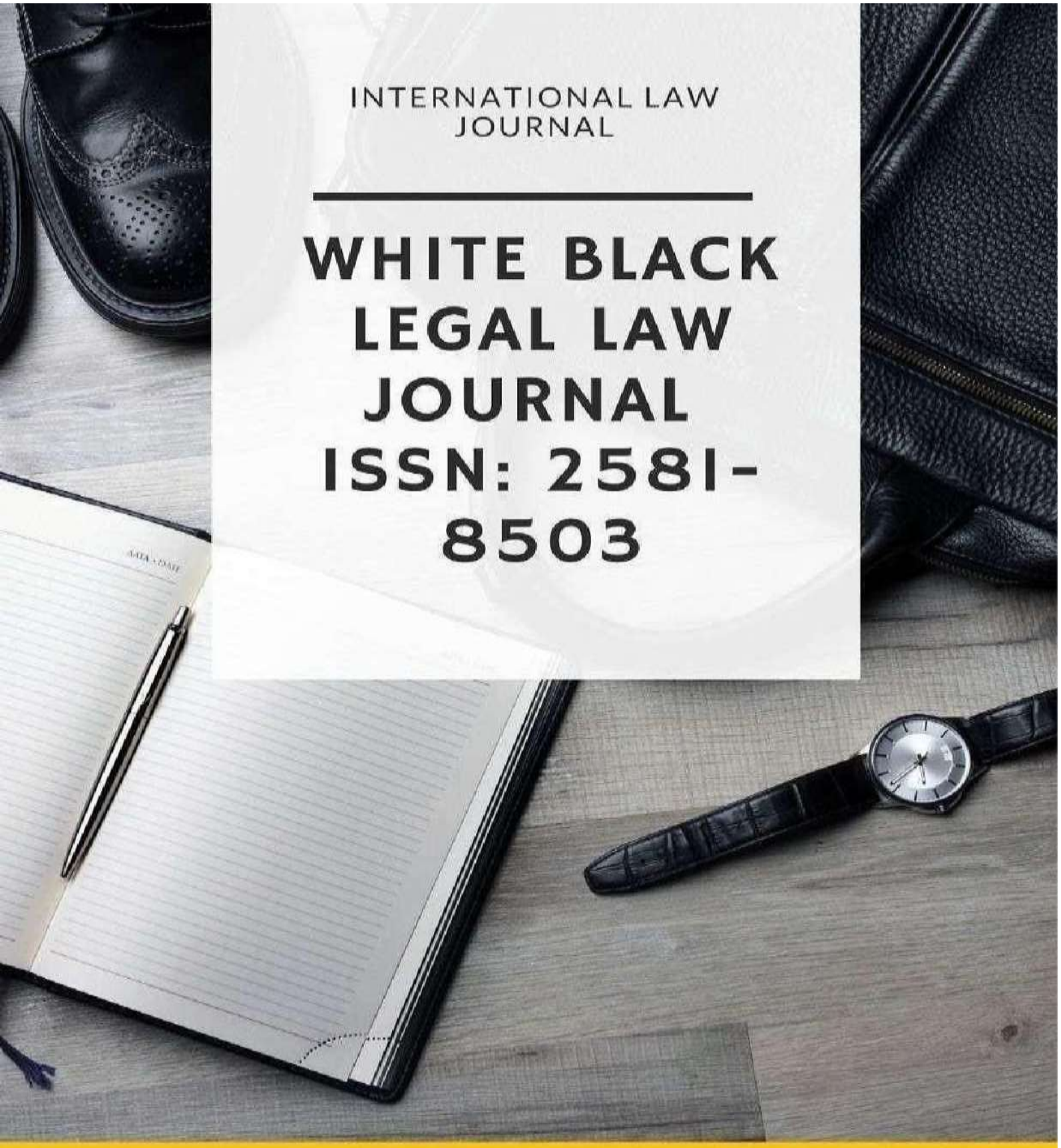

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"PROPERTY, POSSESSION, AND PENAL LAW IN OUTER SPACE: ADDRESSING THEFT AND TRESPASS IN SPACE DEBRIS OPERATIONS"

AUTHORED BY - AYUSH JAISWAL & BASANTA CHHATAR

ABSTRACT

The exponential growth of space debris presents a critical challenge to the sustainable use and governance of outer space, raising complex legal questions concerning property rights, possession, and penal liability. This research paper critically examines the current international legal framework governing space debris, highlighting the ambiguities surrounding the definition, ownership, and abandonment of non-functional space objects. Drawing on principles from international space law, common law doctrines of abandonment, and tort concepts such as market-share liability, the paper argues for a reconceptualization of space debris as abandoned property subject to regulated disposal. It further explores the applicability of penal law and international criminal law to address theft and trespass in debris removal operations, identifying significant enforcement and jurisdictional challenges. Through analysis of relevant case law and treaty provisions, the paper proposes a comprehensive policy framework that integrates binding legal definitions, market-share liability regimes, penal sanctions, and enhanced space situational awareness. The study underscores the necessity of international cooperation, technological innovation, and inclusive governance to internalize the negative externalities of debris creation and incentivize active debris removal. Ultimately, this paper contributes to the evolving discourse on space sustainability by offering pragmatic legal and policy solutions to preserve the space commons for future generations.

RESEARCH METHODOLOGY

This research primarily employs a doctrinal legal methodology, systematically analyzing primary and secondary legal sources to interpret the existing international legal framework governing space debris. Key treaties such as the Outer Space Treaty, Liability Convention, and Registration Convention are examined with a focus on provisions related to ownership, jurisdiction, and liability. Additionally, relevant case law, including domestic and international decisions, is reviewed to extract applicable legal principles. The study also considers soft law

instruments like COPUOS guidelines and draft codes of conduct to understand evolving norms and policy trends in space governance.

Recognizing the interdisciplinary nature of space debris issues, the research integrates insights from space science and technology literature to contextualize legal challenges within the technical realities of debris tracking and active removal. Environmental and economic law principles, such as the tragedy of the commons and market-share liability, are applied to propose innovative legal solutions. Comparative analysis of terrestrial property and penal law doctrines further informs the adaptation of these concepts to the unique context of outer space, identifying gaps and opportunities for reform.

The study also undertakes policy and normative analysis by evaluating the effectiveness of current international and national policies on debris mitigation and removal. It assesses the role of international cooperation, transparency, and enforcement mechanisms in fostering compliance and resolving disputes. Based on this evaluation, the research formulates pragmatic policy recommendations grounded in legal theory, technological feasibility, and geopolitical considerations, aiming to enhance the governance of space debris operations.

Data sources include official treaty texts, United Nations resolutions, COPUOS reports, scholarly articles, legal commentaries, and technical reports from space agencies such as NASA and ESA. The research acknowledges limitations due to the evolving nature of space law, limited judicial precedents, and the complexity of space debris technology. Consequently, the study relies on interpretative and normative analysis rather than empirical data collection, providing a comprehensive and multidisciplinary foundation for addressing the legal and policy challenges of space debris.

INTRODUCTION

The rapid expansion of human activity in outer space has brought to the forefront complex legal challenges concerning property rights, possession, and penal law, particularly in the context of space debris operations. Since the inception of the Outer Space Treaty in 1967, the legal framework governing outer space has been primarily state-centric, emphasizing free access and non-appropriation of celestial bodies. However, the proliferation of space debris—non-functional, man-made objects orbiting Earth—poses significant threats to the

sustainability of space activities and raises novel questions about ownership, abandonment, and liability.

This paper explores the intersection of property law, possession, and penal law in outer space, focusing on the legal implications of theft and trespass in space debris removal and remediation operations. It examines the current international legal regime, the challenges posed by the ambiguous status of space debris, and the potential application of international criminal law principles to regulate and enforce conduct in outer space. Drawing on scholarly commentary, international treaties, and policy guidelines, this research argues for a nuanced approach that reconciles the common-pool nature of outer space with the need for clear property rights and liability mechanisms to incentivize debris cleanup and prevent unlawful interference.

THE SPACE DEBRIS PROBLEM AND LEGAL FRAMEWORK

The Nature and Threat of Space Debris

Space debris, also known as orbital debris or space junk, refers to all artificial, non-functional objects orbiting Earth or re-entering the atmosphere. This includes defunct satellites, spent rocket bodies, fragments from collisions or explosions, and microparticles such as paint flecks and propellant residues. The Committee on the Peaceful Uses of Outer Space (COPUOS) defines space debris as "all man-made objects, including fragments and elements thereof, in Earth orbit or re-entering the atmosphere, that are non-functional." This definition has gained widespread acceptance internationally and is reflected in the guidelines of the Inter-Agency Space Debris Coordination Committee (IADC) and NASA's orbital debris handbook.[1]

The scale of the problem is staggering. As of January 2017, the U.S. Space Surveillance Network tracked approximately 23,000 pieces of debris larger than 10 centimetres, while statistical models estimate the total number of debris pieces to be in the hundreds of millions when including smaller fragments.[2] The velocity of these objects, reaching up to 17,500 miles per hour, means even small debris can cause catastrophic damage to operational spacecraft, threatening crewed missions and critical satellite infrastructure.[3] The Kessler Syndrome, a theoretical cascade of collisions generating exponentially more debris, poses a grave risk to the sustainability of space activities, potentially rendering certain orbital regions unusable for decades or centuries.[4]

The increasing number of space actors, including private companies and emerging spacefaring

nations, exacerbates the problem. Collision avoidance maneuvers have become routine, imposing additional costs and operational constraints on satellite operators. The proliferation of satellite mega constellations and commercial space tourism further intensifies the urgency of addressing space debris.[5]

International Legal Regime Governing Outer Space

The legal framework governing outer space is anchored by three principal United Nations treaties:

1. **The Outer Space Treaty (1967)** establishes outer space as the "province of all mankind," free for exploration and use by all states without national appropriation. It mandates that activities be conducted for the benefit of all countries and requires states to avoid harmful contamination or interference with other states' activities.[6]
2. **The Liability Convention (1972)** holds launching states liable for damage caused by their space objects, but only if fault or negligence can be established. It defines "space objects" broadly to include component parts and launch vehicles.[7]
3. **The Registration Convention (1976)** requires states to register space objects with the United Nations and maintain jurisdiction and control over them, including their component parts, regardless of functionality.[8]

Despite these treaties, space debris remains ambiguously defined and is generally subsumed under the category of space objects, thereby maintaining perpetual ownership and jurisdiction by launching states. The **Space Debris Mitigation Guidelines** adopted by COPUOS in 2007 and updated in 2010 provide nonbinding recommendations to limit debris creation but lack enforcement mechanisms or obligations for debris removal.[9]

The Tragedy of the Commons and Property Challenges

Outer space exemplifies a global common, where individual actors benefit from exploiting the resource while externalizing the costs of debris creation and cleanup. This dynamic leads to overuse and degradation, a phenomenon famously described as the "tragedy of the commons."[10] The strong property rights regime over space objects, including debris, creates legal and political barriers to unilateral cleanup efforts. States and private actors fear violating sovereignty or ownership rights, which may result in international disputes or liability claims.[11] The absence of a binding definition of space debris and lack of an abandonment mechanism further complicate liability and enforcement. Without clear legal status, debris removal operations risk being construed as theft or trespass, deterring investment in active debris

removal (ADR) technologies and initiatives.[12]

PROPERTY AND POSSESSION IN OUTER SPACE: THE LEGAL STATUS OF SPACE DEBRIS

Defining Space Debris: Functional vs. Non-Functional Objects

The legal distinction between space objects and space debris hinges on functionality. The COPUOS guidelines and IADC define space debris as non-functional man-made objects, including fragments and elements thereof, in Earth orbit or re-entering the atmosphere.[13] NASA similarly defines orbital debris as artificial objects left in orbit that no longer serve a useful purpose.[14] This functional test is widely accepted as the optimal criterion for identifying debris, as it captures both large intact defunct satellites and small fragments that pose collision risks.[15]

This distinction is critical because space objects are subject to continuous ownership and jurisdiction by launching states, while debris, being non-functional, arguably lacks positive economic or operational value and may be considered abandoned property.[16] The International Law Association (ILA) has also proposed defining space debris as man-made objects in outer space other than active or useful satellites, when no change in status is expected in the foreseeable future.[17]

The Doctrine of Abandonment and Space Debris

The common law doctrine of abandonment requires two elements: (1) the owner's intent to relinquish rights without transferring ownership to a specific party, and (2) a voluntary act effectuating that intent.[18] Applying this to space debris, non-functional objects that are no longer controlled or registered as operational may be deemed abandoned.[19]

Professor Lior Strahilevitz argues that chattel property can be unilaterally abandoned and subsequently claimed or disposed of by others, provided no intended recipient exists.[20]

This view supports the proposition that space debris, as abandoned property, should be free for cleanup without fear of violating ownership rights.

However, abandonment of property without subjective or market value—such as trash or

pollution—is typically regulated to prevent unilateral disposal that imposes costs on society.[21] Professor Eduardo Peñalver emphasizes that unilateral abandonment is the exception rather than the norm, especially when property is abandoned on land owned by others, which requires consent or regulation.[22] Since outer space is a commons without private land ownership, a regulatory regime is necessary to govern the abandonment and disposal of space debris to internalize negative externalities.

Ownership and Jurisdictional Issues

The Outer Space Treaty and related conventions affirm that launching states retain jurisdiction and control over their space objects indefinitely, including component parts and debris fragments.[23] This continuous ownership regime complicates unilateral debris removal efforts, as states fear violating sovereignty or property rights, which may result in international disputes or liability claims.[24]

No international mechanism currently exists to transfer or relinquish ownership of debris, nor to authorize third-party removal without consent.[25] This legal status creates a chilling effect on active debris removal initiatives, as operators risk accusations of theft or trespass and potential liability for damage caused during removal operations.[26]

PENAL LAW AND INTERNATIONAL CRIMINAL LAW IN OUTER SPACE

Applicability of Penal Law to Space Activities

The application of penal law to outer space activities remains underdeveloped. The Outer Space Treaty imposes international responsibility on states for national activities in space, including those by non-governmental entities, but does not explicitly address criminal liability or penal sanctions.[27] The Liability Convention focuses on civil liability for damage caused by space objects but does not provide for criminal penalties.[28]

International criminal law, as codified in instruments such as the Rome Statute, has not been extended to cover offenses committed in outer space. The absence of dedicated space criminal law leaves a regulatory gap in addressing wrongful acts such as theft, trespass, or intentional damage to space objects or debris.[29]

Theft and Trespass in Space Debris Operations

Theft in outer space can be conceptualized as the unauthorized appropriation or removal of space objects or debris owned by another state or entity. Given the perpetual ownership regime, removing debris without consent may constitute theft or unlawful interference under international law.[30] Similarly, trespass involves unauthorized interference with another's property, including proximity operations or manipulation of space objects or debris, raising sovereignty and security concerns.[31]

The lack of clear legal definitions and enforcement mechanisms creates uncertainty and risk for operators engaging in debris removal, potentially deterring beneficial cleanup activities. This legal ambiguity may result in chilling effects on technological innovation and investment in active debris removal.[32]

Challenges in Enforcement and Jurisdiction

Enforcement of penal law in outer space faces significant hurdles:

- **Jurisdictional ambiguity**: Outer space is a global common without sovereign territory, complicating the application of national criminal laws.[33]
- **State responsibility**: States bear international responsibility for their nationals' activities, but prosecuting individuals or entities for space crimes requires domestic legislation and international cooperation.[34]
- **Evidence and attribution**: Identifying perpetrators and proving intent or fault in the complex space environment is challenging due to limited situational awareness and technical constraints.[35]
- **Lack of international criminal instruments**: No dedicated treaty or international court addresses space crimes, unlike terrestrial crimes under the International Criminal Court.[36]

CASE LAW AND JURISPRUDENCE RELEVANT TO SPACE PROPERTY AND LIABILITY

While international space law is primarily treaty-based and lacks extensive judicial interpretation, several domestic and international cases provide insight into property, liability, and ownership issues relevant to space debris operations.

Sindell v. Abbott Laboratories (1980) and Market-Share Liability

Though not a space case, *Sindell v. Abbott Laboratories* established the doctrine of market-share liability in tort law, where plaintiffs could recover damages from multiple manufacturers of a fungible product without identifying the specific manufacturer responsible for harm.[37] This doctrine has been proposed as a model for apportioning liability among spacefaring nations responsible for debris creation, addressing the causation problem inherent in space debris collisions.[38]

United States v. One Lucite Ball Containing Lunar Material (1973)

This U.S. federal forfeiture case involved ownership claims over lunar samples brought back by Apollo missions. The court recognized that lunar materials collected by NASA are government property, underscoring the principle that space objects and materials remain under the jurisdiction and control of the launching state or entity.[39] This case illustrates the extension of terrestrial property principles to extraterrestrial materials and supports the notion of continuous ownership.

International Court of Justice Advisory Opinions and Dispute Resolution

Though the ICJ has not adjudicated space debris disputes, its advisory opinions on related issues, such as the *Legality of the Threat or Use of Nuclear Weapons* (1996), emphasize the importance of international cooperation and the protection of common spaces. The ICJ's jurisprudence on sovereignty and state responsibility provides a framework for interpreting Outer Space Treaty obligations, including liability for harmful interference.[40]

Arbitration and Claims Commissions under the Liability Convention

The Liability Convention provides for claims commissions to resolve disputes over damage caused by space objects. While no claims commission has yet been convened for debris-related damage, the procedural framework offers a mechanism for peaceful dispute resolution and compensation, reinforcing state responsibility and liability principles.[41]

ADDRESSING LEGAL OBSTACLES: TOWARD A REGULATORY AND PENAL FRAMEWORK FOR SPACE DEBRIS OPERATIONS

Clarifying Property and Possession Rights

To facilitate debris removal and reduce legal uncertainty, the international community should adopt a binding definition of space debris as abandoned, non-functional property subject to regulated disposal. This would allow states to relinquish ownership or authorize third-party removal, akin to terrestrial waste disposal regulations.[42] Establishing a registry or certification system for abandoned debris would provide legal certainty for cleanup operators and reduce fears of liability or accusations of theft.[43]

Implementing Market-Share Liability and Incentive Mechanisms

Market-share liability, first developed in the tort context in *Sindell v. Abbott Laboratories*, apportions liability among multiple parties based on their respective contributions to a harm when individual causation is indeterminate.[44] Applied to space debris, this approach would allocate cleanup costs among spacefaring nations proportionally to their contribution to debris creation, overcoming causation difficulties and free-rider problems.[45]

This mechanism incentivizes debris reduction and cleanup by guaranteeing compensation to operators and can be administered by the United Nations Office for Outer Space Affairs (UNOOSA) using existing registries and tracking data.[46]

Developing Penal Provisions and Enforcement Mechanisms

To address theft and trespass in debris operations, the international community should incorporate penal provisions into existing or new space treaties, criminalizing unauthorized removal or interference with space objects and debris.[47] States should enact domestic legislation criminalizing space theft and trespass, with provisions for extraterritorial jurisdiction where appropriate.[48]

International dispute resolution mechanisms, such as the International Court of Justice (ICJ) or specialized tribunals, should be empowered to adjudicate space-related offenses, including theft and trespass in debris operations. The establishment of such mechanisms would provide a formal avenue for resolving disputes and enforcing compliance with international obligations, thereby enhancing legal certainty and deterrence.

Transparency and information sharing through Space Situational Awareness (SSA) initiatives are essential to monitor activities, attribute violations, and support enforcement. The U.S.

Strategic Command's Space Track Project exemplifies a comprehensive SSA data-sharing platform that provides maneuver assessments and collision warnings to registered operators, fostering cooperative space traffic management and reducing risks of unauthorized interference.[49]

Balancing Sovereignty and the Commons

A regulatory regime must carefully balance respect for state sovereignty and property rights over space objects with the collective interest in preserving the space commons and preventing the tragedy of the commons. While consent and cooperation remain paramount, exceptions for abandoned debris under clear legal standards would facilitate cleanup without infringing sovereignty or provoking international disputes.

This balance can be achieved by recognizing space debris as a negative externality requiring regulation and cost internalization, while maintaining the principle that functional space objects remain under the jurisdiction and control of launching states. Such a regime would incentivize responsible behavior, promote sustainable use of outer space, and preserve equitable access for all spacefaring nations.[50]

TECHNOLOGICAL AND POLICY CONSIDERATIONS

Active Debris Removal Technologies

Technological solutions for debris removal are advancing but remain in early stages. Proposed methods include:

- **Space tugs** that rendezvous with debris and deorbit it by lowering its orbit to accelerate atmospheric re-entry.[51]
- **Drag enhancement devices**, such as deployable sails or "NERF balls," which increase atmospheric drag on debris to hasten orbital decay.[52]
- **Laser systems** designed to impart momentum to small debris, altering their trajectories to avoid collisions or induce re-entry.[53]
- **Robotic arms and capture mechanisms** for retrieving large debris objects, exemplified by projects like Switzerland's CleanSpaceOne and DARPA's Ballistic Orbital Removal system.[54]

These technologies face significant technical, economic, and legal challenges, including the risk of causing damage during removal operations and the need for clear legal authorization to

interact with debris owned by other states.[55]

Space Situational Awareness (SSA)

SSA is critical for safe space operations, enabling tracking of space objects, collision avoidance, and attribution of debris creation. SSA capabilities include ground-based radar and optical sensors, space-based sensors, and data-sharing platforms like the U.S. Space Surveillance Network and Space Track Project.[56]

Effective SSA supports regulatory enforcement by providing transparency, reducing uncertainty, and facilitating timely responses to potential threats. It also underpins market-share liability schemes by enabling accurate apportionment of responsibility for debris creation.[57]

Policy Development and International Cooperation

Sustainable space operations require binding international agreements with enforcement mechanisms, complemented by national implementation of debris mitigation and removal laws. Multilateral cooperation on SSA, debris tracking, and cleanup funding is essential to address the global nature of the debris problem.

Inclusion of emerging space actors and private companies in regulatory frameworks is critical, given their growing role in space activities. Confidence-building measures, transparency initiatives, and dispute resolution mechanisms can reduce geopolitical tensions and foster collaborative solutions.[58]

POLICY SUGGESTIONS

Addressing the multifaceted challenges posed by space debris requires a comprehensive policy approach that integrates legal clarity, technological innovation, international cooperation, and enforcement mechanisms. The following policy suggestions aim to provide a pragmatic roadmap for states, international organizations, and private actors to enhance the governance of space debris operations, particularly concerning property rights, possession, and penal law.

Establish a Binding International Legal Framework for Space Debris

1. **Adopt a Clear, Binding Definition of Space Debris** The international community should formalize a binding definition of space debris as non-functional,

abandoned man-made objects in orbit or re-entering the atmosphere. This definition should distinguish debris from operational space objects to clarify ownership and regulatory responsibilities. Such clarity would reduce legal uncertainty and facilitate debris removal operations without infringing on state sovereignty.[59]

2. **Create an Abandonment Mechanism for Space Objects** A legal mechanism should be established allowing launching states to formally declare space objects as abandoned or non-functional, thereby relinquishing ownership rights and enabling third-party removal. This mechanism could be modeled on terrestrial waste disposal laws and would help overcome the current perpetual ownership regime that hinders cleanup efforts.[60]
3. **Incorporate Market-Share Liability into International Space Law** Building on the doctrine of market-share liability, an international regime should apportion responsibility and cleanup costs among spacefaring nations based on their relative contribution to debris creation. This approach would internalize negative externalities, incentivize debris mitigation, and provide financial support for active debris removal initiatives.[61]

Develop Penal Provisions and Enforcement Mechanisms

1. **Criminalize Unauthorized Removal and Interference** International treaties and national laws should include penal provisions criminalizing unauthorized removal, tampering, or interference with space objects and debris. Clear definitions of theft and trespass in the space context would deter unlawful conduct and protect legitimate property interests.[62]
2. **Enhance International Dispute Resolution** Establish specialized dispute resolution mechanisms, possibly under the auspices of the United Nations or the International Court of Justice, to adjudicate space-related offenses and liability claims. These mechanisms should be accessible, efficient, and equipped to handle the technical complexities of space operations.[63]
3. **Promote Transparency and Information Sharing** Expand and support Space Situational Awareness (SSA) initiatives to improve tracking, attribution, and monitoring of space objects and debris. Transparent data sharing among states and private actors will facilitate enforcement, reduce conflicts, and build trust.[64]

Foster Technological Innovation and Economic Incentives

1. **Support Research and Development of Active Debris Removal Technologies** Governments and international organizations should fund and incentivize the development and deployment of cost-effective, safe, and scalable debris removal technologies. Public-private partnerships can accelerate innovation and reduce financial barriers.[65]
2. **Create a Global Debris Removal Fund**
   Establish a multilateral fund, administered by an international body such as UNOOSA, financed through contributions from spacefaring nations proportional to their debris generation. This fund would subsidize debris removal projects and compensate operators undertaking cleanup activities.[66]
3. **Incentivize Responsible Behavior through Licensing and Insurance** National licensing regimes for space launches and operations should incorporate debris mitigation and removal obligations. Insurance requirements could be linked to compliance, encouraging operators to minimize debris creation and participate in cleanup efforts.[67]

Promote Inclusive and Cooperative Governance

1. **Engage Emerging Space Actors and Private Sector** Policies must include emerging spacefaring nations and commercial entities to ensure broad compliance and shared responsibility. Capacity-building programs and technical assistance can help integrate new actors into the regulatory framework.[68]
2. **Develop Confidence-Building Measures and Norms of Behavior** Encourage the adoption of voluntary codes of conduct, best practices, and transparency measures to foster cooperation and reduce the risk of conflicts. These soft law instruments can complement binding treaties and evolve with technological and geopolitical changes.[69]
3. **Coordinate with Related International Regimes** Align space debris policies with broader international environmental law, maritime law, and arms control agreements to leverage existing legal principles and enforcement mechanisms.

CONCLUSION

The proliferation of space debris presents a profound challenge to the sustainability of outer space activities, implicating complex issues of property, possession, and penal law. The current international legal regime, anchored by the Outer Space Treaty and related conventions,

provides foundational principles but lacks clarity and enforcement mechanisms to effectively address debris ownership, abandonment, and liability.

From a legal scholarship perspective, redefining space debris as abandoned, non-functional property subject to regulated disposal is essential to overcoming the barriers posed by perpetual ownership and sovereignty concerns. The doctrine of abandonment, adapted to the unique context of outer space, offers a pathway to permit debris removal without infringing on state property rights, provided that appropriate regulatory frameworks are established.

Market-share liability regimes present a promising mechanism to allocate cleanup costs equitably among spacefaring nations, internalizing the negative externalities of debris creation and incentivizing remediation efforts. Complementing this with penal provisions criminalizing unauthorized removal or interference can deter theft and trespass, fostering a safer and more cooperative space environment.

Technological advances in active debris removal and enhanced space situational awareness, combined with robust international cooperation and binding legal instruments, are critical to preserving the space commons for future generations. As space activities continue to expand, the development of a comprehensive legal and penal framework addressing property, possession, and penal law in space debris operations is imperative to ensure the long-term viability and peaceful use of outer space.

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[23] Outer Space Treaty, supra note 6, art. VIII; Registration Convention, supra note 8, art. II.

[24] Carns, supra note 11, at 190–91.

[25] May, C., *Triggers and Effects of an Active Debris Removal Market* 2021, at 12

[26] Nevala, supra note 12, at 1500.

[27] *Outer Space Treaty, supra note 6, art. VI.*

[28] *Liability Convention, supra note 7.*

[29] *Carns, supra note 11, at 200–02.*

[30] *Id. at 190–91.*

[31] *Id. at 191.*

[32] *Nevala, supra note 12, at 1500.*

[33] *Outer Space Treaty, supra note 6, art. II.*

[34] *Outer Space Treaty, supra note 6, art. VI.*

[35] *Carns, supra note 11, at 200.*

[36] *Id. at 202.*

[37] *Sindell v. Abbott Laboratories, 26 Cal. 3d 588 (1980).*

[38] *Sundahl, M. J., Unidentified Orbital Debris: The Case for a Market-Share Liability Regime, 24 Hastings Int'l & Comp. L. Rev. 125 (2000); Limperis, P. T., Orbital Debris and the Spacefaring Nations, 15 Ariz. J. Int'l & Comp. L. 319 (1998).*

[39] *United States v. One Lucite Ball Containing Lunar Material, 656 F.2d 196 (9th Cir. 1981).*

[40] *Legality of the Threat or Use of nuclear weapons, Advisory Opinion, 1996 I.C.J. Rep. 226.*

[41] *Liability Convention, supra note 7, arts. XII–XIX.*

[42] *Nevala, E. M., Waste in Space: Remediating Space Through the Doctrine of Abandonment and the Law of Capture, 66 Am. U. L. Rev. 1495, 1528–30 (2017) (arguing for a legal mechanism to allow states to relinquish ownership of abandoned space debris to facilitate cleanup).*

[43] *Nevala, supra note 42, at 1529–30 (proposing a registry or certification system for abandoned debris to provide legal certainty for active debris removal operators).*

[44] *Sindell v. Abbott Laboratories, 26 Cal. 3d 588 (1980) (establishing the doctrine of market-share liability in tort law); Sundahl, M. J., Unidentified Orbital Debris: The Case for a Market-Share Liability Regime, 24 Hastings Int'l & Comp. L. Rev. 125, 130–35 (2000) (applying market-share liability principles to space debris cleanup).*

[45] *Sundahl, supra note 44; Limperis, P. T., Orbital Debris and the Spacefaring Nations: International Law Methods for Prevention and Reduction of Debris, and Liability Regimes for Damage Caused by Debris, 15 Ariz. J. Int'l & Comp. L. 319, 350–55 (1998) (discussing the application of market-share liability to apportion cleanup costs among spacefaring nations).*

[46] *Kurt, J., Triumph of the Space Commons: Addressing the Impending Space Debris Crisis Without an International Treaty, 40 Wm. & Mary Envtl. L. & Pol'y Rev. 305, 329 (2015) (advocating for administration of market-share liability and cleanup funding through UNOOSA using existing registries and tracking data).*

[47] *Carns, M. G., Consent Not Required: Making the Case That Consent Is Not Required Under Customary International Law for Removal of Outer Space Debris Smaller Than 10cm, 77 Air Force L. Rev. 173, 200–02 (2017).*

[48] *Id. at 201.*

[49] *USSTRATCOM Space Track Project, https://www.space-track.org; Carns, supra note 47, at 200.*

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[51] *Akers, A., To Infinity and Beyond: Orbital Space Debris and How to Clean It Up, 33 U. La Verne L. Rev. 285, 308–09 (2012).*

[52] *Sorge, M., & Peterson, G., How to Clean Space: Disposal and Active Debris Removal, Crosslink (Dec. 10, 2015), https://perma.cc/T3SA-CMEX.*

[53] *Akers, supra note 51, at 309.*

[54] *Id. at 310; Kurt, J., supra note 50, at 319.*

[55] *Emanuelli, M., et al., Conceptualizing an Economically, Legally, and Politically Viable Active Debris Removal Option, Acta Astronautica, 104(1), 197–205 (2014).*

[56] *USSTRATCOM Space Track Project, https://www.space-track.org.*

[57] *Kurt, supra note 50, at 329.*

[58] *Sullivan, K., & Ben-Itzhak, S., Securing the Space Domain with Active Orbital Debris Removal: Lessons from Europe and Japan Towards a U.S. Strategy, 21 Astropolitics 127 (2023).*

[59] *COPUOS, Space Debris Mitigation Guidelines (2010); Carns, M. G., Consent Not Required, 77 Air Force L. Rev. 173 (2017).*

[60] *Nevala, E. M., Waste in Space, 66 Am. U. L. Rev. 1495 (2017); Peñalver, E. M., The Illusory Right to Abandon, 109 U. Mich. L. Rev. 191 (2010).*

[61] *Sundahl, M. J., Unidentified Orbital Debris: The Case for a Market-Share Liability Regime, 24 Hastings Int'l & Comp. L. Rev. 125 (2000); Limperis, P. T., Orbital Debris and the Spacefaring Nations, 15 Ariz. J. Int'l & Comp. L. 319 (1998).*

[62] *Carns, supra note 1, at 200–02.*

[63] *Liability Convention, arts. XII–XIX; Outer Space Treaty, art. IX.*

[64] *USSTRATCOM Space Track Project; Kurt, J., Triumph of the Space Commons, 40 Wm. & Mary Envtl. L. & Pol'y Rev. 305 (2015).*

[65] *Akers, A., To Infinity and Beyond, 33 U. La Verne L. Rev. 285 (2012); Emanuelli, M., et al., Conceptualizing an Economically, Legally, and Politically Viable Active Debris Removal Option, Acta Astronautica (2014).*

[66] *Kurt, supra note 6, at 329; United Nations Office for Outer Space Affairs, Roles and Responsibilities, https://perma.cc/SD85-SETU.*

[67] *Carns, supra note 1, at 190; Sullivan, K., & Ben-Itzhak, S., Securing the Space Domain with Active Orbital Debris Removal, 21 Astropolitics 127 (2023).*

[68] *Sullivan & Ben-Itzhak, supra note 9.*

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