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FROM THE EDITOR

Volume 43.2 is undoubtedly eclectic, yet surprisingly thematic and focused on issues very close to our hearts. While many space lawyers would not only be able – but would leap at the opportunity – to work in the vacuum of space, the fact is no one benefits if we try to operate in a vacuum of knowledge. Now more than ever, space lawyers need to understand the technology that is being used, stretched and manipulated to harness the resources of space. We need to engage with engineers and scientists and share cross-disciplinary advice and guidance. After all, we all share the same dream. We seek to expand the human experience to embrace space as our next home. Start-ups and private space companies should view regulations as benefits, not anathemas. Non-lawyers need to appreciate that the law will help. And lawyers need to recognize how to help.

At the University of Mississippi School of Law we are focused on bringing the technological aspects of space into the forefront of our legal education. Our classes include technical presentations about the capabilities of current technologies, as well as the limits that need to be overcome. We don't just study what law might apply to asteroid mining, we learn how and when and where such mining might occur. And we challenge our students not to exploit, but fill gaps in the law that will properly balance commercial investment and the responsibilities imposed by the outer space treaty regime, international law and foundational moralities.

This issue talks about exciting new technologies, troubling realities associated with space exploration, yawning gaps related to armed conflict and the importance of dispute resolution – fundamental to any aspect of society or industry. Our student Article wraps this issue up well. The message from every author is that international collaboration is a necessity. It's not an Earth shattering message to be sure (pun intended), but it is one that bears repeating. *Ad infinitum* if need be.

With thanks, as ever, to all our student editors, especially Senior Editors Charles Ellzey, Hunter Williams and Sean Taylor who have committed so much time and thought to this issue, our process and the future of the *Journal of Space Law*. With students like this, I can assure you, humanity's future in space is very bright. I also single out our Executive Editors, CJ Robison and Jeremy Grunert. CJ, who always finds time. And Jeremy, without whom this issue would have been both less lyrical and massively delayed.

We hope you enjoy, and we look forward to your contributions.

Michelle L.D. Hanlon
Editor-in-Chief
Oxford, Mississippi
December, 2019

EXPLORING THE LEGAL CHALLENGES OF FUTURE ON-ORBIT SERVICING MISSIONS AND PROXIMITY OPERATIONS

Anne-Sophie Martin[*] *and Steven Freeland*[**]

ABSTRACT

On-orbit servicing (OOS) and rendezvous and proximity operations (RPO) currently represent key elements regarding future on-orbit activities. If successfully implemented, these types of missions will greatly increase the viability of and benefits from space activities. Several countries and companies are seeking to develop active debris removal (ADR), OOS, and RPO capabilities. However, these proposed activities raise several legal, safety, security and policy challenges. Indeed, the planned future servicing missions through a so-called space tug –including orbit correction, refueling, space

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debris removal and substitution of payload—highlight a new paradigm in space activities. On the one hand there is a necessity to avoid collision in orbit; on the other hand, in the case of on-orbit rendezvous, the activity is predicated on the docking of two space objects. This article identifies and discusses some of these major challenges, including any associated risks to space security, the "weaponization" of space and their impact on the sustainability of the space environment.

I. INTRODUCTION

OOS activities have recently caught the attention of the international community due to the rising commercial interests behind these activities.[1] OOS missions, however, have occurred since the early age of space exploration.[2] Previous missions such as the Gemini and Apollo programs undertook RPO activities.[3] Skylab and Solar Maximum Mission (SMM) conducted on-orbit activities to repair essential components, with SMM harnessing a modular design using orbital replacement units (ORUs).[4] The Hubble Space Telescope (HST) was serviced five times, including replacement of circuit boards.[5] The International Space Station (ISS) was assembled on-orbit and is continually refueled with propellant through robotic refueling missions (RRMs), with new modules added to boost its capabilities and offer new scientific possibilities.[6] These activities were all carried out by humans or by robotic systems such as the Canadarm2.[7]

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[1] This paper will not address the commercial viability of OOS missions, RPO, and ADR activities. *See, e.g.,* Andrew Robert Graham & Jennifer Kingston, *Assessment of the Commercial Viability of Selected Options for On-Orbit Servicing (OOS)*, 117 ACTA ASTRONAUTICA 38 (2015).

[2] *On-Orbit Satellite Servicing Study*, NASA PROJECT REPORT 5 (Oct. 2010) https://sspd.gsfc.nasa.gov/images/NASA_Satellite%20Servicing_Project_Report_0511.pdf [hereinafter NASA PROJECT REPORT].

[3] Joshua Davis et al., *On-Orbit Servicing: Inspection, Repair, Refuel, Upgrade, and Assembly of Satellites in Space*, AEROSPACE 22 (Apr. 2019), https://aerospace.org/sites/default/files/2019-05/Davis-Mayberry-Penn_OOS_04242019.pdf.

[4] *Id.*

[5] *Id.*

[6] *Id.* at 6.

[7] *About Canadarm2*, CAN. SPACE AGENCY (June 15, 2018), http://www.asc-csa.gc.ca/eng/iss/canadarm2/about.asp.

OOS, RPO and active debris removal (ADR) are strategic missions that ensure the future success of on-orbit activities. Indeed, these missions will greatly increase the viability of and benefits from space activities as more objects are launched into orbit and remain longer in outer space. The availability of "orbital slots" in the geostationary orbit (GEO) is limited, and the low-Earth orbit (LEO) region is becoming crowded, representing a real challenge to commercial, civil and military operators. While government agencies traditionally undertake OOS activities, the commercial space sector is beginning to integrate robotic servicing as an integral part of its space architectures. In this context, several countries and companies are developing OOS and RPO capabilities.[8] Once the market and technologies reach maturity, they will offer important methods for space actors[9] to extend the life of space assets, lower costs and increase profits throughout a satellite's operational lifetime.[10] OOS, for instance, is a useful tool for maintaining, repairing, upgrading, reviewing payload, refueling, or de-orbiting a spacecraft while in orbit.[11] OOS activities require the servicing spacecraft to approach, rendezvous and interact with the asset to be serviced. For repair, upgrade or refuel missions, the servicing spacecraft most often needs to attach to the satellite by either connecting to a docking port or by capturing it with a robotic arm or similar technology through deployment of a so-called a space tug.[12] De-orbit missions may use tethers, harpoons, nets, or lasers.[13]

These missions underscore a new paradigm in space activities. There is a necessity to avoid collisions during OOS missions, but RPO missions raise additional unique legal concerns given the risk of causing damage to another space object during orbital docking.[14]

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[8] Sandra Erwin, *On-Orbit Satellite Servicing: The Next Big Thing in Space?*, SPACENEWS (Nov. 17, 2017), https://spacenews.com/on-orbit-satellite-servicing-the-next-big-thing-in-space/.

[9] NASA PROJECT REPORT, *supra* note 2, at 40.

[10] Martin Losekamm, *On-Orbit Servicing and Active Debris Removal: Technical Aspects*, *in* PROMOTING PRODUCTIVE COOPERATION BETWEEN SPACE LAWYERS AND ENGINEERS 155 (IGI Global ed., 2019).

[11] *Id*.

[12] Sandra Erwin, *In-Orbit Services Poised to Become Big Business*, SPACENEWS (June 10, 2018), https://spacenews.com/in-orbit-services-poised-to-become-big-business/.

[13] NASA PROJECT REPORT, *supra* note 2, at 35.

[14] Olga Stelmakh-Drescher, *OOS and ADR Activities: Facet of Responsible Use of Outer Space and Limits of Their Legality*, *in* 5TH LUXEMBOURG WORKSHOP ON SPACE

For instance, when there is contact between space objects there is also contact between State jurisdictions. What in such instances is the relationship amongst national space regulations? Who is liable if an accident occurs during a servicing mission, possibly involving a servicing spacecraft of another launching State? Who would be liable for damage caused on Earth by a space object being de-orbited? Does that apply even when the spacecraft was de-orbited by an actor other than the launching State? If an accident occurs in outer space, a proof of fault is required under Article III of the Convention on International Liability for Damage Caused by Space Objects (the Liability Convention),[15] which holds the launching State internationally liable for damage caused to other space objects. How can this fault be proven?

Recent technological advances and proposed future OOS and RPO missions have significantly increased the need for a stringent legal and political framework for industry and governments missions at both the national and international level.[16] Even if OSS missions are not considered inherently military activities, the core capability of the system is of a dual-use nature, allowing for potential military application. One can certainly envision that an on-orbit service vehicle might pose a threat to space security. Thus, the first part of this article analyses the legal challenges of the military use of outer space in the context of OOS and RPO, particularly in light of the United Nations space treaties to which many of the States that may seek to take advantage of OOS and RPO technologies are State Parties. Of particular importance in this regard are the 1967 Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, Including the Moon and

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AND SATELLITE COMMUNICATION LAW 14 (2016), *available at* https://wwwen.uni.lu/content/download/91841/1118911/file/OOS%20and%20ADR%20Activities%20-%20Facet%20of%20Resposnible%20Use%20of%20Outer%20Space%20and%20Limits%20of%20Their%20Legality.pdf.

[15] Convention on International Liability for Damage Caused by Space Objects art. III, Mar. 29, 1972, 24 U.S.T. 2389, 961 U.N.T.S. 187 [hereinafter Liability Convention] ("In the event of damage being caused elsewhere than on the surface of the Earth to a space object of one launching State or to persons or property on board such a space object by a space object of another launching State, the latter shall be liable only if the damage is due to its fault or the fault of persons for whom it is responsible.").

[16] Theresa Hitchens, *Satellite Servicing Industry Wants New Rules*, BREAKING DEFENSE (May 9, 2019), https://breakingdefense.com/2019/05/satellite-servicing-industry-wants-new-rules/.

Other Celestial Bodies (the Outer Space Treaty),[17] the Liability Convention[18] and the 1975 Convention on Registration of Objects Launched into Outer Space (the Registration Convention).[19] Then, in view of the nature of these activities, a comparison will be made with the law of salvage in maritime law. However, OOS and RPO missions are not completely covered by the existing treaties, leaving several key legal issues unaddressed. Hence, given the legal challenges, it will be interesting to examine industry practice in the field.

II. ON-ORBIT SERVICING VEHICLE: FRIEND OR FOE?

A. Insights on the Military Use of Outer Space

OOS and RPO capabilities are rapidly evolving due to the proliferation of space technology. RPO capabilities are being developed and tested for a wide variety of commercial, civil and national security applications such as human spaceflight docking and orbital assembly, satellite servicing, repair and refueling, inspection and intelligence collection and co-orbital anti-satellite weapons (ASATs). One of the main legal challenges in using these technologies is to avoid their "weaponization" and ensure they are utilized in a peaceful manner while also taking into account the sustainability of the space environment. Due to the dangers of weaponization, the development of OOS vehicles may disrupt space security.

Weaponization is a grey zone in the law of space activities.[20] The only article in the Outer Space Treaty directly addressing weapons and military uses of outer space is Article IV.[21] This article prohibits States from placing any weapons on the Moon or other

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[17] Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, Including the Moon and Other Celestial Bodies, Jan. 27, 1967, 18 U.S.T. 2410, 610 U.N.T.S. 205 [hereinafter Outer Space Treaty].

[18] Liability Convention, *supra* note 15.

[19] Convention on Registration of Objects Launched into Outer Space, Nov. 12, 1975, 28 U.S.T. 695, 1023 U.N.T.S. 15 [hereinafter Registration Convention].

[20] *See generally* Jinyuan Su, *Use of Outer Space for Peaceful Purposes: Non-Militarization, Non-Aggression and Prevention of Weaponization*, 36 J. SPACE L. 253 (2010); Jackson Maogoto & Steven Freeland, *From Star Wars to Space Wars - The Next Strategic Frontier: Paradigms to Anchor Space Security*, 33 ANNALS AIR & SPACE L. 10 (2008).

[21] Outer Space Treaty *supra* note 17, art. IV ¶ 2. *See also*. Kai-Uwe Schrogl & Julia Neumann, *Article IV*, *in* 1 COLOGNE COMMENTARY ON SPACE LAW 70 (Carl Heymanns ed., 2009).

celestial bodies,[22] but only expressly precludes States from placing some weapons, such as nuclear weapons and other weapons of mass destruction (WMD), into Earth orbit.[23] This means that placing conventional weapons in Earth orbit or deep space is not *explicitly* prohibited. As a result, one could claim that Article IV of the Outer Space Treaty only presents a partial limit regarding the use of weapons in outer space. Despite the conventional weapons "loophole," there are several articles within the Outer Space Treaty that are indicative of an underlying requirement that space activities should be undertaken for peaceful purposes. Still, even if such an underlying requirement existed, difficulties would still arise due to varying interpretations of the term "peaceful purposes"[24] and the fact that military activities have occurred in outer space since the beginning of the space age.[25]

When discussing the legal instruments relevant to military activities in outer space, it is important to mention (i) the Anti-Ballistic Missile Treaty (ABM Treaty)[26] of 1972 between the United-States and the Soviet Union, which prohibited the deployment of conventional weapons in outer space; (ii) the Convention on the Prohibition of Military or Any Other Hostile Use of Environmental Modification Techniques (ENMOD Convention),[27] which bans State Parties engaged in military activities from using environmental modification techniques that have devastating effects in outer space (Article II); and (iii) the Agreement Governing the Activities of

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[22] Outer Space Treaty *supra* note 17, art. IV ¶ 2.

[23] *Id.*

[24] *See* STEPHAN HOBE, SPACE LAW 76-77 (2019); Stephan Hobe, *The Meaning of Peaceful Purposes in Article IV of the Outer Space Treaty*, 40 ANNALS AIR & SPACE L. 9 (2015).

[25] *See generally* Steven Freeland, *The 2008 Russia/China Proposal for a Treaty to Ban Weapons in Space: A Missed Opportunity or an Opening Gambit?*, 51 PROC. INT'L INST. SPACE L. 261 (2008).

[26] Treaty Between the United States of America and the Union of Soviet Socialist Republics on the Limitation of Anti-Ballistic Missile Systems, U.S.-U.S.S.R., May 26, 1972, 23 U.S.T. 3435, 944 U.N.T.S. 13. Although the United States withdrew from the ABM Treaty in 2002, its provisions still inform the legal framework relevant to military uses of outer space.

[27] Convention on the Prohibition of Military or Any Other Hostile Use of Environmental Modification Techniques, Dec. 10, 1976, 31 U.S.T. 333, 1108 U.N.T.S. 151.

States on the Moon and Other Celestial Bodies (the Moon Agreement),[28] Article 3 of which stipulates that the Moon must be used exclusively for peaceful purposes, and any threat or use of force or any other hostile act on the Moon is prohibited.

Efforts by the international community to address military activities in outer space have centered around the development of policy regimes known as the Prevention of an Arms Race in Outer Space (PAROS).[29] Attempts to advance the PAROS initiative occur within two international organizations. First, the United Nations General Assembly (UNGA) passes a resolution on PAROS each year reiterating the necessity to maintain international peace and security in outer space. Secondly, PAROS is on the list of the Conference on Disarmament (CD) competencies. However, the legal obligations linked to PAROS are difficult to achieve[30] because both these organizations have different aims and diverse legal standpoints on the "weaponization" of space.[31]

In 2017, the UNGA resolution entitled *Further practical measures for the prevention of an arms race in outer space*[32] urged the CD to implement a balanced and comprehensive program of work at its earliest opportunity. It also requested the United Nations Secretary General to establish a Group of Governmental Experts that would analyze and make recommendations on substantial elements of an international legally binding instrument on the prevention of an arms race in outer space, including, *inter alia*, on the prevention of the placement of weapons in outer space. The two

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[28] Agreement Governing the Activities of States on the Moon and Other Celestial Bodies, Dec. 18, 1979, 1363 U.N.T.S. 3.

[29] G.A. Res. 36/97, at C (Dec. 18, 1981). *See generally* Steven Freeland, *Peaceful Purposes? Governing the Military Uses of Outer Space*, 18 EUR. J.L. REFORM 35 (2016); Ben Baseley-Walker, *Outer Space, Geneva and the Conference on Disarmament: Future Directions*, 28 SPACE POL'Y 45 (2012).

[30] *See* Setsuko Aoki, *Law and Military Uses of Outer Space*, *in* ROUTLEDGE HANDBOOK OF SPACE LAW 207 (2017).

[31] JAMES CLAY MOLTZ, THE POLITICS OF SPACE SECURITY: STRATEGIC RESTRAINT AND THE PURSUIT OF NATIONAL INTERESTS 42-43 (2008). *See also* Sa'id Mosteshar, *Space Law and Weapons in Space*, *in* OXFORD RESEARCH ENCYCLOPEDIA OF PLANETARY SCI. 7 (May 2019), *available at* https://oxfordre.com/planetaryscience/view/10.1093/acrefore/9780190647926.001.0001/acrefore-9780190647926-e-74?print=pdf.

[32] G.A. Res. 72/250 (Jan. 12, 2017).

sessions of the CD in 2018 and 2019, however, failed to reach a consensus on a final report.[33]

The most recent treaty proposal, presented jointly by Russia and China to the CD, is the draft Treaty on Prevention of the Placement of Weapons in Outer Space, the Threat or Use of Force against Outer Space Objects (more colloquially known as the draft Prevention of the Placement of Weapons Treaty, or draft PPWT).[34] However, some States expressed strong opposition to accepting binding legal instruments on this matter, particularly the United States.[35] Moreover, an aspect that complicates the negotiation of a binding treaty is the absence of concrete verification mechanisms for objects launched into space[36] which thus limits the ability to definitively determine if those objects can be classified as weapons.[37]

Whether as part of the CD or the UNGA, there have also been various proposals calling for the development of non-legally binding instruments to advance transparency and confidence building measures (TCBM).[38] One example of such a TCBM is the pledge of

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[33] Group of Governmental Experts on Further Practical Measures for the Prevention of an Arms Race in Outer Space, Working Paper Submitted by Bassem Hassan, U.N. Doc. GE-PAROS/2019/WP.7 (Mar. 22, 2019), *available at* https://undocs.org/pdf?symbol=en/GE-PAROS/2019/WP.7. *See also* European External Action Service, Statements on Behalf of the EU (June 13, 2019), https://eeas.europa.eu/headquarters/headquarters-homepage/64087/conference-disarmament-informal-thematic-session-agenda-item-3-prevention-arms-race-outer_en.

[34] Draft Treaty on the Prevention of the Placement of Weapons in Outer Space, the Threat or Use of Force Against Outer Space Objects, U.N. Doc. CD/1985 (June 12, 2014).

[35] U.S. Mission to International Organizations in Geneva, *Statement by Ambassador Wood: The Threats Posed by Russia and China to Security of the Outer Space Environment, Geneva, August 14, 2019 available at* https://geneva.usmission.gov/2019/08/14/statement-by-ambassador-wood-the-threats-posed-by-russia-and-china-to-security-of-the-outer-space-environment/.

[36] Frank Cleminson & Pericles Alves, *Space Weapons Verification: A Brief Appraisal*, *in* VERIFICATION OF DISARMAMENT OR LIMITATION OF ARMAMENTS: INSTRUMENTS, NEGOTIATIONS, PROPOSALS 177 (United Nations ed., 1992); *see also* Space-Based Verification: *PAXSAT A* Then and Developments Since, Working Paper, U.N. Doc. CD/1785 (June 21, 2006) ; Verification Aspects of Paros, Working Paper, U.N. Doc. CD/1781 (May 22, 2006), *available at* https://undocs.org/pdf?symbol=en/CD/1781.

[37] Jinyuan Su, *Towards an Effective and Adequately Verifiable PPWT*, 26 SPACE POL'Y 152 (2010);
Michael Listner & Rajeswari Rajagopalan, *The 2014 PPWT: A New Draft but With the Same and Different Problems*, THE SPACE REVIEW (Aug. 11, 2014), http://www.thespacereview.com/article/2575/1.

[38] Transparency and Confidence-Building Measures in Outer Space Activities and the Prevention of Placement of Weapons in Outer Space, Working Paper, U.N. Doc.

"*no first placement of weapons in outer space*." a number of States, including Argentina, Armenia, Belarus, Brazil, Cuba, Indonesia, Kazakhstan, Kyrgyzstan, Russia, Sri Lanka and Tajikistan have publicly stated they will not be the first States to place weapons in space, and a 2014 UNGA Resolution encouraged all States to abide by such a policy.[39] The adoption of policy positions like the "no first placement" pledge or other TCBM instruments is of the utmost importance for fostering international cooperation in the field and ensure the peaceful use of outer space.

Regardless of the possible adoption of TCBMs and the development of treaties designed to prevent the weaponization of space, the possibility of unsupervised access to space assets by service spacecraft presents a security risk. Hence, the main concern is to understand the legal issues that arise should a vehicle be used for an OOS, RPO or ADR mission. This encompasses a number of challenges, including: finding ways to differentiate between civil, commercial RPO for peaceful purposes and potentially hostile RPO; identifying the best practices and standards for reducing mishaps and mistakes that could damage satellites and/or generate orbital debris; setting up norms of behavior and TCBMs for military RPO to reduce the risks of misperceptions that could potentially spark crisis or conflict; and improving space situational awareness (SSA) for monitoring and verification.

B. The Dual-Use Nature of These Systems

The term "weaponization of space" refers to the deployment of weapons in outer space to attack, destroy, or damage objects in outer space, as well as human beings and objects on the Earth.[40]According to the draft PPWT, the term "weapon in outer space" means

> any outer space object or its component produced or converted to destroy, damage or disrupt the normal functioning of objects

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CD/1778 (May 22, 2006) (In 2006, China and Russia presented a working paper on transparency and confidence-building measures in outer space activities and the prevention of weapons positioning in space). *See also* G.A. Res. 62/43 (Jan. 8, 2008) ; G.A. Res. 61/75 (Dec. 18, 2006); G.A. Res. 60/66 (Jan. 6, 2006).

[39] G.A. Res. 69/32, No First Placement of Weapons in Outer Space (Dec. 11, 2014).

[40] Steven Freeland, *International Law and the Exploration and Use of Outer Space*, *in* RISK AND THE REGULATION OF UNCERTAINTY IN INTERNATIONAL LAW 77 (Oxford ed., 2017).

> in outer space, on the Earth's surface or in its atmosphere, or to eliminate human beings or components of the biosphere which are important to human existence, or to inflict damage on them by using any principles of physics.[41]

However, several difficulties exist in clearly defining "space weapons" or "weapons in space," in part due to the variety of potential space weapons and the fact that many space technologies have both civil or commercial and military applications.[42]

Thus, even if certain space technologies, such as OOS and RPO capabilities, are not weapons *per se*, they can be viewed as latent threats as a result of their dual-use nature.[43] Dual-use technologies have a growing strategic value and, even if civilly developed, have the potential to increase security concerns. Indeed, the capability to perform proximity operations, rendezvous, contact/capture and de-orbit makes OOS and RPO technologies useable as pseudo-ASAT systems.[44]As a result, we should consider the legality of these technologies in light of their dual-use capacity.

OSS missions are not necessarily military space activities; however, their core capabilities to maneuver around, rendezvous with and manipulate other space objects allows for potential military application. This technology has the capability to interfere

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[41] Letter dated 10 June 2014 from the Permanent Representative of the Russian Federation and the Permanent Representative of China to the Conference on Disarmament addressed to the Acting Secretary-General of the Conference transmitting the updated Russian and Chinese texts of the draft treaty on prevention of the placement of weapons in outer space and of the threat or use of force against outer space objects (PPWT) introduced by the Russian Federation and China, U.N. Doc. CD/1985 (June 12, 2014).

[42] FRANCIS LYALL & PAUL LARSEN, SPACE LAW: A TREATISE 469 (2018).

[43] Hobe, *supra* note 24, at 100; Joseph Pelton, *Satellite Security and Performance in an Era of Dual Use*, 6 Online J. of Space Comm. (Winter 2004), https://spacejournal.ohio.edu/issue6/pdf/pelton.pdf.

[44] Shang Kuan, *Legality of the Deployment of Anti-Satellite Weapons in Earth Orbit: Present and Future*, 36 J. SPACE L. 207, 230 (2010); David Koplow, *Asat-isfaction: Customary International Law and the Regulation of Anti-Satellite Weapons*, 30 MICH. J. INT'L L. 1187, 1272 (2009). The dual nature of these technologies poses some difficulties under international humanitarian law and particularly under *jus in bello* principles. It should take into account the unique features of space operations and the increasing reliance to dual use satellites for military missions, which makes difficult to distinguish between civil or military *status* of satellites used for both purposes. *See* Dale Stephens & Cassandra Steer, *Conflicts in Space: International Humanitarian Law and Its Application to Space Warfare*, 40 ANNALS AIR & SPACE L. 71 (2015).

with other States' space assets. Hence, OSS missions raise questions related to the "weaponization" of space and the extent to which OSS technology can be used in a non-peaceful manner. A State's ability to interfere with another State's space asset reflects a key strategic capability,[45] and the use of OSS capabilities might be perceived as an "aggressive' activity." Thus, the key issue is whether OOS, RPO and ADR technologies violate the principle of peaceful uses of outer space in light of the ultimate purpose of the OOS vehicle. As these technologies are specifically designed to interact with other objects in space, they have the potential to interfere with other spacecraft.

Dual-use technologies such as OOS, RPO and ADR capabilities have a growing strategic value and may serve as "Trojan Horses" opening the way for an arms race in outer space.[46] Because these technologies have the potential to be destabilizing, States must take measures to identify their intent when engaging in these activities regardless of whether the main purpose is commercial or civil. Furthermore, States should implement clear policy and legal frameworks concerning the use of these technologies by taking into account the recent long-term sustainability guidelines adopted by the United Nations Committee on the Peaceful Uses of Outer Space (UNCOPUOS).[47] Given the uncertainty of the legal framework regarding the weaponization of outer space; the progress of rapidly

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[45] *See generally* Michel Bourbonniere, *National-Security Law in Outer Space: The Interface of Exploration and Security*, 70 J. AIR L. & COM. 3 (2005).

[46] Marco Cervino et al., *Is the Peaceful Use of Outer Space Being Ruled Out?* 19 SPACE POL'Y 231 (2003).

[47] Comm. On the Peaceful Uses of Outer Space, Science and Technical Subcomm., Guidelines for the Long-Term Sustainability of Outer Space Activities, U.N. Doc. A/AC.105/C.1/L/366 (July 17, 2018). During its 62nd session, the Committee on the Peaceful Uses of Outer Space adopted a preamble and 21 guidelines for the long-term sustainability of outer space activities. These guidelines provide guidance on policy and regulatory framework for space activities, safety of space operations; international cooperation, capacity-building and awareness; and scientific and technical research and development. Among the most significant guidelines for the purposes of easing the security risks of utilizing dual-use technologies are: guideline A.3, "Supervise national space activities;" guideline A.5, "Enhance the practice of registering space objects; guideline B.1, "Provide updated contact information and share information on space objects and orbital events;" guideline B.2, "Improve accuracy of orbital data on space objects and enhance the practice and utility of sharing orbital information on space objects;" guideline B.4, "Perform conjunction assessment during all orbital phases of controlled flight;" guideline B.8, "Design and operation of space objects regardless of their physical and operational

advancing technologies; and the risks of dual-use systems (such as OOS, RPO and ADR capabilities) that make it difficult for States to distinguish between civilian and military uses of outer space, it is in the interest of all countries to establish best practices, through the development of TCBMs.[48] These may have the aim of offsetting normative behavior for future space activities while also ensuring other States of the legality of space operations in order to avoid conflict.

III. AN OVERVIEW OF OOS MISSIONS AND RPO FROM THE UNITED NATIONS SPACE LAW TREATIES PERSPECTIVE

A. The Outer Space Treaty and the Liability Convention

As previously mentioned, the Outer Space Treaty and the Liability Convention are of particular interest to OOS activities. Article VI of the Outer Space Treaty provides States bear "international responsibility for national activities in outer space . . . whether such activities are carried on by governmental agencies or by non-governmental entities."[49] Moreover, it states that these entities "shall require authorization and continuing supervision by the appropriate State Party to the Treaty."[50] In this context, States have traditionally implemented these obligations at the domestic level through licensing regimes granted by government authorities.

Furthermore, space missions represent high risk activities, and Article VII of the Outer Space Treaty holds the relevant States liable for accidents they cause on the surface of the Earth, in air space or in outer space.[51] Thus, States engaged in RPO and OOS will be liable for any damage caused under the terms of the treaty.

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characteristics;" guidelines C.2, "Share experience related to the long-term sustainability of outer space activities and develop new procedures, as appropriate, for information exchange;" guideline C.3, "Promote and support capacity-building;" and guideline D.1, "Promote and support research into and the development of ways to support sustainable exploration and use of outer space."

[48] G.A. Res. 72/65 Report on the Conference on Disarmament (Dec. 13, 2017); *see also* Rep. of the Group of Governmental Experts on Transparency and Confidence-Building Measures in Outer Space Activities, U.N. Doc. A/68/189 (2013).

[49] Liability Convention, *supra* note 15, art. VI.

[50] *Id.*

[51] *See* Armel Kerrest & Caroline Thro, *Liability for Damage Caused by Space Activities*, *in* ROUTLEDGE HANDBOOK OF SPACE LAW 59 (2017).

However, given that the activity may involve two launches and perhaps two different groups of potentially liable States, one of the main questions will involve identifying the liable State amongst the launching States of the "docked" vehicles and the launching States of the spacecraft to be serviced.

With some differences,[52] Article VII of the Outer Space Treaty was expanded upon by the Liability Convention which established an international liability regime for States engaging in outer space activities. Indeed, the Liability Convention holds a launching State liable under a fault-based standard in cases of damage caused by its space objects in outer space and under an absolute or strict liability standard for damage caused on the surface of the Earth or to aircraft in flight.[53] Under the Liability Convention, the "launching State" is liable for damage caused "by its space object."[54] "Launching State" is defined as a State which launches a space object, procures the launch of the space object and from whose territory or facility a space object is launched.[55]

It is possible that a RPO or an OOS mission might target a space object that does not belong to the State engaging in the mission.[56] Thus, RPO and OOS can create issues of liability when the

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[52] Article VII of the Outer Space Treaty does not require damage to "a space object" and is therefore wider and potentially has broader scope where one of the relevant parties is not a party to the Liability Convention. The Liability Convention is *lex specialis* in relation to the Outer Space Treaty. According to the maxim *lex specialis derogate legi generali*, whenever two or more norms deal with the same subject matter, priority should be given to the norm that is more specific. *See* Armel Kerrest and Lesley Jane Smith, *Article VII*, *in* 1 COLOGNE COMMENTARY ON SPACE LAW, 126-45 (Carl Heymanns ed. 2009) ("[G]iven that Art.VII contains the general liability provision on which the LIAB is based, acceptance of liability under one or both treaties may be read as recognition of the binding force of the State liability rule as a customary rule of international law derived from a treaty obligation. International State liability is fully accepted at international and bilateral level and now constitutes standard State practice in relation to launch agreements and more generally in space activities manifested in the form of cross-waivers of State to State liability. Although detailed rules of liability have been further developed within the LIAB, Art.VII of the OST remains the central international legal norm to be applied, particularly where the rules of LIAB are not applicable or are not favourable to the victim. This may in particular apply in cases of damage taking place in orbit . . . .")."

[53] Liability Convention, *supra* note 15, arts. II, III.

[54] *Id.* at arts. I, III.

[55] *Id.* at art. I.

[56] Tare Brisibe, *Satellite Servicing On-Orbit by Automation and Robotics: Legal and Regulatory Considerations*, 29 J. SPACE L. 21 (2003).

targeted object and the targeting object belong to different launching States.[57] In such instances, issues of causation may occur in various scenarios involving these technologies.[58] For instance, if the rendezvous of one space object inadvertently affects another object's orbit, causing it to collide with a third party's spacecraft, then a question of which space object caused the damage will arise. Article V of the Liability Convention provides clarification in that "the participants in a joint launching may conclude agreements regarding the apportioning among themselves of the financial obligation in respect of which they are jointly and severally liable."[59] If international law does not give legal detail about RPO and OOS missions, contractual terms between the participants may fill in any gaps, including some of the issues identified above.

Furthermore, one can observe that these activities may not be limited to space objects owned by the States engaging in these activities. Indeed, States should address issues of ownership, particularly for that State whose entity has ownership rights over the asset, and jurisdiction when engaging with RPO and OOS activities. In particular, Article VIII of the Outer Space Treaty stipulates that "[a] State Party to the Treaty on whose registry an object launched into outer space is carried shall retain jurisdiction and control over such object . . . . Ownership of objects launched into outer space is not affected by their presence in outer space."[60] This means that States engaged in OOS missions will need to be mindful of the rights and obligations of the launching State(s), the State of registration, and the State of ownership, which itself raises several legal issues about which State(s) must be approached before engaging in an OOS mission. Most likely the State of registration, which has jurisdiction, would be sufficient, but the high risk of the activity and the potential liability of the launching States may necessitate further consultation and cooperation among the participants.

Given the nature of the OOS activities, the question of risk and insurance must be underscored. Undoubtedly, it will be difficult for insurers, in the early stages of the activity, to determine adequate

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[57] P.J. Blount, *On-Orbit Servicing and Active Debris Removal: Legal Aspects*, *in* PROMOTING PRODUCTIVE COOPERATION BETWEEN SPACE LAWYERS AND ENGINEERS 184 (Information Science Reference ed., 2019).

[58] *Id.*

[59] Liability Convention, *supra* note 15 at art. V.

[60] *Id.* at art. VIII.

coverage,[61] due to the lack of clarity in relation to applicable domestic laws. An idea could be for a State regulator to impose insurance premiums to ensure that damage does not overexpose that State under the international liability regime.[62]

Finally, States must have affirmative consent from the owner of a space object and States with jurisdiction before engaging with that object. Such consent would result from "consultations" between States *inter alia* pursuant to Article IX of the Outer Space Treaty.[63] Without such consent, space objects remain under the jurisdiction and control of the State of registry, and interferences could be a hostile act.

Additionally, Article IX of the Outer Space Treaty stipulates that

> If a State Party to the Treaty has reason to believe that an activity or experiment planned by it or its nationals in outer space, would cause potentially harmful interference with activities of other States Parties in the peaceful exploration and use of outer space, it shall undertake appropriate international consultations before proceeding with any such activity or experiment. A State Party to the Treaty which has reason to believe that an activity or experiment planned by another State Party in outer space would cause potentially harmful interference with activities in the peaceful exploration and use of outer space may request consultation concerning the activity or experiment.[64]

This means that States must act "with due regard to the corresponding interests of other State Parties to the Treaty" and to engage in "international consultations" when their space activities could cause "potentially harmful interference." States should avoid any measures aimed at disrupting the space activities of other States.[65] Hence, States that pursue RPO and OOS activities will have a legal obligation to use these technologies with "due regard"-

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[61] Paul Ordyna, *Insuring Human Space Flight: An Underwriter's Dilemma*, 36 J. OF SPACE L. 231-51 (2010).

[62] Blount, *supra* note 57, at 187.

[63] Sergio Marchisio, *Article IX*, *in* 1 COLOGNE COMMENTARY ON SPACE LAW 169-82 (Carl Heymanns ed., 2009).

[64] Outer Space Treaty, *supra* note 17 at art. IX.

[65] Marchisio, *supra* note 63 at 169-82.

that is, with a certain standard of care and attention – and not interfere with other States' space missions.

The principle of due regard must be observed in conjunction with the facts and circumstances of the case. This includes ensuring a spacecraft employed in OOS or RPO activities is not involved in collisions with the spacecraft of other States, that the mission is not a source of more space debris through collisions with the intended target and that the maneuver does not harmfully interfere with other space objects. States engaged in such activities must mitigate the creation of space debris through adherence to mechanisms such as the Inter-Agency Space Debris Coordination Committee (IADC) Debris Mitigation Guidelines[66] and the Space Debris Mitigation Guidelines of the UNCOPUOS.[67]

Lastly, Article X of the Outer Space Treaty stipulates:

> . . . States Parties to the Treaty shall consider on a basis of equality any requests by other States Parties to the Treaty to be afforded an opportunity to observe the flight of space objects launched by those States. The nature of such an opportunity for observation and the conditions under which it could be afforded shall be determined by agreement between the States concerned.[68]

The Outer Space Treaty affords the opportunity to observe the flight of a space object that will perform RPO and OOS missions. Hence, Space Situational Awareness (SSA) activities will be relevant in the context of these missions.[69] SSA aims to monitor the outer space environment in order to identify and assess natural and human-made objects in flight, and also to evaluate risks to space assets.[70] The objective is to create transparency regarding satellite

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[66] Inter-Agency Space Debris Coordination Committee, IADC Space Debris Mitigation Guidelines, IADC-02-01 (Sept. 2007), *available at* https://www.unoosa.org/documents/pdf/spacelaw/sd/IADC-2002-01-IADC-Space_Debris-Guidelines-Revision1.pdf.

[67] U.N. Office for Outer Space Affairs, Space Debris Mitigation Guidelines of the Committee on the Peaceful Uses of Outer Space, U.N. Sales No. E.99.I.17 (2010), *available at* http://www.unoosa.org/pdf/publications/st_space_49E.pdf.

[68] Outer Space Treaty, *supra* note 17 at art. X.

[69] *See* Brian Weeden, *Space Situational Awareness Fact Sheet*, SECURE WORLD FOUND. (May 2017), https://swfound.org/media/205874/swf_ssa_fact_sheet.pdf.

[70] Rafael Moro-Aguilar & Steven Mirmina, *Space Traffic Management and Space Situational Awareness*, *in* ROUTLEDGE HANDBOOK OF SPACE LAW 189 (2016).

information[71] and to foster international cooperation both on the technical aspects of surveillance and on the sharing of data among actors involved.

B. The Registration Convention: Distinction Between Two Phases in Orbit

As previously mentioned, OOS and RPO missions will involve at least two launches, with one or two launching States, or possibly two different groups of launching States. OOS and RPO missions will involve a launching State that must register the spacecraft, thus becoming the State of registry, and another launching State that must register the "docked" vehicle, also becoming its State of registry. Hence, there will be two States of registry. Nevertheless, it could be possible that the two launching States are the same. In this case, identical owners and launching States will reduce the legal complexity. However, in the specific case of two launching States and two space objects with different "nationalities," there would be "contact" between two different domestic legal regimes with both exercising jurisdiction and control over their registered space objects. It is therefore necessary to distinguish between two phases in orbit.

Firstly, in the "on-orbit rendezvous" phase, there is a possibility that two space objects with different nationalities meet, so it will be necessary to get two authorizations from the two States involved in the mission. In this case, consistency among the technical regulations of both States may better facilitate the mission under similar conditions for both participants. If one regulatory regime is tighter or more flexible than the other, States risk exposing themselves to different levels of risk for the same activity. Consequently, States and private entities should think about a possible harmonization.

Secondly, during the "anchoring" phase, it is necessary to determine the status of the two docked objects. They might become a single object, or alternately remain as two distinct space objects. Likely, the idea would be two separate objects with a possibility of two different States of registry. Furthermore, in order to ensure

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[71] Stefan Kaiser, *Legal and Policy Aspects of Space Situational Awareness*, 31 SPACE POL'Y 5-12 (Feb. 2015).

that the operation unfolds under the best conditions of security and safety, it would be necessary to apply only one domestic law with one set of technical regulations to the anchoring phase. Another issue to underscore is whether there is a transfer of control of the space object by the client to the spacecraft servicer. This point will most likely be solved by the contractual arrangements between the parties, on a case-by-case basis.

To conclude, a harmonization and an alignment between national laws, authorization and technical regulations is recommended. It is highly likely these issues will be resolved by a contract between the parties involved. Nevertheless, both public and private space actors have an important role to play in creating future "soft law" OOS and RPO guidelines and standards. Of particular important is addressing issue of liability in case of damage and registration and control over the two space objects involved in such missions.

IV. TOWARDS A SPACE LAW OF SALVAGE?

A. The law of Salvage: A Principle of Maritime Law

According to Article 1(a) of the International Convention on Salvage of 1989 (1989 Salvage Convention), "salvage operation means any act or activity undertake to assist a vessel or any other property in danger in navigable waters or in any other waters whatsoever."[72] In maritime law, the purpose of salvage is to encourage persons to render prompt, voluntary and effective service to ships in peril or distress by assuring them compensation and reward for their salvage efforts.[73] Rather than obtaining title to the salvaged property, the rescuer, known as the salvor, acts on behalf of the property's owner, and has to carry out the operations with due care.[74]

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[72] International Convention on Salvage, Apr. 28, 1989, 1953 U.N.T.S. 165 art. 1(a) [hereinafter Salvage Convention].

[73] Archie Bishop, *Law of Salvage*, *in* 2 IMLI MANUAL ON INTERNATIONAL MARITIME LAW 474-501 (Oxford Univ. Press ed., 2016); Michael Listner, *Taking Salvage in Outer Space From Fiction to Fact*, THE SPACE REVIEW (Mar. 20, 2017), http://www.thespacereview.com/article/3198/1.

[74] Salvage Convention, *supra* note 72, art. 8.

Salvage does not warrant possession of the property to the salvor, but entitles the salvor to compensation for return of the property to its owner.[75] Except for salvage performed under contract and apart from the general duty to give assistance to those in peril at sea, the entitlement to a salvage reward arises when a person, acting as a volunteer - that is without any pre-existing contract or other legal duty to render assistance - preserves or provides assistance at sea to any vessel, cargo, or freighting need. Moreover, the salvor is not required to obtain the owner's permission prior to undertaking the salvage operation, as any delay in such a critical situation may lead to disastrous consequences.[76]

The term "salvage" is often confused with the law associated with finding an object, which allows a finder of abandoned property to acquire the title of the property.[77] The 1989 Salvage Convention introduces the "no cure, no pay" principle under which a salvor is only rewarded for services if the operation is successful.[78] Furthermore, the Convention includes a provision for an enhanced salvage award, taking into account the efforts of the salvor in preventing or minimizing damage to the environment.[79]

As previously mentioned, the salvor does not become the owner of the property, unless it was abandoned by the owner, and the owner may claim his property from the salvor upon payment of salvage money.[80] The salvor, for its part, has a maritime lien on the salved property and does not have to return the property to the owner until its claim is satisfied or until security to obtain an award

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[75] *Id.* at art. 12.

[76] *See United Kingdom and British Maritime Law Association's Joint Response to the IMO Questionnaire on Salvage Convention 1989*, BRITISH MARITIME L. ASS'N, https://www.bmla.org.uk/documents/Questionnaire.htm (last visited August 15, 2019) (on the issue concerning consent in salvage operations).

[77] Mark Wilder, *Application of Salvage Law and the Law of Finds to Sunken Shipwreck Discoveries*, 1 DEFENSE COUNSEL J. 92-105 (2000).

[78] Salvage Convention, *supra* note 72, art. 12.

[79] *Id.* at arts. 8, 13, 14. Damage to the environment is defined as "substantial physical damage to human health or to marine life or resources in coastal or inland waters or areas adjacent thereto, caused by pollution, contamination, fire, explosion or similar major incidents."

[80] *Salvage*, ENCYCLOPEDIA BRITANNICA, https://www.britannica.com/topic/salvage (last visited Aug. 15, 2019).

is given.[81] Frequently, rescues are led under contract by professional salvors.[82] Hence, there are two types of salvage recognized by maritime law. One is contract salvage, where a salvage service is entered into between the salvor and the owners of the imperiled property. This is pursuant to a written agreement providing the amount of compensation to be paid, whether or not the mission is successful. By contrast, pure salvage is a voluntary service rendered to imperiled property at sea, where compensation is dependent upon success, without prior agreement or arrangement.[83]

B. Future OOS Missions Leading to a Potential Space Law of Salvage?

From the definition of salvage provided by the 1989 Salvage Convention, it would be interesting to consider the application of the law of salvage in outer space. In particular, this might be relevant in the case of RPO and OOS, if a space object - be it a satellite, a component, a rocket stage orbiting in LEO, or a module from the ISS - is endangered or needs to be repaired, and a company or an agency, with the appropriate authorization, decides to intervene. With the potentiality of future missions of ADR, RPO and OOS, we might have to develop new ways of acting in outer space that would ultimately lead to a potential space law of salvage.[84]

Article VIII of the Outer Space Treaty grants a State continuous possession over a space object registered under its jurisdiction:

> A State Party to the Treaty on whose registry an object launched into outer space is carried shall retain jurisdiction and control over such object, and over any personnel thereof, while in outer space or on a celestial body. Ownership of objects launched into outer space, including objects landed or constructed on a celestial body, and of their component parts, is not affected by their presence in outer space or on a celestial body or by their return to the Earth.[85]

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[81] *See* Salvage Convention, *supra* note 72, art. 21.

[82] ENCYCLOPEDIA BRITANNICA, *supra* note 80.

[83] Listner, *supra* note 73.

[84] Cargill R. Hall, *Comments on Salvage and Removal of Man-Made Objects from Outer Space*, 33 J. AIR L. & COM. 288-313 (1967).

[85] Outer Space Treaty, *supra* note 17 at art. VIII.

Once a space object is launched into outer space, it continues to be registered to the country that launched it, even upon its returns to Earth. This concept applies to space objects owned by non-governmental organizations and governmental organizations alike. Thus, a continuous jurisdiction and control on a space object exists in space activities.

At first sight, this would appear to create a barrier to commercial entities engaging in future activities resembling salvage in outer space, particularly for activities involving OOS, RPO, or ADR. However, while an outer space analogue of pure salvage and the law of finding would be excluded, it could take shape in the form of contract salvage.[86] As discussed earlier, contract salvage involves a written contract between the salvor and the owner of the imperiled property. In case of RPO and OOS, it would be necessary to have the consent of the launching State(s) or the State of registry and/or the owner.

Contract salvage missions in outer space such as OOS, ADR, or removal of derelict satellites in GEO could be concluded between private/commercial entities with the appropriate level of government supervision or amongst private companies and governmental agencies. Undoubtedly, any space activities that involve contract salvage may implicate national security and could also trigger the international responsibility provisions of Article VI of the Outer Space Treaty. Hence, States interested in these activities must create international legal obligations with regards to private/commercial space activities and focus on developing a regulatory and licensing regime in a manner that does not discourage future RPO and OOS activities, by addressing the legal issues those activities will entail.[87] In addition, as noted in the 1989 Salvage Convention, the

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[86] The commercial satellite Palapa B2 launched in 1984 by the shuttle mission STS-41B for the Indonesian government, but it failed to reach geosynchronous orbit. While it was in a useless orbit around Earth, the satellite was purchased by Sattel, an insurance company that covered the loss. Later on, Sattel contracted with NASA to pick the satellite up. Sattel subsequently contracted with Hughes Aircraft Company, which originally manufactured the satellite, and the launch service provider, McDonnell Douglas, to refurbish and re-launch the satellite. The satellite was renamed Palapa B2-R and was successfully re-launched in April 1990. After the re-launch, title of the satellite was transferred back to Indonesia. *See* Russ Banham, *It's Up, Up and Away for Saved Satellite,* JOC.COM (Jan. 31, 1988).

[87] Frans Von der Dunk, *Space Debris and the Law*, SPACE, CYBER AND TELECOMM. L. PROGRAM FAC. PUBLICATIONS 4 (2001).

protection of the environment,[88] the importance of cooperation in conducting the activity[89] and cases of misconduct are additional relevant considerations in conducting RPO and OOS activities.[90]

A system based on some form of salvage by contract could be a useful approach for future satellite servicing or targeted removal of large space objects. However, an important issue to be addressed is the growing population of small space objects (largely 1-10 cm in size) that have not been placed on any national registry, and for which it might be impossible to conclusively identify as being associated with a specific launch, and therefore launching State(s), with whom one could sign a contract.[91]

V. INDUSTRY PRACTICE AND THE NECESSITY OF LEGAL CERTAINTIES

Parties conducting OOS activities should look for opportunities to share lessons learned from operational successes and anomalies while protecting intellectual property and sensitive information, and while complying with export control regulations. Indeed, the ever-changing nature of space technology means that the categorization of technologies within the United States Munitions List[92] and Commerce Control List, must also constantly evolve.[93]

Contract law represents a way to address several of the legal gaps related to permission to engage with a space object, the allocation of risk and liability of the parties involved and mission parameters.[94] The nature of these contracts and their impact on State

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[88] *See* Salvage Convention, *supra* note 72, arts. 6, 8, 11, 13, 14.

[89] *See id.* at art. 11; Outer Space Treaty, *supra* note 17 arts. I, III, IX, X, XI.

[90] *See* Salvage Convention, *supra* note 72, art. 18.

[91] Brian Weeden, *How Do I Ask Permission to Engage with a Piece of Space Debris?* 3RD EUROPEAN WORKSHOP ON SPACE DEBRIS MODELING AND REMEDIATION (June 16-18, 2014), https://swfound.org/media/171984/weeden_permission_to_engage_june2014.pdf.

[92] Consortium for the Execution of Rendezvous and Servicing Operations, Comment Letter on the Review of United States Munitions List Categories IV and XV, DOS-2018-0048, (Apr. 20, 2019), *available at* https://www.satelliteconfers.org/wp-content/uploads/2019/06/CONFERS_Comment_State_ITAR_ANPRM_04222019.pdf.

[93] Consortium for the Execution of Rendezvous and Servicing Operations, Request for Public Comment Regarding Review of Commerce Control List for Items Transferred From United States Munitions List Categories IV and XV, BIS-2018-0029, (Apr. 20, 2019), *available at* https://www.satelliteconfers.org/wp-content/uploads/2019/06/CONFERS_Comment_Commerce_ITAR_ANPRM_04222019.pdf.

[94] Blount, *supra* note 57, at 187.

interests would make them an important part of a submission to a licensing authority. Moreover, contractual elements can become widely used and standardized as industry best practices.[95] Such best practice can result in regulatory behavior comparable to a *lex mercatoria* of space.[96] A *lex mercatoria*, or the law between merchants, is a set of norms through which merchants institute consistent rules in their exchanges. Contract clauses can support both domestic and international law by developing some standards in the form of best practices that are easily recognized because of their efficiency. As a result, private contracts have an important role to play in order to ensure that the rights of operators and States are preserved notwithstanding any apparent legal gaps that exist in the initial stages of the deployment of OOS technologies.

Contract clauses can help shape both domestic and international law by developing a set of standards in the form of best practice. For instance, the cross-waivers of liability clauses have become the standard in high-risk industry.[97] This is typically reflected by an agreement between counterparties who waive their own recourse to compensation for damage to their property, equipment and personnel, as well as to those suffered by their subcontractors and certain third parties. In other words, through a cross-waiver clause, parties to the contract agree to forgo any right to initiate legal procedures for claims should any damage arise in the framework of their partnership.[98]

The inclusion of cross-waiver of liability in the contract might have a positive impact by encouraging participation in space activities.[99] For instance, Article16 of the International Space Station

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[95] Martin J. Losekamm, Jacob Hacker, Nikita Sardesai, Anja (N.) Pecujlic & Adam Vigneron, *Legal and Political Implications of Future On-Orbit Servicing Missions*, 66TH INTERNATIONAL ASTRONAUTICAL CONGRESS 8 (2015).

[96] Annette Froehlichand & Anja Nakarada Pecujlic, *Mechanisms for the Development of International Norms Regarding Space Activities*, 39 EUROPEAN SPACE POL'Y INST. REP. 57 (May 2016).

[97] Rakibi (A.), *Les Clauses Récriproques d'Abandon de recours et de Garanties dans les Contrats de l'Industrie Spatiale*, in Achilleas (P.), Mikalef (W.), *Pratiques Juridiques dans l'Industrie Aéronautique et Spatiale*, Paris: Pedone, 2014, pp.143-155 [hereinafter Récriproques d'Abandon].

[98] GÉRARDINE GOH, DISPUTE SETTLEMENT IN INTERNATIONAL SPACE LAW 50 (2007).

[99] *Id*.

Intergovernmental Agreement (IGA)[100] establishes a "cross-waiver of liability" prohibiting any of the five Partners or their related entities to initiate a claim against another Partner or its related entities for damage sustained as a result of International Space Station activities.

Generally, each party is obliged to implement this cross-waiver in the contract with its own contractors and sub-contractors. Each party would thus bear all the damage that it would suffer in the context of the execution of the contract. However, there may be exceptions to its application, such as cases of gross negligence or willful misconduct by one of the parties.[101] Thus, in the context of OOS and RPO, a cross-waiver clause could be included in the contract in order to ensure a fair allocation of the pecuniary consequences of the damage between the operators and their co-contractors and subcontractors. It will also avoid the multiplication of insurance policies. Cross-waiver clauses are effective because the parties involved trust each other, collaborate in the achievement of the mission and share any necessary risk taking.[102] Disputes can thus be avoided, which enables a way of pacifying the relations between the parties.

Moreover, an incentive clause[103] might be introduced in the contract in order to foster salvage operations, analogous to the salvage reward in maritime law.[104] An incentive scheme encouraging either party, or even elaborating payment schemes to third parties who salvage or rescue the parties' space objects, may be introduced

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[100] Agreement Among the Government of Canada, Governments of Member States of the European Space Agency, The Government of Japan, the Government of the Russian Federation, and the Government of the United States of America Concerning Cooperation on the Civil International Space Station, Jan. 29, 1998, 1998 U.S.T. LEXIS 212, Hein's No. KAV 5119 [hereinafter 1998 IGA]; ESA, International Space Station Legal Framework, UNITED SPACE IN EUROPE, https://www.esa.int/Our_Activities/Human_and_Robotic_Exploration/International_Space_Station/International_Space_Station_legal_framework (last visited August 15, 2019) (the legal framework defines the rights and obligations of each of the countries and their jurisdiction and control with respect to their space station elements).

[101] Récriproques d'Abandon, *supra* note 97, at 147.

[102] Laithier (Y.M.), L'Avenir des Clauses Limitatives et Exonératoires de Responsabilité Contractuelle, Revue des contrats, n°3, 2010, p.1091.

[103] Ravillon (L.), *Les Contrats Spatiaux de Droit privé à l'Epreuve du Contentieux*, in Achilleas (P.), Mikalef (W.), *Pratiques Juridiques dans l'Industrie Aéronautique et Spatiale*, Paris: Pedone, 2014, pp.111-122.

[104] Salvage Convention, *supra* note 72, arts. 12, 13.

in the contract. Such a scheme will be linked to the fulfillment of contractual requirements including performance parameters. In this context, it is interesting to highlight the work undertaken by the Consortium for Execution of Rendezvous and Servicing Operations (CONFERS), which aims, through collaboration with industry and government space experts and stakeholders, to benefit the on-orbit servicing industry by building common understanding between developers, operators, customers, investors, insurers and government policy makers while protecting commercial participants' financial and strategic interests. In 2018, CONFERS developed some guiding principles for commercial RPO and OOS activities[105] focused on consensual operations, compliance with relevant laws and regulations, responsible operations and transparent operations.

In 2019, it presented the CONFERS Recommended Design and Operational Practices[106] regarding the design for mission success, the design of satellites to improve mission safety, the design of operations to minimize mishaps, the prevention of interference during all operations, the sharing of information on anomalies and resolutions and promoting space sustainability guidelines/practices. CONFERS envisages a holistic approach to set up standards related to interfaces and designs (engineering and design to increase the safety, viability and interoperability of satellite servicing); operational practices (behavior of satellite servicing and RPO activities); data exchange and sharing (information sharing between servicing companies, clients and governments); transparency (mechanisms to reduce misperceptions and clarify intent about the dual-use activities).

VI. CONCLUDING OBSERVATIONS

Recent technological advances have significantly increased the need for specific norms and standards for the space actors in order

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[105] Consortium for Execution of Rendezvous and Servicing Operations, *Guiding Principles for Commercial Rendezvous and Proximity Operations (RPO) and On□Orbit Servicing (OOS)* (Nov. 2018), *available at* https://www.satelliteconfers.org/wp-content/uploads/2018/11/CONFERS-Guiding-Principles_7Nov18.pdf.

[106] Consortium for Execution of Rendezvous and Servicing Operations, *CONFERS Recommended Design and Operational Practices* (Feb. 2019), *available at* https://www.satelliteconfers.org/wp-content/uploads/2019/02/CONFERS-Operating-Practices-Approved-1-Feb-2019-003.pdf.

to enable cooperative OOS/RPO missions. From a legal perspective, OOS and RPO are space activities like any other and thus need to be authorized by States. Moreover, due to the interaction with another spacecraft, attention must be paid to the fact that the target owner and its launching State(s) agree to the service; that the consequences of damage are clarified in advance among the parties of the service; and that there are no other obstacles to properly carrying out the activity, such as export control regulation or risk of harmful interference.

Obviously, an OOS/RPO mission with identical owners and launching States reduces legal complexity. Nevertheless, a future OOS/RPO market will require novel legal approaches to reduce issues in legal relations. Two important elements should be taken into consideration in view of the risk of unwanted interference or damage. First, the contractual perspective - that is the contractual relation between service providers and customers. Secondly, elements of "soft law" that might be created by space actors and industry through instruments such as technical standards, guidelines and best practices.

Currently the State from which the spacecraft is launched is responsible and liable for the asset place in orbit. In scenarios where objects might be built in one country, launched by another country and serviced by a third country, the liability for damage imposed may need to be reallocated. On-orbit servicing regulation should be further discussed by UNCOPUOS, and as perhaps also as part of the Conference on Disarmament, with the aim to develop working and widely recognized guidelines to be ratified by nations participating in the activities, including providers and customers.

Furthermore, States should initiate the monitoring and licensing of on-orbit servicing activities by national governmental agencies. In addition, a further issue is whether the State must impose insurance minimums to ensure that an accident in space does not disproportionately expose the State within the international liability regime. In this context, a possible law of salvage applicable to outer space activities could be a solution under written agreement. Private companies and governmental agencies could already now consider a form of template applicable to RPO/OOS missions. This type of contract salvage would be approved by the parties and the entities that authorized space activities in each country.

In sum, standards will need to be developed and agreed upon. These standards can emanate from industry associations, international organizations and domestic regulation or alternatively through adoption by the market. The new commercial interest in these technologies is creating a need for legal answers so that the economic potential and development of these technologies are not blocked. One can observe that the emergence of regulation is likely to occur at the national level as a first step. Domestic regulation could play a large role in expanding the international regime to more fully cover these technologies.

Finally, it is of utmost importance to create transparency and confidence building measures to prevent the threat that on-orbit vehicles in space may represent, and also, to ensure the long-term sustainability of space activities. Confidence and appropriate transparency in servicing services needs to be established by all operators in order to create a safe market.

There is no doubt, therefore, that the potential implementation and utilization of technologies such as these will give rise to the need for careful consideration of the regulatory and policy frameworks at both the international and s national levels. We have attempted in this introductory article to raise some of these issues and point in general terms to some possible solutions. There is much work to be done in this regard and we welcome the input from all stakeholders so that a clear path forward, that strikes an appropriate balance between all the relevant factors, will ultimately evolve.

INTERDISCIPLINARY TEAM TEACHING IN SPACE LEGAL EDUCATION

Ermanno Napolitano[*]

ABSTRACT

Today, space law professionals face many difficulties in addressing everyday legal issues due to an increased intertwining of law and other disciplines. In an era where legal professionals tend to specialize in a specific practice area, a firm understanding of matters beyond the traditional realm of law is a prerequisite for addressing and elucidating the challenges presented by varying disciplines. As outside disciplines rapidly intermingle with the law, a holistic approach to legal education emerges as one of the pedagogical challenges that law schools must address in the near future. This article discusses the need to foster interdisciplinary classes in space law education and endorses team teaching as the key method for cultivating multi-dimensional understanding of the highly-specialized body of space law.

I. INTRODUCTION

As law steadily seeps into other disciplines, attorneys face increasingly novel and complex legal issues. Such challenges in the field of space law require highly specialized knowledge and a solid understanding of other inextricably connected disciplines. Today, a space legal professional may face questions concerning engineering, political science or even chemistry. Since space law envelopes so many tangential areas of expertise, basic knowledge of relevant non-legal disciplines may be integral to answering a single legal question. Without the capacity to grasp such fundamentals, simple problems may mutate into obstacles with seemingly insurmountable complexities.

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Legal education is usually organized into a monothematic setting where a single professor teaches a course through a purely legal perspective.[1] If legal education does not embolden students to tackle non-legal concepts, it is deficient of practicality and encourages assessment of legal problems from myopic viewpoints that lend only a "distorted image of the whole."[2] Legal education must adapt to the needs of modern practitioners.

This article examines both American and Canadian law schools and focuses on the importance of interdisciplinary team teaching[3] in space law education. Both interdisciplinarity and team teaching are crucial components of an effective and productive interdisciplinary course. This article presents its case for holistic legal education by first presenting the benefits of interdisciplinary teaching, as opposed to "traditional" disciplinary teaching and the "thinking like a lawyer" approach. Second, it expounds on why team teaching should be preferred to the single professor model in achieving interdisciplinarity.

II. WHY INTERDISCIPLINARITY?

A. Tailoring Legal Education for Success in Space Law

Since its inception, the space sector has steadily grown into a fundamental part of the international economy. Between 2005 and 2017, global space revenues increased from $175 to $385 billion.[4] This corresponds to a growth rate of about 7% per year. The American Chamber of Commerce estimates that the value of the space

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[1] Kim Diana Connolly, *Elucidating the Elephant: Interdisciplinary Law School Classes*, 11 WASH. U. J. L. & POL'Y. 11, 14 (2014).

[2] *Id.* at 13.

[3] The term "interdisciplinary team teaching" is composed of two critical elements. The term "interdisciplinary" as used here refers to an integration of information and concepts across subject matters. This article uses the term "interdisciplinarity" in place of linguistic equivalents such as "multidisciplinary," "cross-disciplinary" or "transdisciplinary." While the use of such terms has generated a stimulating scholarly debate in recent years, this paper's objective is not to decipher the differences between such terms. The author has simply selected the term that seems most appropriate to the objective above described. Similarly, "team teaching" refers to a team of instructors that co-teach in a singular specialized course, as opposed to a single instructor for a singular course, or to multiple instructors that separately teach (i.e. in "modules") in a single course.

[4] Brian Higginbotham, *The Space Economy: An Industry Takes Off*, U.S. CHAMBER OF COMMERCE (Oct. 11, 2018), https://www.uschamber.com/series/above-the-fold/the-space-economy-industry-takes.

sector will grow to at least $1.5 trillion by 2040 at an estimated rate of 6% per year.[5] The exponential growth of space activity will inevitably correspond to an increased demand for highly specialized legal services. Space assets and related services, however, are heavily dependent upon the technological advancement of physics, engineering and science. In order to maintain a successful, cutting-edge practice in space law, attorneys must be able to untangle issues presented by tangential disciplines.

Imagine a United States (US) company decides to operate a private remote sensing system and offer commercial services based on the data the system collects. The company would require proper licensing by the National Oceanic and Atmospheric Administration (NOAA) Assistant Administrator for Satellite and Information Services.[6] Relevant federal regulations indicate what information the applicant must file in order to be evaluated for suitability to hold a private remote sensing space system license.[7] Some of the information required, such as corporate information, can easily be supplied by the company's legal bureau itself or by the appropriate legal team. However, other information, such as that pertaining to the launch, space and ground segments of the operation, or the plan for post-mission disposition of any remote sensing satellites owned or operated by the applicant, must be provided and distilled by relevant technical experts – for instance, specialized engineers familiar with the technical operations of the mission.[8]

Further, once the company is licensed, any retained space law counsel should ensure that the activities are carried out according to the conditions established in the National and Commercial Space Programs Act (NCSPA) and its corresponding regulations.[9] Monitoring conditions, such as the licensee's obligation to timely notify the Assistant Administrator of its intent to enter into a significant foreign agreement,[10] could be fulfilled by space law counsel assisting the company. However, monitoring compliance with some of the conditions required to hold the license is impossible without the as-

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[5] *Id.*
[6] *See* 15 C.F.R. § 960 (2019).
[7] *Id.*
[8] *See* 15 C.F.R. § 960, Appendix 1.
[9] *See* 51 U.S.C. §§ 10101-71302 (2012).
[10] 15 C.F.R. § 960.11(b)(5) (2006).

sistance of non-legal experts. This is the case, for example, in instances which require immediate transmission to the Assistant Administrator of NOAA for Satellite and Information Services of data concerning any operational deviation[11] or submission to the Assistant Administrator of a data protection plan for review and approval.[12]

Frequently, space law counsel assisting the company with regulatory compliance or providing general legal guidance does not possess specialized knowledge about the technical aspects of the remote sensing satellite system. Nevertheless, such counsel should be capable of communicating with relevant experts of different fields in order to properly complete the license application and to ensure continued compliance with governing regulations.

Alternatively, imagine a US company intending to offer launch services. In order to operate legally, the company requires proper licensing.[13] The legal team must work with experts of other disciplines in order to ensure a successful licensing process. For instance, if the company applies for a launch operator license,[14] it will need to develop and obtain approval in respect of a diverse portfolio of documents including a policy review,[15] a safety review for launches from a federal launch range (assuming it will launch from one)[16] and an environmental review.[17] Providing all required information on a license application requires expertise that does not relate to a single field, but rather is both multi and interdisciplinary.[18]

Unfortunately, many space legal professionals lack the necessary knowledge to prepare technical documentation pertaining to non-legal disciplines that must be submitted along with the launch operator license request. Thus, a basic technical knowledge and capacity to communicate with relevant experts from other fields is necessary to ensure a smooth licensing application. Indeed, to apply

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[11] 15 C.F.R. § 960.11(b)(11) (2006).
[12] 15 C.F.R. § 960.11(b)(13) (2006).
[13] 14 C.F.R. § 413.3 (2007).
[14] 14 C.F.R. § 415.3 (b) (2007).
[15] 14 C.F.R. § 415.21 (2019).
[16] 14 C.F.R. § 415.31 (2006).
[17] 14 C.F.R. § 415.201 (2006).
[18] *See, e.g.,* 14 C.F.R. §§ 415.25, 415.203.

for a launch operator license, the intersection of legal and technical aspects requires smooth communication between all stakeholders.

A lawyer may also represent a satellite components supplier in a breach of contract dispute involving a settlement discussion. The legal professional should consider the client's goals – including non-legal ones, such as business productivity – when doing so. Furthermore, such counsel must craft a negotiating strategy that not only balances the opposite interests of the parties, but also facilitates the settlement's negotiation.

Consider a scenario wherein groups of investors establish a communications satellite system company which provides broadcast feed benefits to booming television station markets in Asia. Such a company might invest several million dollars to acquire the necessary satellites. The State in which the company is located should, on behalf of this company, file a request with the International Telecommunication Union (ITU) to seek the assignment of orbital positions and radio frequencies necessary to transmit. Indeed, "ensuring interference-free operation of satellite systems" depends upon "adherence to the Radio Regulations and following its detailed procedures for coordination and registration in the [Master International Frequency Register]."[19]

The legal department of such a satellite system company must, in order to provide adequate legal advice, understand the ITU Constitution, Convention[20] and Radio Regulations[21] and be able to read a table of frequency allocations. That legal department should also ensure constant communication and mutual understanding exists amongst the company's lawyers, engineers, physicists and other leadership.

In the field of space law, it is essential that lawyers are able to address the relevant legal aspects of all space missions, despite such missions being designed by engineers and professionals in

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[19] AUDREY L. ALLISON, THE ITU AND MANAGING SATELLITES ORBITAL AND SPECTRUM RESOURCES IN THE 21ST CENTURY 19 (2014).

[20] *See* INTERNATIONAL TELECOMMUNICATION UNION, COLLECTION OF THE BASIC TEXTS OF THE INTERNATIONAL TELECOMMUNICATION UNION ADOPTED BY THE PLENIPOTENTIARY CONFERENCE (2019).

[21] INTERNATIONAL TELECOMMUNICATION UNION, RADIO REGULATIONS (2016).

other fields.[22] Experts Anja Pecujlic and Matteo Tugnoli (respectively a lawyer and an astrophysicist) point out that

> problems in communication and cooperation arise mostly due to the fact that typically neither engineering nor space law education curricula cover relevant aspects of the other field . . . . [S]pace engineer[s] . . . lack . . . understanding as to why certain technologies . . . could be difficult to implement and employ from a legal perspective. . . . [S]pace lawyers may have difficulties in grasping key technical aspects that in turn could have relevant implications for the legal status of the mission.[23]

Legal professionals in all practice areas should strive to acquire substantive knowledge of other fields and develop the skills to communicate effectively with professionals in other fields. Such training is essential; it helps to avoid confusion, delays and poor decision making.[24]

A space lawyer may, through time and experience in the field alone, reach some level of understanding of those relevant non-legal disciplines. Nevertheless, if the only pedagogical factor that pertains to interdisciplinary knowledge is practical experience, the lawyer's competence will be strictly limited to specific areas of – repeated – practice, and a significant amount of time would be needed to achieve even basic knowledge.[25] Therefore, it is necessary to foster interdisciplinary teachings in legal education in order to enable space law graduates to skillfully navigate the complex legal challenges they are sure to encounter.

B. Problems with "Thinking Like a Lawyer" and Traditional Law School

Despite the necessity of preparing law students to tackle complex issues by mastering concepts that are related to, but outside of, traditional doctrinal law,[26] it appears that "legal educators . . . are not apt to revise the educational curriculum in terms of a world

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[22] *See* ANJA NAKARADA PECUJLIC & MATTEO TUGNOLI, PROMOTING PRODUCTIVE COOPERATION BETWEEN SPACE LAWYERS AND ENGINEERS xvi (2019).

[23] *Id.*

[24] Suellyn Scamecchia, *An Interdisciplinary Seminar in Child Abuse and Neglect with a Focus on Child Protection Practice*, 31 U. MICH. J.L. REFORM 33, 34 (1997).

[25] PECUJLIC & TUGNOLI, *supra* note 22, at xvi. *See also* Connolly, *supra* note 1, at 15.

[26] Connolly, *supra* note 1, at 16.

that ought to be."[27] The teaching of legal education throughout American and Canadian law schools is remarkably similar and is characterized by a specific teaching method which creates a common experience among graduates of different law schools.[28] Legal education seems to rely on the "institutionalized belief" that Langdell's "case method," is the best method of instruction.[29] The "case method" requires professors to teach using compilations of cases, typically from appellate courts, and is designed to rely on a Socratic style of classroom discussion.[30]

The "Socratic method" consists of a dialogue between students and the professor where the latter pushes the former to discern general rules from case law and then apply them to different factual scenarios.[31] Of course, the teaching legal reasoning is not at issue; on the contrary, it is a fundamental skill. However, such methods often constitute "the [sole] focus on legal analysis to the exclusion of other equally important skills."[32] While legal analysis is a fundamental skill, it is far from the only skill required of a competent attorney.

Recently the Socratic method has been questioned in terms of its pedagogical efficiency, but the case method remains at the core of most American and Canadian Law schools.[33] Nevertheless, the problem with this method is that, when used in isolation, it "impairs lawyers' professional development"[34] because students are unable to apply legal thinking in the complexity of law practice. Rather, they are "trained to disregard all facts and consequences that are outside the precise legal issue at hand."[35] Langdell's approach, which he developed in 1870,[36] seemingly contributes to law schools' inability to quickly adapt their curricula to needs of the legal world

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[27] William Pincus, *Reforming Legal Education* 53 A.B.A. J. 436, 436 (1967).

[28] Jess M. Krannich, James R. Holbrook & Julie J. McAdams, *Beyond Thinking Like a Lawyer and the Traditional Legal Paradigm: Toward a Comprehensive View of Legal Education*, 86 DEN. U. L. REV. 381, 381 (2009).

[29] *Id.* at 382.

[30] *Id.* at 384.

[31] *Id.*

[32] *Id.*

[33] Eric C Johnson, *A Populist Manifesto for Learning the Law*, 60 J. OF LEGAL ED. 41, 44 (2010).

[34] Krannich, Holbrook & McAdams, *supra* note 28, at 387.

[35] *Id.* at 389.

[36] *Id.* at 383.

outside the classroom.[37] Likewise, graduates often fail to appreciate context and the overlap of approaches in practice.

The need for continuing adaptation of education has not gone unnoticed throughout history. As Francis Allen points out

> Social changes affect the nature of the knowledge that is relevant to law teaching and legal scholarship; and methods of knowledge-discovery that served reasonably well in the past do not suffice today.[38]

Indeed, the same is true for law students. Many scholars have highlighted the inadequacy of legal education in terms of an absence of practical skills. Anita Weinberg and Carol Harding opined

> [h]istorically, the role of law schools has been to teach students how to think like a lawyer (i.e., with legal reasoning and analytical thought process). It has become clear, however, that "thinking like a lawyer" (or, for that matter, "thinking like a psychologist" or "thinking like a social worker") is not sufficient when working in [a specialized area of] law.[39]

Allen identifies university law classes as "the dominant mode of professional legal training."[40] Nevertheless, he believes that law schools are going through the wider crisis of today's humanistic education because of their inability to contribute to the general purpose of universities.[41] Allen identifies the university's purpose as the organization and communication of existing *relevant* knowledge, the discovery of new knowledge and the provision of means for such discovery.[42] These goals are very important to space lawyers who, in order to provide answers to the legal issues they encounter, must increasingly acquire more than the ordinary knowledge of the classic profession.[43] As Allen points out, the social

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[37] Johnson, *supra* note 33, at 63.

[38] Francis A Allen, *Humanistic Legal Education: The Quite Crisis*, *in* ESSAYS ON LEGAL EDUCATION 9, 11 (Neil Gold ed. 1982).

[39] Anita Weinberg & Carol Harding, *Interdisciplinary Teaching and Collaboration in Higher Education: A Concept Whose Time Has Come*, 14 WASH. U. J. L. & POL'Y. 15, 26 (2004).

[40] Allen, *supra* note 38, at 11.

[41] *Id.*

[42] *Id.*

[43] *Id.* at 13.

core of legal professionals has changed: lawyers are no longer the sole expression of hegemony in their profession, but, rather, they must communicate and share their authority with professionals of other disciplines.[44]

One of the most important responsibilities of law schools is to vigilantly provide the tools legal professionals need to deliver adequate representation and to give their students the necessary means of anticipating the future developments of law.[45] If law schools are unable to provide the necessary competences to their students, the social function of future legal professionals will be impaired. In this sense, law schools have an obligation to provide effective means of enhancing such competences.[46] Law schools should therefore provide interdisciplinary classes in subjects – such as space law – that require skills beyond pure legal analysis and that require an ability to analyze legal issues comprehensively from a variety of different – including non-legal – perspectives.[47]

III. BENEFITS AND CHALLENGES ASSOCIATED WITH ENRICHING SPACE LAW KNOWLEDGE THROUGH THE METHODS AND INSIGHTS OF RELATED DISCIPLINES

A. Benefits of interdisciplinarity

Interdisciplinary space law classes facilitate an optimal level of understanding of non-legal disciplines through the study and understanding of different terminologies, rules, beliefs and "the ethical and legal constraints within which each profession operates."[48] With it, this understanding brings a capacity to communicate with respective professionals of other disciplines without the need to master those disciplines. This helps diminish frustration and interpersonal animosity among professionals of different fields, such as lawyers and engineers, that have to cooperate.[49]

Familiarity working with other disciplines and their respective professionals is especially beneficial for space law counselors

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[44] *Id*.
[45] *Id.* at 15.
[46] *Id.* at 19.
[47] Krannich, Holbrook & McAdams, *supra* note 28, at 389.
[48] Weinberg & Harding, *supra* note 39, at 27.
[49] *Id.* at 22.

as it allows them to properly advocate for their client's technical needs. In "A Holistic Education Curriculum for Capacity-Building in Space Law," Ram Jakhu and Kuan-Wei Chen expanded upon this line of thinking:

> In order to fully comprehend international space law as well as national space laws and regulations, it is vital to know relevant basic facts about space technology, various space applications, their value as well as the potential legal and policy considerations that may arise from the use of such technology and applications.[50] [Space law students need to] integrate technical and scientific understanding with knowledge of legal principles and processes of law-making at international and national levels.[51]

The "thinking like a lawyer" approach brings students' minds into isolation, training them to analyze things from a purely legal perspective and creating a lack of capacity to relate with colleagues or with experts of other disciplines.[52] On the contrary, "interdisciplinary study . . . hold[s] the key to truly understanding the nature of . . . [the legal] profession."[53]

An interdisciplinary approach to space law courses would sensitize law graduates to recognize the limitations of the legal profession and to understand when it is time to seek collaboration with non-lawyers.[54] Interdisciplinary law classes develop a "level of human cognition that simulates thoughts about an issue from all viewpoints, taking into account varied and, as yet, unthought possibilities."[55] Interdisciplinary thinking creates a state of mind that tends to have "consciousness of [the] whole."[56] Interdisciplinarity "encourage[s] diversity of thought" allowing the thinker to make those connections that reach "beyond the information given."[57] Interaction among different professions and integration of various

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[50] Ram S. Jakhu & Kuan-Wei Chen, *A Holistic Education Curriculum for Capacity-Building in Space Law*, XLII ANN. OF AIR & SPACE L. 271, 276 (2017).

[51] *Id.* at 278.

[52] Weinberg & Harding, *supra* note 39, at 30-31.

[53] Connolly, *supra* note 1, at 17.

[54] *Id.* at 37-38.

[55] Weinberg & Harding, *supra* note 39, at 22-23.

[56] *Id.* at 23.

[57] *Id.*

disciplines "produces a cumulative result that is greater than the sum of its parts."[58]

As Anita Weinberg and Carol Harding point out, when professionals of different disciplines communicate,

> [t]he goal is not for one professional to convince another of the correct answer, but rather for the group members, together, to challenge one another's ideas, perspectives, and beliefs – and together, to reach a conclusion that addresses all of their concerns and examines alternative courses of action. . . . It is when the law and the insights revealed by the interdisciplines are palpably incongruent that the interdisciplines are most useful. . . .[59]

If space lawyers understand human phenomena from the perspectives of multiple disciplines,[60] they may act on a more reliable basis.[61] Furthermore, constant research into the larger picture can foster appreciation and respect of other disciplines in space law students, in turn promoting a culture of team work,[62] and subsequently increasing graduates' marketability.[63] Interdisciplinary law graduates are more suitable to the "real-world" of law practice[64] and better understand the legal needs emerging from the complexity of modern society.[65]

B. Challenges of Interdisciplinarity

Engaging in interdisciplinary education is a process that is more time-consuming, costly and complex than teaching a single discipline.[66] Difficulty also arises from the "traditional university structures and the education . . . most faculty members and students have undergone."[67] Interdisciplinary legal education requires

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[58] *Id.* at 24.

[59] *Id.* at 31.

[60] Connolly, *supra* note 1, at 13.

[61] Stanley Bailis, *Interdisciplinary Curriculum Design and Instructional Innovation: Notes on the Social Science Program at San Francisco State University*, *in* INNOVATIONS IN INTERDISCIPLINARY TEACHING 3, 4 (Carolyn Haynes ed. 2002).

[62] Connolly, *supra* note 1, at 36.

[63] *Id.* at 38.

[64] *Id.* at 37.

[65] Weinberg & Harding, *supra* note 39, at 19.

[66] Connolly, *supra* note 1, at 30. *See also* Weinberg & Harding, *supra* note 39, at 31.

[67] Weinberg & Harding, *supra* note 39, at 18.

collaboration of both students and professors in creative, critical and constructive work that is deeper and broader than in traditional legal education.[68]

Interdisciplinary legal education requires effort to comprehensively address various disciplines to properly structure a course. However, as Newell and Green point out,

> [disciplines are] distinguished from one another by the questions they ask about the world, by their perspective of the world view, by the set of assumptions they employ, and by the methods which they use to build up a body of knowledge (facts, concepts, theories) around a certain subject matter.[69]

Interdisciplinary professors should consider all those variables when structuring and delivering a course. Combining different ways of thinking and applying various methods within a single law course, however, is not an easy task.

When a space law professor attempts to break down barriers of non-legal disciplines to allow for cross-discipline interaction, the risk of misunderstanding is very high.[70] Furthermore, disciplines also present different ethical norms which require different approaches to ethical issues. In fact, the code of lawyers' professional responsibility is different from those of other non-legal professionals.[71]

Because integrating disciplinary insights is inherently complex, space law professors confronted with teaching an interdisciplinary class may feel overwhelmed by their personal limitations.[72] The professor would be required to learn and synthesize different disciplines and to select a working vocabulary that could be understood by an audience of law graduates.[73] They should be capable of structuring a course that critically combines elements of various

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[68] ROBERT STEVENS, LAW SCHOOL: LEGAL EDUCATION IN AMERICA FROM THE 1850S TO THE 1980S 131, 138 (1983).

[69] INNOVATIONS IN INTERDISCIPLINARY TEACHING xi, xii-xiii (Carolyn Haynes ed. 2002).

[70] Weinberg & Harding, *supra* note 39, at 28.

[71] Connolly, *supra* note 1, at 34.

[72] Haynes, *supra* note 69, at xiii.

[73] *Id.* at xii.

disciplines, deciding which perspectives are more appropriate for the context and knowing how to integrate them.[74]

While working on this structure, the interdisciplinary space law teacher should always keep in mind the main objective of fostering knowledge. Students can use such knowledge to face the complex issues they will encounter in their future careers.[75] For example, they should be able to individuate those theories of physics that pertain to radio frequencies, explain how frequencies work and how they are assigned for communication purposes. Such a future legal space professional would know the means to deal, for example, with legal aspects of frequency interference and potentially be able to do so singlehandedly.

It has been proven that, because of the rigid disciplinary approach of most American and Canadian law schools, the challenges that an interdisciplinary legal educator faces provide for a level of discomfort higher than that experienced by teachers who deliver interdisciplinary courses in non-legal graduate institutions.[76]

In analyzing a 1979 experimental interdisciplinary course in energy policy, Professor Weaver, who took part in the course delivery, explains that the instructor of an interdisciplinary law course is exposed to many risks, including that parts of the course may not be comprehensible to students untrained in the particular non-law discipline; that lectures may be un-coordinated and therefore provide a distorted, rather than integrated, view of the highly specialized legal discipline at stake; and that, if the professor does not properly analyze, elaborate and select the relevant content, lessons may only provide superficial analysis and oversimplification due to restrictions in time and material.[77] Interdisciplinary law classes take time to design, and their implementation within classes of a smaller size is favorable compared to traditional ones because no one is left behind. Logistics is also often an issue, especially when instructors from two or more schools participate in the teaching, organizational issues can greatly increase.[78]

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[74] *Id.* at xv-xvi.

[75] *Id.* at xvi.

[76] Connolly, *supra* note 1, at 21.

[77] Jacqueline L Weaver, *Teaching Energy Policy: An Interdisciplinary Approach*, 30 J. L. ED. 574, 579 (1980).

[78] Connolly, *supra* note 1, at 36.

Interdisciplinary legal education further exposes professors and students to a risk of marginalization. Indeed, because professors who decide to embark on interdisciplinary teaching are a minority, they could receive little understanding from their colleagues, resulting in psychological isolation.[79] Similarly, students taking interdisciplinary courses may risk being marginalized by their colleagues who would rather focus on those courses deemed essential to passing the bar examination.[80]

Considering the above, the greater challenge of interdisciplinary legal education remains the risk of the instructor oversimplifying the content of his or her teaching. Oversimplification, as seen below, is especially prevalent when a single professor embarks on interdisciplinary higher education.[81] As such, team teaching is a crucial component to maximizing the effectiveness of an interdisciplinary course.

IV. WHY TEAM TEACHING?

A. Problems with single-professor teaching

Teaching is a very difficult task and even more so if the teaching is interdisciplinary. For a law professor who has mastered a single discipline, as most law professors have, it may be hard to prepare for and initiate an interdisciplinary teaching experience.[82] Furthermore, in the majority of cases where professors lack specific education and preparation for teaching, they naturally depend on the instructional methodology of the first years of their own university experience.[83] Such experience is based on the teaching of a single discipline in a "thinking like a lawyer" format.[84] The professor may have neither sufficient time nor information to accurately select those topics most relevant to the course and integrate them with the main discipline, especially if he or she lacks expertise in other matters.[85]

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[79] *Id.* at 32.
[80] *Id.* at 35.
[81] *Id.* at 32.
[82] Haynes, *supra* note 69, at xi-xii.
[83] *Id.* at xii.
[84] *Id.*
[85] Weinberg & Harding, *supra* note 39, at 34-35.

If a single law professor ventures alone in delivering interdisciplinary teaching, the risk of misrepresenting non-legal disciplines is very high.[86] Such a professor may lack "scholarly mechanisms for identifying error[s]," as well as models and methods of interpretation or evaluation of non-legal subjects.[87] It is almost impossible for a law professor to possess such a deep knowledge of the other disciplines to the point of being able to adequately convey their basics. Even if a law professor has a previous degree in another subject, such as engineering, they would likely not have utilized it for years. Further, in subjects such as space law, there are multiple intersecting disciplines. Therefore, no single law professor can have all the answers and competences required to teach each intersecting non-legal subject or even an adequate portion of it.

The risk of embarking on such a project alone is to become an "interloper" in one or more non-legal field(s).[88] One should also note that, despite interdisciplinary legal education fostering the understanding of non-legal subjects, being able to understand them is a far cry from being able to teach them. Teaching other disciplines requires mastery of very specialized knowledge. Usually, professors teaching a discipline have a deep knowledge of it and convey only those aspects that are relevant for the entire class.[89] A space law professor may, therefore, interpret certain key aspects of another discipline as unimportant and omit them from the interdisciplinary course. If the disciplines at stake are not mastered, the risk of overconfidence and misinterpretation is very high.[90] Further, if an interdisciplinary law course is taught by a single professor, students cannot interact with professionals educated in other disciplines, which is one of the aims of interdisciplinary teaching.[91]

Interdisciplinary space law courses cannot, therefore, be properly delivered by a single professor. Transmitting knowledge outside the realm of law and explaining its interaction with the legal discipline necessarily requires, at a minimum, a space law pro-

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[86] Mark A. Graber, *Law and Sports Officiating: A Misunderstood and Justly Neglected Relationship*, 16 CONST. COMMENT. 293, 304 (1999).

[87] *Id.* at 295.

[88] Connolly, *supra* note 1, at 32-33.

[89] Weinberg & Harding, *supra* note 39, at 35.

[90] *Id.* at 35-36.

[91] *Id*. at 36.

fessor leading the course with integrated lecturers from other disciplines such as engineering and physics. While integrated lectures provide interdisciplinarity, they are much less efficient than team-taught courses. Space law is a very complex field with multiple intersecting disciplines. For space law courses that need to be interdisciplinary, team teaching is strongly desirable – if not necessary.

B. Challenges of interdisciplinary team teaching

Interdisciplinary team teaching greatly helps achieve results that would not be possible for a single professor. Nevertheless, even a *group* of teachers from multiple disciplines which is engaged in delivering knowledge within a single course could not achieve the same results as an *interdisciplinary team*. Many space law courses are multi-professor-taught courses, and they tend to become multi- rather than inter-disciplinary due to difficulty on part of their instructors to properly integrate course content when both forming the curriculum and delivering such knowledge to students.[92]

The degree of collaboration in the following aspects differentiates a team-taught interdisciplinary course from a multidisciplinary group-taught course: 1) the level of faculty *planning* (whether a course has a main coordinator who interacts with others and the extent of the collaborative decision-making process in planning the course); 2) the level of *integration* of the multiple disciplines; and 3) the delivery of the *teaching*.[93]

Conceptual and instructional integration are the core elements of an interdisciplinary team-taught course.[94] A lack of integration risks providing fragmentation and confusion to the students, and may result in a series of different lectures or modules that scarcely interact among themselves.[95] It is the interaction between the course instructors which provides the necessary means to implement truly interdisciplinary – rather than multidisciplinary – knowledge.[96] Nevertheless, integrating and delivering the

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[92] Jay Wentworth & James R. Davis, *Enhancing Interdisciplinarity Through Team Teaching*, *in* INNOVATIONS IN INTERDISCIPLINARY TEACHING 16, 17-18 (Carolyn Haynes ed. 2002).

[93] JAMES R. DAVIS, INTERDISCIPLINARY COURSES AND TEAM TEACHING: NEW ARRANGEMENTS FOR LEARNING 8-9 (1995).

[94] Wentworth & Davis, *supra* note 92, at 17-18.

[95] Weinberg & Harding, *supra* note 39, at 36-37.

[96] *Id.* at 36.

content are the most challenging aspects of team teaching. Team members, indeed, are exposed to a risk of misunderstanding between each other and to a lack of agreement in the course structure, its content, or in the way it should be delivered.[97]

Wentworth and Davis, in taking as an example the sportive concept of a "dream team", point out that

> [a] teaching team represents a kind of "anti-dream team." Instead of pulling together the best players of one sport, with similar skills, knowledge, and attitude about the game, we intentionally bring together people whose methods of study, subject interests, values, and personalities may be quite different. Then we ask them to play together in a public arena, when most of their training and professional experience has taught them to "go it alone." It is as if we are bringing together one excellent player each from hokey, soccer, basketball, baseball . . . and asking them to [play] . . . a new sport.[98]

Considering this example, if members of the team are selected from among those who are willing to listen, learn and change perspectives, the team would certainly be easier to build.[99] Members should be able to confront differences, overcome walls created by their own expertise through loosening the boundaries of their own discipline, be open to new turf and become welcoming tour guides of their own turf.[100] Team teachers need to plan and agree in advance on multiple aspects of the course such as its theme, their roles in the course, which teaching strategies will be used, what material should be provided, which topic has to be analyzed in more depth, what the learning objectives are, what evaluation methods will be used and what the timing and class size are.[101] Further, weekly meetings to track the progress and adjust the pedagogical approach throughout the course are necessary.[102] Indeed, a theme or topic that requires the integration of multiple disciplines creates a new

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[97] Wentworth & Davis, *supra* note 92, at 18.
[98] *Id.* at 21.
[99] *Id.*
[100] *Id.* at 23.
[101] *Id.* at 19-20.
[102] *Id.* at 21.

field of inquiry, but is also very complex to manage. The danger of "losing direction" is constant.[103]

Integration, nevertheless, other than through content planning, also stems from the way the knowledge is delivered and promoted.[104] For example, in a space law course, it is not sufficient that the law professor explains the legal aspects of filing a frequency allocation request with the ITU while a physicist gives a lecture on radiofrequencies. Rather, the professor and the physicist should work together in explaining how legal and electromagnetic aspects are both relevant when submitting a request and how both aspects interact with and complement each other. Overall, the most challenging aspect of interdisciplinary team teaching is to integrate the various disciplines into a new field and deliver it effectively.

C. Benefits of interdisciplinary team teaching

In the last century, universities have created a loop of infinite specialization through a reasonable effort to delineate domains of study and specify methods of investigation for each field. The direction that has been set is to "know more and more about less and less."[105] Such direction also applies to space law. Such excess of specialization isolates professionals of each discipline, pushing them to analyze their subjects through a single lens; this method generates frustration when contact with another field appears necessary, especially for space lawyers.[106] Society is now imposing the need to change education from a vertical transmission of knowledge to a lateral one, which allows for the inclusion of whole other dimensions of learning.[107] Because any single teacher typically absolutizes his or her method and thus tends to impose certain ideas and values to the teaching of a topic, a true interdisciplinary approach cannot be reached without a team.[108]

In fact, the team element of interdisciplinarity is one of its greatest assets. As Francis Buckley points out,

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[103] Wentworth & Davis, *supra* note 92, at 25.
[104] *Id.* at 27.
[105] DAVIS, *supra* note 93, at 35.
[106] *Id.*
[107] FRANCIS J. BUCKLEY, TEAM TEACHING: WHAT, WHY, AND HOW? 11 (2000).
[108] DAVIS, *supra* note 93, at 35-36.

> [a] great advantage of interdisciplinary team teaching is demonstrating the relationships between the subject areas studied, opening both teachers and students to new points of view, new questions, and new discoveries. . . . [I]t connects learning with real life – which is messy and complex, with many viewpoints and alternative solutions.[109]

Interdisciplinary team teaching also provides for a "resolution of false conflicts between disciplines. . . . Team teaching usually involves a variety of approaches to a subject area . . . [d]ifferent role models are offered for imitation that complement one another. . . ."[110] As the course progresses, both teachers and students gain practical knowledge of how to tackle intersecting disciplines.

Interdisciplinary team teaching highlights the advantages and limitations of each discipline's content and methods, but also combines teachers' strengths and remediates their weaknesses. A team can quickly improve the pedagogical approach as its self-evaluation is necessarily more insightful and balanced than that of an individual teacher. Interdisciplinary team teaching exposes students to different methods and forces them to develop analytical skills that embrace multiple investigative angles. Students can also benefit from watching, listening to and interacting with teachers of different fields as well as learning first-hand how a topic may be approached from different perspectives.[111] Francis Buckley, comparing the strength of a team to a single professor, points out:

> Aware of the learning objectives agreed upon by the team, the lecturer presents an overview of the key ideas from the background reading; analyzes, illustrates, clarifies, reinforces the central content; invites questions and comments; and finally summarizes and applies the material. Other team members cut in from time to time to raise questions or propose alternate interpretations, provoking the students to think for themselves and engage more actively in the class. The entire period is more lively, more free-flowing, and more creative – for teachers and students. . . . Key points of the lecture are clarified, enriched,

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[109] BUCKLEY, *supra* note 107, at 47-48.

[110] *Id.* at 48.

[111] *Id.* at 13-14.

> reinforced, and tied in to practical applications and skills. The abstract is made concrete.[112]

Perhaps the best pedagogical model of interdisciplinary team teaching in space law would include a group leader, in this case the law professor, who traces the main route towards the course objectives. There is no mandate that the entire group shall follow or use his or her methods, but rather they should be able to contribute to complementing the legal course with those insights, materials, methods and evaluations they regard as necessary.[113]

Another advantage team teaching offers is that when teachers do not deliver the lessons, they would play other roles in support of their integration rather than simply being absent. For example, they can be *model learners* to show students how to apprehend content in an interdisciplinary class,[114] or *observers* to observe the teaching process, keep track of time, note discrepancies and provide feedback to colleagues on how to better the class.[115] More significantly, a team-teaching faculty member may also *co-lecture* by providing complementary viewpoints or provoking intense discussion, one of the very essential aspects of interdisciplinary classes.[116] At times, if the class simultaneously requires multiple viewpoints from different expertise, each faculty member may act as a *panel member* and one may *moderate* such a panel by also making sure that interaction with students remains constant.[117] At other times, break-out groups may be organized and the faculty member who does not teach that day could function as *discussion leader*.[118] Further, the class may be split into groups and each professor may function as *group facilitator*.[119] Through team work, team teachers make a greater contribution than the sum of them working separately within the same course.[120]

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[112] *Id.* at 99.
[113] *Id.* at 37-38.
[114] Wentworth & Davis, *supra* note 92, at 27.
[115] *Id.* at 28.
[116] *Id.* at 29.
[117] *Id.* at 29-30.
[118] *Id.* at 30.
[119] *Id.* at 31.
[120] BUCKLEY, *supra* note 107, at 3-4.

V. CONCLUSION

Interdisciplinary classes in highly specialized space law courses are essential and are most effective only through team teaching. American and Canadian higher education has been characterized by the introduction and development of specialization mechanisms in support of disciplinary or departmental structures. For over one hundred years, the typical professor of American and Canadian universities has been "a disciplinary specialist with highly developed research skills, unhampered by any formal knowledge of teaching."[121] Nevertheless, new teachers increasingly realize, almost as soon as they are hired, that knowledge of disciplines far beyond their specialization is indispensable. The interest in interdisciplinary teaching, especially team teaching, is growing; however, its concrete development is still undertaken on few occasions.[122] The lack of such development is especially true in the field of space law.[123]

Most of the time, law schools leave students on their own with little (in the case of multidisciplinary teaching) or no guidance (in traditional classes) about how to bridge disciplines. However, the world is changing and society now requires legal professionals be more prepared than ever in different disciplines. Even academia itself is increasingly realizing the need to hire new faculty members who already have an interdisciplinary orientation, are familiar with planning interdisciplinary courses and have experience in team teaching.[124] New legal professionals, especially in booming fields such as space law, must be introduced to new perspectives stemming from the interaction of different disciplines with law. As James Davis pointed out,

> [s]urely each generation fails to notice many things in its intellectual journeys, but perhaps the faculty and at least some students of the next generation will see things no one else has seen by developing new perspectives through interdisciplinary studies.[125]

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[121] DAVIS, *supra* note 93, at 147.

[122] *Id.*

[123] For a broad view, see Jakhu & Chen, *supra* note 51, at 288, 290.

[124] DAVIS, *supra* note 93, at 147-148.

[125] *Id.* at 150.

As space law rapidly develops, so too must the appropriate curricula from which the next generation of outer space legal professionals will emerge. Interdisciplinary team teaching will be the most effective way to implement space law curricula's adaptation to the ever-demanding needs of today's clients.

WHERE NO WAR HAS GONE BEFORE: OUTER SPACE AND THE ADEQUACY OF THE CURRENT LAW OF ARMED CONFLICT

Gemmo Bautista Fernandez[*]

ABSTRACT

This article delves into the implications of armed conflicts in outer space to international humanitarian law and examines whether the current law of armed conflict is sufficient to accommodate the challenges that these implications pose. The article begins by providing a context of the militarization of outer space and notes the development of military capabilities and how international law developed in light of this militarization. This article then delves into several of the theoretical and practical implications of armed conflicts waged in space, including the lack of clear definitions, the classification of armed conflicts, the legality of means and methods of warfare and the status of persons and objects involved in space-based armed conflict. Finally, this article analyzes how the current law of armed conflict responds to these challenges. It examines the parallelism of the development of the rules on aerial warfare with that of armed conflicts in outer space. It notes that regardless of advances in military space capabilities, these capabilities still remain subject to relevant treaty obligations, established customs, principles of international humanitarian law and the dictates of public conscience

I. INTRODUCTION

Technology both enhances the means and methods of warfare in "range, detectability, precision, or destructive power" and creates

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new options for such means and methods.[1] The invention of the airplane, for instance, ushered in a new method for performing surveillance, transporting troops and materials and delivering weapons – thereby providing belligerents with distinct advantages on the battlefield.[2] The same is true with respect to access to outer space. If air superiority is viewed as a requirement to triumph in conflicts, then "space is the ultimate altitude from which to gain military advantage" over the terrestrial theatre.[3]

The militarization of outer space is characterized, in the terrestrial context, as having the "high ground."[4] Outer Space "offers unique advantages" to parties to an armed conflict such as that of global access and "persistency of coverage."[5] It provides capabilities, including, but not limited to: greater battlefield situational awareness through accurate information; improved command and control through enhanced communication; and effective measures of combat by means of advanced weaponry.[6] Further, "space-based objects are . . . insulated from [the] disadvantages of terrestrial infrastructure."[7] This means that "national borders do not bind [parties] and it is difficult for one [party] to exert any control over [another's space assets]."[8] Nonetheless, the advantages of possessing this "high ground" should not be overestimated. It would not be hard to imagine that means and methods may be developed to negate the advantage of this "high ground." Moreover, space orbits are limited, predictable and allow the enemy to engage in unobserved activity between passes or target space assets.[9] Thus, "despite the infinite nature of space, the manoeuverability [sic] of space objects around the Earth is restricted."[10]

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[1] HITOSHI NASU & ROBERT MCLAUGHLIN, NEW TECHNOLOGIES AND THE LAW OF ARMED CONFLICT 2 (2014).

[2] *See* C.M. Picciotto, *Notes on Air-Warfare*, 15 J. SOC'Y. COMP. LEGIS. 150, 155 (1915).

[3] JOAN JOHNSON-FREESE, SPACE AS A STRATEGIC ASSET 132 (2007).

[4] Duncan Blake, *Law Applicable to Military Strategic Use of Outer Space*, *in* HITOSHI NASU & ROBERT MCLAUGHLIN NEW TECHNOLOGIES AND THE LAW OF ARMED CONFLICT 97, 100 (2014).

[5] Michael N. Schmitt, *International Law and Military Operations in Space*, 10 MAX PLANCK Y.B. U.N. L. 89, 94 (2006).

[6] JOHNSON-FREESE, *supra* note 3, at 82.

[7] Blake, *supra* note 4, at 100.

[8] *Id.*

[9] Schmitt, *supra* note 5, at 94.

[10] Blake, *supra* note 4, at 101.

This militarization should not come as a surprise. The development of space capabilities dates back to the Second World War.[11] The subsequent space race between the Soviet Union and the United States further contributed to militarization in space. Although represented as a fight "for the prestige and global influence that [flows] from technical prowess," the "knowledge and the hardware" created during this period brought not only domestic benefits but also military knowledge and capabilities.[12] Currently, space-based assets are continually integrated to ground, air and sea assets as "other [S]tates enter the space age militarily."[13] As States race to develop space-based weapons, it becomes clearer that outer space has become the "fourth domain of warfare.[14] Only recently, the Trump Administration announced its intention to establish a new branch of the United States military to handle threats from outer space.[15] Similarly, France has stated that its military would begin launching weaponized satellites into space.[16]

However, while the "technological advance in weaponry seems to be unstoppable," a balance must be struck between the advent of technology and the "manner in which warfare is conducted."[17] Yet, the "law does not tend to anticipate the process of technical advance."[18] It is "inevitable that there should be a delay between the appearance of a new weapon technology and the formation of legal provisions to address any concerns that the technology may

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[11] JOHNSON-FREESE, *supra* note 3, at 83.

[12] *Id.* at 55.

[13] SCHMITT, *supra* note 5, at 91. *See also* Douglas MacGregor, *Resurrecting Transformation for the Post-Industrial Era*, *in* FUTURE ARMIES, FUTURE CHALLENGES: LAND WARFARE IN THE INFORMATION AGE 46, 55 (Michael Evans, Alan Ryan, & Russel Parkin, eds., 2004); Elizabeth Waldrop, *Weaponisation of Outer Space: US National Policy*, 29 ANNALS AIR & SPACE L. 329, 333 (2004).

[14] Wolff Heintschel von Heinegg, *Neutrality and Outer Space*, 93 INT'L LEGAL STUD. 526, 527 (2017); *See also* Cassandra Steer, *Global Commons, Cosmic Commons: Implications of Military and Security Uses of Outer Space*, 18 GEO. J. INT'L AFF. 9, 12 (2017); Steven Freeland, *In Heaven as on Earth - The International Legal Regulation of the Military Use of Outer Space*, 8 US-CHINA L. REV. 272, 284 (2011).

[15] Helen Cooper, *Trump Signs Order to Begin Creation of Space Force*, N.Y. TIMES (Feb. 19, 2019), https://www.nytimes.com/2019/02/19/us/politics/trump-space-force.html.

[16] Hanneke Weitering, *France Is Launching a "Space Force" With Weaponized Satellites* (Aug. 3, 2019), https://www.space.com/france-military-space-force.html.

[17] WILLIAM H. BOOTHBY, CONFLICT LAW: INFLUENCE OF NEW WEAPONS, TECHNOLOGY, HUMAN RIGHTS, AND EMERGING ACTORS 155 (2014).

[18] *Id.* at 157.

arouse."[19] States "cannot necessarily know in advance what scientific endeavor will produce, nor can they always anticipate with any degree of reliability what humanitarian or other concerns that such advancements will generate."[20] Thus, the implications of new technologies only "become clear once development has achieved a sufficient maturity and after the resulting product or capability has been appropriately tested."[21]

This article delves into some theoretical and practical implications of armed conflicts in outer space to international humanitarian law and examines whether the current law of armed conflict is sufficient in accommodating the challenges that these implications pose. The first part of this article provides a context of the militarization of outer space. It notes the development of treaties created in an attempt to prevent this militarization and their respective limitations in regulating armed conflict. The second part of this article examines several implications posed by armed conflicts waged in space, including the lack of clear definitions, the classification of armed conflicts, the legality of the means and methods of warfare and the status of persons and objects involved in such armed conflict. To be sure, the implications are not limited to these representative issues; however, a comprehensive review of all aspects of outer space warfare and its implications for the law of armed conflict is beyond the scope of this article. Lastly, the third part of this article notes that the absence of specific regulations does not grant parties to armed conflicts in outer space unfettered right to employ any effective means and methods of warfare. In this regard, it examines the parallelism of the development of the rules on aerial warfare with that of armed conflicts in outer space and how regulations were developed with regard to the former. The article concludes with the assertion that, in the absence of specific regulations, the principles of international law provide a semblance of rules for humanitarian rights to be protected and upheld as States' militaries engage in outer space.

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[19] *Id.*
[20] *Id.*
[21] *Id.*

II. PHANTOM MENACE*:* MILITARIZATION OF OUTER SPACE

A. Development of Capabilities

Space-related technology was first put to large-scale military combat use by Nazi Germany during the Second World War.[22] The V-2 rocket, though relying on rudimentary guidance and control mechanisms, briefly exited the Earth's atmosphere before making its way to its target, which was ultimately unable to mount a defense against it.[23] Following the close of hostilities, United States (US) and Soviet scientists developed their own, more advanced rockets based on the knowledge gained from captured German scientists.[24] This advent of rocketry eventually led to the development of ballistic missiles which continue to play an "important role in any sophisticated national security structure."[25]

The development of rocketry was not confined to the delivery of conventional and nuclear weapons. The advancements in technology, such as the launch of *Sputnik*, led to the realization of the benefits of satellite technology in facilitating and augmenting military activities.[26] These include the "surveillance of troop movements and weapons facilities, intelligence-gathering, and early warning systems designed to detect the launch of nuclear missiles."[27] Satellite systems were also developed to carry "military

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[22] WILLIAM J. DURCH & D. A. WILKENING, STEPS INTO SPACE IN NATIONAL INTERESTS AND MILITARY USE OF SPACE 17 (1984); Robert A. Ramey, *Armed Conflict on the Final Frontier: the Law of War in Space*, 48 A.F. L. REV. 1, 8 (2000) (citing DANIEL N. SPIRES, BEYOND HORIZONS: A HALF CENTURY OF AIR FORCE SPACE LEADERSHIP 5 (1998)).

[23] Ramey, *supra* note 22, at 8.

[24] *Id.* at 10–11 (citing T. A. HEPPENHEIMER, COUNTDOWN: HISTORY OF SPACE FLIGHT, 60 (1997)).

[25] Freeland, *supra* note 14 at 283 (citing Regina Hagen & Jurgen Scheffran, *International Space Law and Space Security: Expectations and Criteria for a Sustainable and Peaceful Use of Outer Space*, *in* SPACE LAW: CURRENT PROBLEMS AND PERSPECTIVES FOR FUTURE REGULATIONS 273 (Marietta Benkö & Kai-Uw Schrogl eds., 2005)).

[26] Kubo Maćak, *Silent War: Applicability of the Jus in Bello to Military Space Operations*, 94 INT'L L. STUD. 1, 3 (2018); Mitchell Ford, *War on the Final Frontier: Can Twentieth-Century Space Law Combat Twenty-First-Century Warfare*, 39 HOUSTON J. INT'L L. 237, 238 (2017).

[27] Columba Peoples, *Assuming the Inevitable? Overcoming the Inevitability of Outer Space Weaponisation and Conflict*, 29 CONTEMP. SEC. POL'Y 502 (2008).

communication, provide weather intelligence, and aid navigation."[28] Simply, space-based systems were developed under the belief that conflicts "could be won on Earth through a geopolitical advantage above by creating an active defense capability in space."[29]

As technology matured, measures to counter the advantages of space-related assets were also developed. One countermeasure pertained to defending against ballistic missiles. For instance, the US developed terrestrial anti-missile defense systems "intended to protect itself against nuclear threats."[30] Other measures were also developed to potentially negate the advantages of satellites in orbit. The Soviets, for example, tested a weapon that "steers close to its target and blows it up by detonation in the target's vicinity."[31] The US, on the other hand, developed kinetic energy-based weapons that travel at tremendous speeds and could destroy space-based objects "without the use of an explosive warhead."[32]

Subsequent developments in space-based technology are marked by increased integration with terrestrial military assets and strategy. The 1991 Gulf War inaugurated use of satellite capabilities in the conduct of military operations.[33] The 1991 Gulf War is viewed as "a watershed event for the advancement of space information to the war-fighting personnel" – where satellite communication supplemented traditional military communication.[34] Satellite technology was used "to direct military activity" including relying on meteorological data for planning operations.[35] Other services were also used for navigation and directing precision munitions.[36] This trend has also been seen in other conflicts, such as the North

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[28] Ramey, *supra* note 22, at 16–17.

[29] Steer, *supra* note 14, at 11.

[30] Steven A. Mirmina, *The Ballistic Missile Defense System and Its Effects on the Outer Space Environment*, 31 J. SPACE L. 287, 291 (2005).

[31] Jackson Maogoto & Steven Freeland, *The Final Frontier: The Laws of Armed Conflict and Space Warfare*, 23 CONN. J. INT'L L. 165, 187 (2007); Ramey, *supra* note 22, at 26.

[32] Ramey, *supra* note 22, at 22.

[33] Maćak, *supra* note 26, at 4.(internal citations omitted).

[34] RICHARD HAND, SPACE HANDBOOK: A FIGHTER'S GUIDE TO SPACE 47 (1993); Percy J. Blount, *Targeting in Outer Space: Legal Aspects of Operational Military Actions*, *in Space*, HARV. NAT'L SEC. J. F. 14 (2012).

[35] Maogoto & Freeland, *supra* note 31, at 169. *See also* Bhupendra Jasani, *Military Use of Outer Space*, 27 ANNALS AIR & SPACE L. 347, 351 (2002).

[36] Dale Stephens, *Star Wars: Legal Controls on Armed Conflict in Outer Space*, 37 AUSTL. SCI. 14, 16 (2016).

Atlantic Treaty Organization (NATO) campaign in the former Yugoslavia, suggesting that reliance on space assets will increasingly lead to the space environment becoming a distinct theatre of military operations.[37]

As the "coincidental inability and unwillingness to fight over space are coming to an end[, a] growing number of [S]tates are developing the means . . . not merely to access and exploit space but to conduct space warfare as well."[38] For instance, China and India have recently tested weapons aimed at destroying satellites in space.[39] Moreover, new weapons are being developed such as directed energy and particle beam weapons that can attack space or terrestrial-based targets;[40] electromagnetic and radiation devices that can impair electronic circuitries or interfere with other equipment;[41] kinetic energy armaments that can strike terrestrial targets;[42] and cyber weapons that could disable or interfere with the operations of space-based assets.[43]

B. Response of International Law

Under general international law, "outer space and celestial bodies [appear to] share the basic legal condition of the high seas without, however, the special rules that pertain solely to the high seas."[44] This means that "the legal status of outer space and of celestial bodies is that they are open to use by all [S]tates and their nationals."[45] It is, of course, recognized that there may be restrictions in peacetime on the "testing or deployment of weapons, target practice, [and] dumping of waste in outer space or on the

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[37] Ramey, *supra* note 22, at 122.

[38] Howard Kleinberg, *On War in Space*, 5 ASTROPOLITICS 1, 1 (2007).

[39] William Broad & David Sanger, *China Tests Anti-Satellite Weapon, Unnerving US*, N.Y. TIMES (Jan. 18, 2007) https://www.nytimes.com/2007/01/18/world/asia/18cndchina.html; Nicole Chavez & Sugam Pokharel, *India Conducts successful Anti-satellite Missile Operation, Prime Minister Says*, CNN (Mar. 28, 2019) https://edition.cnn.com/2019/03/27/india/india-modi-satellite-missile-mission/index.html.

[40] Maogoto & Freeland, *supra* note 31, at 169 (citing PAUL B. STARES, THE MILITARIZATION OF SPACE: U.S. POLICY, 1945-1984 111 (1985)).

[41] *See* Steer, *supra* note 14, at 12; Maogoto & Freeland, *supra* note 31, at 185.

[42] JOHNSON-FREESE, *supra* note 3, at 139.

[43] Roger Handberg, *Is Space War Imminent? Exploring the Possibility*, 36 COMP. STRATEGIES 413, 422 (2017).

[44] BIN CHENG, STUDIES IN INTERNATIONAL SPACE LAW 525 (1997).

[45] *Id.*

moon and other celestial bodies."[46] However, no "special rules of general international law have been developed specifically governing the use of outer space, the moon and other celestial bodies for military purposes in time of war or armed conflict."[47] The post-1957 recodification effort of *jus in bello* rules, which resulted in the adoption of the 1977 Additional Protocols, "took place at a time when extending the relevant rules to outer space was not a priority."[48] Further, while the United Nations (UN) General Assembly has passed resolutions calling for the continued peaceful use of space and the prevention of an arms race in space,[49] no political momentum seems to have been directed to regulating its wartime use.

The outer space legal regime consists of treaties aimed at the limitation of weapons in space and treaties which govern the exploration and use of outer space by States, organizations and private persons.[50] Under the former category of treaties is the Limited Test Ban Treaty, which prohibits the explosion of nuclear weapons in the atmosphere or any other environment if such explosion causes radioactive debris to be present outside the territorial limits of the State.[51] Arguably, given the title of the treaty, "the intention of the Treaty is essentially to ban nuclear tests in time of peace."[52] Thus, "it is not as such intended to regulate the use of nuclear weapons in time of war or its equivalent."[53] The now-terminated Anti-Ballistic Missile Treaty between the US and the Soviet Union was also under this category of treaties to limit weapons in outer space. The treaty

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[46] *Id.*

[47] *Id.*

[48] Maćak, *supra* note 26, at 11.

[49] *See* GA Res. 47/68, Principles Relating to the Use of Nuclear Power Sources in Outer Space (Dec. 14, 1992); Principles Relating to Remote Sensing of the Earth from Space (Dec. 3, 1986) GA Res. 41/65 (XLII), U.N. GOAR, 29th Sess., 95th Plen. Mtg., U.N. Doc. A/Res/41/65 (1987). *See also* Sa'id Mosteshar, *Outer Space: Arena for War or Peace*, 51 PROC. INT'L INST. SPACE L. 199, 201 (2008) (citing Declaration of Legal Principles Governing the Activities of States in the Exploration and Use of Outer Space (Dec. 13, 1963), GA Res. (XVIII), U.N. GOAR, 18th Sess., 1280th Plen. Mtg., U.N. Doc. A/5515).

[50] *See* Blount, *supra* note 34, at 2; Ramey, *supra* note 22, at 5 (citing IVAN BEKEY, FORCE PROJECTION FROM SPACE IN NEW WORLD VISTAS: AIR AND SPACE POWER FOR THE 21ST CENTURY, 83, 85 (1995)).

[51] CHENG, *supra* note 44, at 526 (1997) (citing Treaty Banning nuclear weapon tests in the atmosphere, in outer space and under water art.1, Aug. 5, 1963, 14.2 U.S.T. 1313, 1316, 480 U.N.T.S. 43).

[52] *Id.*, at 527.

[53] *Id.*

limited the deployment, testing and use of missile systems designed to intercept incoming strategic ballistic missiles.[54] The rationale behind the Treaty was that effectually limiting anti-missile systems would curb the race in strategic offensive arms. The Conventional Weapons Convention also finds some application. Protocol IV of the Convention limits the use of laser weapons – which may, one day, also be employed in space.[55]

The latter category of agreements deals with the responsibilities of States in relation to their activities in outer space. For instance, the Agreement on the Rescue of Astronauts and the Return of Objects Launched in Outer Space (Rescue and Return Agreement) imposes a number of requirements towards assisting astronauts in distress.[56] With regard to objects in space, the Convention on the International Liability for Damage Caused by Space Objects (Liability Convention) establishes liability for launching States for damages caused by their space objects.[57] The Convention on Registration of Objects Launched into Outer Space (Registration Convention) imposes identification requirements for objects launched into outer space.[58] Significantly, the Agreement Governing the Activities of States on the Moon and Other Celestial Bodies (Moon Agreement) restricts the militarization of celestial bodies by prohibiting the use or threat of hostile acts against celestial bodies; the placing of weapons of mass destruction in the vicinity of celestial bodies; and the establishment of installations for military purposes.[59]

The Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, Including the Moon and Other Celestial Bodies (Outer Space Treaty) is the most comprehensive of the treaties regulating activities in outer space.[60] However, the Outer Space Treaty, like other treaties, lacks provisions

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[54] *See* Mosteshar, *supra* note 49, at 200; Blake, *supra* note 4, at 125.

[55] Mosteshar, *supra* note 49, at 201.

[56] *See* Agreement on the Rescue of Astronauts and the Return of Objects Launched in Outer Space, Dec. 19, 1967, 19 U.S.T. 7570, 672 U.N.T.S. 119.

[57] *See* Convention on the International Liability for Damage Caused by Space Objects, Mar. 29, 1972, 24 U.S.T. 2389, 961 U.N.T.S. 187.

[58] *See* Convention on Registration of Objects Launched into Outer Space, Nov. 12, 1974, 28 U.S.T. 695, 1023 U.N.T.S. 15.

[59] *See* Agreement Governing the Activities of States on the Moon and Other Celestial Bodies arts. I, III, Dec. 18, 1979, 18 I.L.M. 1434, 1363 U.N.T.S. 22.

[60] Dale Stephens, *International Legal Implications of Military Space Operations: Examining the Interplay Between International Humanitarian Law and the Outer Space*

relating to wartime and post-war application.[61] Thus, questions persist as to its applicability during times of armed conflict. Nevertheless, it could be argued that since "international law has to be looked at as a whole" and cannot be divided into "self-contained boxes which have no bearing upon one another,"[62] these provisions may continue to apply on a case-by-case basis insofar as they are not inconsistent with the *lex specialis* of international humanitarian law.[63]

Notwithstanding the points made in the preceding paragraphs, the Outer Space Treaty's provisions pertaining to armed conflicts are lacking. In general, it states that activities in outer space are expressly limited by reference to international law, including the UN Charter.[64] It further requires that activities in outer space be undertaken "in the interest of maintaining international peace and security."[65] Interpretations of the Treaty's provision restricting the use of space to "peaceful purposes" is problematic. Often, the term is interpreted as meaning "non-aggressive" consistent with the requirements of the UN Charter.[66] What the treaty does not do is lay down the rules on the conduct of hostilities in outer space. Notably, it forbids the testing of any type of weapon; the establishment of bases, installations and fortifications; and military maneuvers on celestial bodies.[67] It also prohibits the deployment of nuclear weapons and weapons of mass destruction.[68] However, it does not restrict the utilization of other conventional weapons nor

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Legal Regime, 94 INT'L L. STUD. 75, 78 (2018) (citing Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, Including the Moon and Other Celestial Bodies art. I, Jan. 27, 1967, 18 U.S.T. 2410, 610 U.N.T.S. 205 [hereinafter Outer Space Treaty]).

[61] *See id.* at 82 (citing Hague Convention on the Protection of Cultural Property in a Time of Armed Conflict, May 14, 1954, 249 U.N.T.S. 215); Schmitt, *supra* note 5, at 101.

[62] Christopher Greenwood, *Human Rights and Humanitarian Law - Conflict or Convergence*, 43 CASE W. RESERVE J. INT'L L. 491, 504 (2010).

[63] *See* Stephens, *supra* note 60 at 78 (internal citation omitted); Schmitt, *supra* note 5 at 101.

[64] *See* Outer Space Treaty, *supra* note 60, art. III.

[65] *Id.*

[66] Stephens, *supra* note 60, at 81. *See also* Jean-Christophe Martin, *Theatre of Operations*, *in* THE OXFORD HANDBOOK OF THE USE OF FORCE IN INTERNATIONAL LAW 752, 760 (Marc Weller ed., 2015).

[67] Outer Space Treaty, *supra* note 60, at art. IV.

[68] *Id.*

does it regulate the deployment of space-based assets with military capabilities.[69]

III. FORCE AWAKENS: IMPLICATION OF OUTER SPACE ARMED CONFLICTS

A. Definitions

In dealing with outer space armed conflicts, defining what activity or activities constitutes armed conflict in outer space is imperative. If outer space conflict is to be regulated, a definition of what outer space is and what armed activities are to be considered to be within the purview of an outer space armed conflict must be made.

i. Outer Space

As to what outer space is, "there is no precise internationally agreed definition of the altitude(s) from the [terrestrial] surface at which outer space begins and airspace ends."[70] There are a number of reasons for this, "not least the objective difficulty for the [S]tates concerned to agree on legal definitions in the context of rapidly developing technology and their apprehension that legally binding definitions might restrict their sphere of operation."[71] Nonetheless, "the absence of a formal definition of outer space does not mean that no general perception exists as to what is meant by outer space, even if the use of the term in natural sciences and in law may not always be exactly the same."[72]

One approach proposes that outer space begins at the "highest altitude at which an aircraft can derive lift from its interaction with the air and below the lowest possible perigee of an earth satellite in

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[69] Bill Boothby, *Space Weapons and the Law*, 93 INT'L L. STUD. 179, 201 (2017).

[70] *Id.* at183. *See also* Schmitt, *supra* note 5, at 99.

[71] Vladlen Vereshchetin, *Outer Space*, *in* MAX PLANCK ENCYCLOPEDIA OF PUBLIC INTERNATIONAL LAW ¶ 1 (Rüdiger Wolfrum online ed., 2006); *See* Ramey, *supra* note 22, at 5 (citing IVAN VLASIC, NEGOTIATING AND DRAFTING AGREEMENTS RELATING TO OUTER SPACE IN ARMS CONTROL AND DISARMAMENT IN OUTER SPACE: TOWARDS A NEW ORDER OF SURVIVAL, 209 (Matte ed., 1991)).

[72] Vereshchetin, *supra* note 71, at ¶ 2.

orbit."[73] While potentially providing a standard definition, this approach has its share of problems. First, the variable chosen, altitude records, makes the definition very unstable and open to constant changes. Altitude records are often broken and will continue to be with the advent of technology. Second, exact figures, especially if the aircraft used is one with advanced military capabilities, are usually classified as national security information and thereby not disclosed by States.[74] Thus, it could be argued that the "[a]irspace, or the atmosphere, is the frame of reference by which aircraft is defined but is not itself delimited by."[75]

Another approach to defining outer space pegs the starting point of space to the upper limit of the atmosphere. However, this method also presents difficulties. To begin with, scientists are still uncertain as to where that upper limit lies, notwithstanding the fact that scientific knowledge of the atmosphere has considerably increased during the past several decades.[76] Notably, the limit is neither a sharp nor a well-defined feature and "may vary considerably according to the regions and the seasons, and its determination may involve a certain amount of arbitrariness."[77] Thus, it may be "impossible to trace the outer limit of the earth's atmosphere, if such an outer limit exists at all, from the scientific standpoint."[78]

If the functional and the natural approaches both fail in significant respects, a third option is to define the limits based on agreement between States – as has been done with nautical boundaries within the law of the sea. Of course, as previously mentioned, this option is fraught with complications. Difficulties and delays have been encountered by States in the effort to "reach agreement on the much more mature and well-established subject of the inner and outer limits of the territorial sea, once thought to be the ripest

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[73] Boothby, *supra* note 69, at 183. *See also* JEAN-CHRISTOPHE MARTIN, THEATRE OF OPERATIONS IN THE OXFORD HANDBOOK OF THE USE OF FORCE IN INTERNATIONAL LAW, 760 (Marc Weller ed., 2015) (citing Bin Cheng, *The Legal Status of Outer Space and Relevant Issues: Delimitation of Outer Space and Definition of Peaceful Use*, 11 J. SPACE L. 89 (1983)); J. C. Cooper, *High Altitude Flight and National Sovereignty* 4 INT'L L. Q. 411, 415 (1951)*; See* US Air Force, *Space Operations*, Doctrine Document 2-2 of 27 November 2001, 1; UK Ministry of Defence, *Manual of the Law of Armed Conflict* (2004), ¶¶12.3.

[74] CHENG, *supra* note 44, at 7.

[75] *Id.*

[76] *Id.* at 8.

[77] *Id.*

[78] *Id.*

topic for international codification."[79] Nevertheless, this method avoids the variability of the other two methods previously discussed, even if consent appears to be only remotely attainable.

ii. Outer Space Conflict

Similarly, defining the nature of outer space conflict is an equally important task. One view is that warfare in outer space includes the employment of weapons that operate exclusively in space.[80] It could, thus, exclude ballistic missiles, which travel through space but do not go into orbit. This definition also omits terrestrial objects that could potentially affect space-based assets.

The better view is a more broadly inclusive definition of outer space conflict which encompasses activities whether "located on land, under or on the surface of the sea or in airspace, [provided] they have operational effects in outer space."[81] Thus, the definition includes any offensive, defensive and support operations carried out using space-based or space-related assets with the intention of imposing an actor's will on the "adversary by achieving a sufficient degree of superiority."[82] The rationale behind this more inclusive view is that it contemplates military space activities which would otherwise be uninhibited. Moreover, adopting the less inclusive view may lead to the formation of fewer and less precise rules governing such warfare. Thus, any military action with a material nexus to outer space should be the subject of any future regulation.[83]

Following this inclusive definition, the means and methods of space warfare may be generally classified in several groups. The first group pertains to military operations in space. This includes space-based infrastructures that are intended to effect other space-based infrastructures. Examples in this category would include military satellites designed to service friendly assets or target hostile objects.[84] Future crewed missions, with objectives that include the

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[79] *Id.* at 9. *See also* Tullio Treves, *Historical Development of the Law of the Sea*, *in* THE OXFORD HANDBOOK OF THE LAW OF THE SEA 13 (Donald Rothwell et al. eds., 2015).

[80] Boothby, *supra* note 69, at 183.

[81] *Id.* at 184. *See also* Stephens, *supra* note 60, at 77.

[82] Javier Guisández Gómez, *The Law of Air Warfare*, 323 INT'L REV. RED CROSS 347, 353 (1998).

[83] *See* Maćak, *supra* note 26, at 7.

[84] *Id.*

development of space-based assets, are also included in this group.[85] The second group of means and methods of space warfare involves operations from space that affect terrestrial objects. This group includes weaponry originating from orbit, or from deeper space, that kinetically targets objects on the Earth. Of course, the technology for such warfare may be too advanced to be of current concern.[86] Nevertheless, the technological possibility does not appear to be remote. The Soviet Union, in the past, developed a method of nuclear weapon delivery involving the placement of a warhead in low Earth orbit that, in turn, may be deorbited.[87] Kinetic-energy weapons have also been considered, but the "expense of launching these systems into space merely as a contingency does not appear to be currently viable."[88]

The means and methods need not be in space in order to effect space-based architecture.[89] Hence, the third group comprises of operations directed towards space or space objects. Terrestrial assets may readily be directed to space such as missiles targeting space infrastructure or those that counter the threat of incoming ballistic missiles.[90] There are also directed-energy weapons, such as lasers designed to "dazzle, disrupt, shift, tumble or destroy" space objects.[91] "Soft-kill" methods are also included, such as cyber-attacks that interfere with communications, damage equipment or jam signals.[92]

Considering that operations need not be in orbit, objects that pass-through space *en route* to its destination are also included. Thus, the fourth category involves those that pass-through space such as ballistic missiles and other sub-orbital assets.

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[85] Blake, *supra* note 4, at 109.

[86] *Id.* at 110 (noting DAVID WRIGHT, LAURA GREGO & LISBETH GRONLUND, THE PHYSICS OF SPACE SECURITY: A REFERENCE MANUAL 89 (2005)).

[87] *See* Columba Peoples, *Assuming the Inevitable? Overcoming the Inevitability of Outer Space Weaponisation and Conflict*, 29 CONT. SEC. POL. 502 (2008).

[88] Blake, *supra* note 4, at 110 *citing* WRIGHT ET AL, *supra 86*; *See also* Boothby, *supra* note 69, at 193.

[89] *See* TALLINN MANUAL 2.0 ON THE INTERNATIONAL LAW APPLICABLE TO CYBER OPERATIONS 415-16, 437 (Michael Schmitt ed., 2018) [hereinafter TALLINN MANUAL]; JOHNSON-FREESE, *supra* note 3, at 7.

[90] *See* Maćak, *supra* note 26, at 7; Mirmina, *supra* note 30, at 292.

[91] Blake, *supra* note 4, at 109.

[92] *See* Steer, *supra* note 14, at 12; Ford, *supra* note 26, at 248.

Finally, space warfare includes those activities that are supported by space operations and those that support such activities.[93] Included under the former are satellites that facilitate military communication;[94] those employed for intelligence, surveillance and reconnaissance;[95] and satellites that provide guidance for terrestrial navigation and precision weapons targeting.[96] On the other hand, the latter comprises activities that facilitate space operations. These activities include, among others, the ground command and control of space-related assets, systems that enable the relay of data and facilities that launch, deploy, maintain, sustain or recover space vehicles.[97]

B. Classification & Geographical Scope

The second concern pertains to the classification of armed conflicts waged in outer space. Under the traditional classification, armed conflicts are classified into two main categories: international and non-international. When an armed conflict is between two or more States, the whole scope of the law of war becomes applicable to the conflict.[98] Notably, Article 1(4) of Additional Protocol I extended the scope of international armed conflicts to include armed conflicts in which peoples are fighting against colonial domination, alien occupation and racist regimes.[99] On the other hand,

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[93] *See* JOHNSON-FREESE, *supra* note 3, at 84, 91; Waldrop, *supra* note 13, at 333.

[94] Blake, *supra* note 4, at 105.

[95] JOHNSON-FREESE, *supra* note 3, at 185.

[96] Blake, *supra* note 4, at 105-06.

[97] JOHNSON-FREESE, *supra* note 3, at 84, 91.

[98] DIETER FLECK, THE HANDBOOK OF INTERNATIONAL HUMANITARIAN LAW 50 (2013); Sylvain Vite, *Typology of Armed Conflicts in International Humanitarian Law: Legal Concepts and Actual Situations*, 91 INT'L REV. RED CROSS 69, 92 (2009); Marco Sassòli, *The Legal Qualification of the Conflict in the Former Yugoslavia: Double Standards or New Horizons for International Humanitarian Law? in* INTERNATIONAL LAW IN THE POST-COLD WAR WORLD: ESSAYS IN MEMORY OF LI HAOPEI 307, 311 (Sienho Yee & Wang Tieya eds., 2001); Int'l Comm. Red Cross, International Humanitarian Law and the Challenges of Contemporary Armed Conflicts, 9-10 (Geneva, Nov. 28 – Dec. 1, 2011), https://e-brief.icrc.org/wp-content/uploads/2016/08/4-international-humanitarian-law-and-the-challenges-of-contemporary-armed-conflicts.pdf [hereinafter International Humanitarian Law and the Challenges of Contemporary Armed Conflicts].

[99] Protocol Additional to the Geneva Conventions and relating to the Protection of Victims of International Armed Conflicts (Protocol I) art. 1(4), June 8, 1977, 16 I.L.M. 1442, 1125 U.N.T.S. 3 [hereinafter Protocol I].

common Article 3 of the Geneva Conventions provide for non-international armed conflicts which are those not between States but "occurring in the territory of one of the High Contracting Parties."[100]

The difficulty arises in the geographical scope of the definitions. Of course, there appears to be no problem, with regard to international armed conflicts, that the law of international armed conflicts applies to the conduct of hostilities between two or more States wherever it takes place.[101] The problem lies in the case of non-international armed conflicts that take place solely in outer space and those conflicts that do not occur within an existing terrestrial armed conflict. If it is accepted that the phrase "in the territory of one of the High Contracting Parties" does not limit the coverage of the Article to internal armed conflicts, then these armed conflicts may fall under the classical dichotomy of armed conflicts. However, if the opposite interpretation is accepted, then non-international armed conflicts may fall under a legal void that is not classified by any of the conventions of international humanitarian law.

The latter interpretation is submitted to be the proper one. It has been said that "the notion of [non-international armed conflict] has undergone evolution, particularly since the beginning of the twenty-first century."[102] It has been put forward that "[t]here is nothing in the drafting history of Common Article 3 on the basis of which it may be concluded that the territorial clause was *deliberately* formulated to limit its geographical application to the territory of a single [S]tate."[103] The draft text, submitted to the Diplomatic Conference in Geneva, provided as follows: "[in] all cases of armed conflict not of an international character, especially cases of civil war, colonial conflicts or wars of religion, which may occur on

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[100] Geneva Convention Relative to the Treatment of Prisoners of War art. 3, Aug. 12, 1949, 6 U.S.T. 3316, 75 U.N.T.S. 135.

[101] Maćak, *supra* note 26, at 34.

[102] *Id.* at 35. *See also* BOOTHBY, *supra* note 17, at 50; YORAM DINSTEIN, WAR, AGGRESSION, AND SELF DEFENCE 218 (3d ed. 2001); Barry A. Feinstein, *Operation Enduring Freedom: Legal Dimensions of an Infinitely Just Operation*, 11 J. TRANSNAT'L L. & POL'Y. 201, 280 (2002).

[103] Jelena Pejic, *The Protective Scope of Common Article 3: More than Meets the Eye*, 93 INT'L REV. RED CROSS 189, 199 (2011).

the territory of one or more of the High Contracting Parties."[104] The drafting history does not provide any signal that there was an intention to limit non-international armed conflict to hostilities within the territory of the State.[105] The provision refers to armed conflicts that do not fall under common Article 2 but satisfy the minimum threshold of Article 3 as a non-international armed conflict.[106] This means that conflict not involving a clash between nations yet otherwise satisfying the minimum requirements are to be considered non-international.[107] In this sense, a "non-international armed conflict" should not be equated to necessarily mean "internal."[108]

The inclusion of the discussion of non-international armed conflicts in relation to hostilities in outer space is an essential one. For the longest time, access to space has been limited to the governments of developed States.[109] Private actors have not been able to participate in space activities because of the immense development costs, high financial risks and great technological requirements.[110] Moreover, "governments hesitated to entrust anyone but their own military or governmental space agencies with the exploration and utilization of space."[111] Presently, however, the case is different and private entities are rapidly becoming involved in space activities.[112] The argument for considering non-State armed groups in outer space hostilities mirrors conventional wisdom at the time of the drafting of the Geneva Conventions in 1949, where inter-State wars were the most common type of armed conflict and non-State armed

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[104] Fourth Geneva Convention, Final Record of the Diplomatic Conference of Geneva of 1949, 122 (Vol. II-B Berne, Federal Political Department, 1950–1951), https://www.loc.gov/rr/frd/Military_Law/pdf/Dipl-Conf-1949-Final_Vol-3.pdf.

[105] *See* Pejic, *supra* note 103, at 199 (citing ANTHONY CULLEN, THE CONCEPT OF NON-INTERNATIONAL ARMED CONFLICT IN INTERNATIONAL HUMANITARIAN LAW (2010)).

[106] *See id.* at 191.

[107] Hamdan v. Rumsfeld, 548 U.S. 557, 628-633 (2006); LIESBETH ZEGVELD, ACCOUNTABILITY OF ARMED OPPOSITION GROUPS IN INTERNATIONAL LAW 136 (2002).

[108] FLECK, *supra* note 98, at 50.

[109] *See* N. Jasentuliyana, *International Space Law Challenges in the Twenty-First Century*, 5 SING. J. INT'L & COMP. L. 10, 11 (2001).

[110] Edith Walter, *The Privatisation and Commercialisation of Outer Space*, *in* OUTER SPACE IN SOCIETY, POLITICS, AND LAW 493-94 (Christian Brünner & Alexander Soucek eds., 2011).

[111] *Id.* at 493.

[112] Frans von der Dunk, *Sovereignty Versus Space – Public Law and Private Launch in the Asian Context*, 5 SING. J. INT'L & COMP. L. 22, 22 (2001).

groups were not as powerful and did not pose a serious threat to States.[113] Thus, while the capacity to conduct military operations in outer space may currently be limited to governments, it would not be a stretch of the imagination to say that non-State armed groups may, one day, have the same capacity.

C. Targeting

Another problem presented by armed conflicts in outer space pertains to the difficulty of distinguishing between lawful and unlawful targets. In space, distinguishing between civilian objects and military objectives is made difficult by the nature of the space environment, lack of an effective regime of identification or marking and the proliferation of dual-use objects.[114]

The nature of the space environment "is such that it is nearly impossible to get a first-hand look at . . . space objects in orbit."[115] In this theatre, "there is limited opportunity for 'eyes on' to verify a particular target" and "'patterns of life' analysis [or] imagery [is not] readily available."[116] Thus, these "may lead to an incomplete picture of exactly what is being targeted."[117] The Registration Convention may provide some assistance, but "most descriptions of satellites that are recorded . . . are generic and vague and are unlikely to assist in determining the real nature and function of a particular satellite."[118] Hence, "considerable reliance will be placed on intelligence to make the determination of military status."[119] Even "[orbital] parameters are only estimates and are not exact," as demonstrated by the collision of *Cosmos-2251* and *Iridium-33*.[120]

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[113] *See* Roy Schondorf, *Extra-State Armed Conflicts: Is there a Need for a New Legal Regime?* 37 N.Y.U. J. INT'L L. & POL'Y 1, 3 (2004); Ruth Wedgwood, *Responding to Terrorism: The Strikes Against Bin Laden*, 24 YALE J. INT'L L. 559, 560 (1999); Robert Beck & Anthony Clark Arend, *Don't Tread on Us: International Law and Forcible State Responses to Terrorism*, 12 WIS. INT'L L. J. 153, 173-86 (1994).

[114] Blake, *supra* note 4, at 135.

[115] Blount, *supra* note 34, at 6.

[116] Dale Stephens, *Increasing Militarisation of Space and Normative Responses*, *in* RECENT DEVELOPMENTS IN SPACE LAW: OPPORTUNITIES & CHALLENGES 99 (Venkata Rao et al. eds., 2017).

[117] Blount, *supra* note 34, at 6.

[118] Stephens, *supra* note 116 at 99-100.

[119] *Id.* at 99.

[120] Blount, *supra* note 34, at 8.

The problem is compounded by the fact that most objects in space are considered "dual-use", or objects which may be used, simultaneously or alternatively, for military and civilian purposes.[121] "[R]ecent studies have shown that approximately ninety-five percent of space technologies can be categorized as dual use."[122] For instance, rockets may be used to launch civilian payloads and military hardware; remote sensing satellites may be used for scientific observations and military reconnaissance; and navigation satellites may be used for civilian navigation and directing munitions for military operations.[123] Of course, it could be argued that under the traditional understanding of the notion of military objective, "when a particular object is used for both civilian and military purposes, it becomes a military objective even if the military use is marginal in relation to civilian use."[124] Indeed,"'[t]he fact that an object is also used for civilian purposes does not affect its qualification' as a military objective."[125] Thus, an "attack against a 'dual-use' target is therefore not barred unless it runs counter to the principle of proportionality."[126]

D. Effects

The fourth question delves into the effects of the means and methods of warfare conducted in outer space. After all, the "laws and customs of [armed conflicts] apply both to the area where the hostilities actually take place, as well as the broader areas that are in some way affected by the hostilities."[127] If "direct military action

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[121] Arjen Vermeer, *The Laws of War in Outer Space: Some Legal Implications for the Jus ad Bellum and the Jus in Bello of the Militarisation and Weaponisation of Outer Space*, in THE NEW ORDER OF WAR 75 (Bob Brecher ed., 2010).

[122] JOHNSON-FREESE, *supra* note 3, at 30 (citing OFF. OF THE UNDER SEC. OF DEF., MCTL, Section 17–Space Systems Technology 17-1 (1996)).

[123] *See id.* at 33; Michael Bourbonnière & Ricky J. Lee, *Legality of the Deployment of Conventional Weapons in Earth Orbit: Balancing Space Law and the Law of Armed Conflict*, 18 EUR. J. INT'L L. 873, 894-96 (2008).

[124] Richard Desgagne, International Humanitarian Law in Outer Space, ASEAN Regional Forum Workshop on Space Security (Nov. 30 – Dec. 2, 2015).

[125] YORAM DINSTEIN, CONDUCT OF HOSTILITIES UNDER THE LAW OF INTERNATIONAL ARMED CONFLICT 120 (3d ed. 2016) (citing MARCO ROSCINI, CYBER OPERATIONS AND THE USE OF FORCE IN INTERNATIONAL LAW 185 (2014)).

[126] *Id.* (citing A. P. V. ROGERS, LAW ON THE BATTLEFIELD 111-12 (3d ed. 2012)).

[127] Maogoto & Freeland, *supra* note 31, at 181 (citing William Fenrick, *Protecting Civilians in 21st Century Warfare: Target, Selection, Proportionality, and Precautionary*

takes place in one area, but the effects of that action impact civilians elsewhere, that represents a relevant consideration in deciding whether such action is consistent with the rules of war."[128] Hence, "any military activity that takes place in outer space will be subject to the *jus in bello* in relation not only to the direct action but also as to its effects elsewhere, including on Earth."[129]

A primary concern is the effect of armed conflicts in outer space on the environment. Hostilities in outer space "will leave its traces during and (long) after armed conflict in the form of space debris."[130] Further, debris "can have the same effect as a weapon."[131] If "sufficient conditions are met, this may cause a never-ending cascade of damage and reverberating effects that will last infinitely."[132] As such it can be said that in space, "collateral damage has a greater physical and temporal dimension." The "physical amplitude is magnified by the fact that the resulting effects orbit the planet" while "its temporal breadth is amplified in that the orbiting particles can remain in orbit for a prolonged period."[133] Thus, "an attack causing a wide debris field could violate the principle that an attack must not create [whether intended or not] long-term, widespread, and severe damage to the environment."[134]

Parties to an armed conflict, then, must take "environmental considerations into account when assessing what is necessary and proportionate in the pursuit of legitimate military objectives."[135] It would be incumbent upon parties planning an attack to not "'employ a method or means of combat the effects of which cannot be

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Measures in Law and Practice, *in* PROSECUTING VIOLATIONS OF COMBAT LIMITATIONS 77-83 (Mirielle Hector et al. eds., 2001).

[128] *Id.* at 181-82.

[129] *Id.* at 182. *See* David Koplow, *ASAT-isfaction: Customary International Law and the Regulation of Anti-Satellite Weapons*, 30 MICH. J. INT'L L. 1187, 1190-94 (2009).

[130] Vermeer, *supra* note 121, at 75.

[131] *Id.* at 222 (citing Marietta Benkö, *Problem of Space Debris: A Valid Case Against the Use of Aggressive Military Systems in Outer Space? in* SPACE LAW: CURRENT PROBLEMS AND PERSPECTIVES FOR FUTURE REGULATIONS 167 (Marietta Benkö & Kai-Uw Schrogl eds., 2005)).

[132] Stephens, *supra* note 116, at 101.

[133] Michel Bourbonnière, *Law of Armed Conflict (LOAC) and the Neutralisation of Satellites or "*Jus In Bello Satellitis*,"* 9 J. CONFLICT & SEC L. 43, 66 (2004).

[134] Blount, *supra* note 34, at 20. *See also* Martin, *supra* note 66, at 761.

[135] Legality of the Threat or Use of Nuclear Weapons, Advisory Opinion, 1996 I.C.J. 226, ¶ 30 (July 8).

limited as required by' international law."[136] Thus, the use of kinetic interceptors, electromagnetic pulses and other similar options may be foregone in favor non-destructive methods, such as jamming or directed energy weapons, which can engage the space-based object reliably and may leave the space asset intact.[137]

However, the incidental effects of such non-destructive attack also have to be taken into consideration. Even if the attack on a space-based object does not result in its physical destruction, because most of these objects are of "dual-use," the attack may still have harmful effects on civilians and civilian objects.[138] An attack on a communication or navigation satellite, though representing a legitimate military target, may have effects on civilians and civilian objects which are disproportionate to any expected military advantage.[139] In such a scenario, "[m]illions of lives and livelihoods could potentially be affected, economies destroyed and essential services incapacitated."[140] After all, the notion of "damage to civilian objects" might, in certain circumstances, include deprivation of functionality."[141] Thus, actors in outer space must consider not only the reverberating effects of the attack but also the incidental harm and whether these objects are indispensable to the survival of the civilian population.[142]

E. Status of Persons

The fifth concern that Article III presents pertains to the status of persons in outer space who may be involved in hostilities, either directly or indirectly. Though there are unlikely to be many persons in outer space for the foreseeable future, combatants in space are legitimate targets.[143]

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[136] Blount, *supra* note 34, at 19.

[137] *See* Boothby, *supra* note 69, at 209; Blount, *supra* note 34, at 21; Maogoto & Freeland, *supra* note 31, at 187.

[138] *See* Maogoto & Freeland, *supra* note 31, at 184.

[139] *See id. See also* Maurice Cotter, *Military Necessity, Proportionality and Dual-Use Objects at the ICTY: A Close Reading of the Prlić et al. Proceedings on the Destruction of the Old Bridge of Mostar*, 23 J. CONFLICT & SEC. L. 283, 296 (2018).

[140] Maogoto & Freeland, *supra* note 31, at 184.

[141] TALLINN MANUAL, *supra* note 89, at 472.

[142] *See* Cotter, *supra* note 139, at 297 (citing Shue & Wippman, *Limiting Attacks on Dual-Use Facilities Performing Indispensable Civilian Functions*, 35 CORNELL INT'L L. J. 559 (2002)).

[143] *See* Blake, *supra* note 4, at 134.

Under the Outer Space Treaty and the Rescue Agreement, astronauts are regarded as "envoys of [hu]mankind" and are entitled to "all possible assistance."[144] Neither treaty, however, distinguishes between astronauts undertaking military and civilian activities. Additionally, neither of the treaties precludes the grant of combatant status to persons in space.[145] The status of these persons should be in accord with the relevant distinctions made in the two aforementioned treaties consistent with their objects and purposes. In order to be entitled to the protections provided by the two treaties, the activities of an astronaut must be consistent with the "peaceful purposes" provision.[146] Thus, should an astronaut engage in hostile actions, he or she no longer exercises the "diplomatic functions" envisioned by the two treaties.[147]

However, it must be stressed that the fact that an astronaut is a member of an armed force does not automatically convert his or her status to that of a combatant. Of course, under the law of armed conflict, "all members of the armed forces, whether or not they are actually engaged in combat" may be considered lawful targets.[148] However, the submission is that such status should also depend on the nature of the activities performed by him or her. Given the practice of sending members of armed forces to space to participate in "peaceful activities" and protection afforded by the two aforementioned treaties, it has been suggested that "non-belligerent astronauts would come under a 'modified *hors de combat* concept.'"[149]

On the other side of the problem lie civilians who may have a semblance of participation in the hostilities. It has been noted that military space commands employ "civilians to conduct their operations" while "civilian space companies provide services that the armed forces often rely on to conduct combat operations."[150] To address this situation, what is proposed is to analyze the directness of

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144 Ramey, *supra* note 22, at 86.

145 *Id*. at 151.

146 *Id*. at 152.

147 Michael Bourbonnière & Louis Haeck, *Jus in Bello Spatialis*, *in* PROCEEDINGS OF THE SPACE INSTITUTE 8 (1999).

148 Blount, *supra* note 34, at 16 (citing YORAM DINSTEIN, THE CONDUCT OF HOSTILITIES UNDER THE LAW OF INTERNATIONAL ARMED CONFLICT 94 (2004)).

149 Maćak, *supra* note 26, at 31 (citing Dale Stephens & Cassandra Steer, *Conflicts in Space: International Humanitarian Law and its Application to Space Warfare*, 40 ANNALS AIR & SPACE L. 71, 87 (2015)).

150 Schmitt, *supra* note 5, at 122.

the participation of civilians in outer space armed conflicts. By this standard, "most space operations conducted by civilians do not constitute direct participation."[151] For instance, neither a civilian maintaining the data of an imagery satellite nor a civilian operating a navigation system would be considered as directly participating in hostilities.[152] On the other hand, those individuals or locations whose participation is more direct, such as facilities launching military space assets, may be considered to be more directly involved and therefore be legitimate targets.

IV. *A NEW HOPE*: RESPONDING WITH THE CURRENT LAW OF ARMED CONFLICT

A. Parallelisms

The relative absence of positive law "does not mean complete freedom in the use of means and methods, tactics and technology."[153] International law is "no longer . . . based on a *Lotus*-like presumption that without express constraining rules, [S]tates are free to act as they please."[154] As such, "when [S]tates extend their activities to a new domain, that domain does not become a lawless zone." Instead, "generally applicable rules of international law will follow States' activities to their new locus."[155] The same goes with the gap in regulating hostilities in outer space. After all, principles of international law on armed conflict were "meant to apply to weapons existing then as well as to weapons to be created in the future, weapons already known and weapons as yet unvisualized [sic]."[156]

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[151] *Id.*

[152] *See id.*

[153] Gómez, *supra* note 82, at 351.

[154] Maćak, *supra* note 26, at 12 (citing Accordance with International Law of the Unilateral Declaration of Independence in Respect of Kosovo, Advisory Opinion, 2010 I.C.J. 403, 478-79 (July 22)). *See also* Dale Stephens & Cassandra Steer, *Conflicts in Space: International Humanitarian Law and its Application to Space Warfare*, 40 ANNALS AIR & SPACE L. 71, 80 (2015); MYRES S. MCDOUGAL ET AL., LAW AND PUBLIC ORDER IN SPACE, 389 (1963).

[155] Maćak, *supra* note 26, at 12.

[156] Legality of the Threat or Use of Nuclear Weapons, Advisory Opinion, 1996 I.C.J. 226, 485 (July 8) (Weeramantary, dissenting). *See also* Legal Consequences of the Construction of a Wall in the Occupied Palestinian Territory, Advisory Opinion, 2004 I.C.J. 136, ¶ 89 (July 9).

It seems fair to say that laws do not tend to "anticipate the process of technical advance."[157] It is "inevitable that there should be a delay between the appearance of a new weapon technology and the formation of legal provisions to address any concerns that the technology may arouse."[158] It is difficult for the law to foresee the implications of new technologies and, in most cases, it would be the advent of technology that would drive the evolution of law.[159] Further, States have been "reluctant to accept any form of regulation in relation to military applications of new technologies."[160] States are usually "reluctant to legislate in the absence of a clear case based on battlefield experience" such that potential regulators will have to make the case, based on clear scientific data.[161] In such a case, the "critical factors will be the military purpose or utility of the weapon and the consequences, both satisfactory and otherwise, of its actual use."[162]

With regard to hostilities in outer space, there are views that terrestrial laws are "neither sufficiently specific nor entirely appropriate to military action in outer space."[163] There are also arguments to support the conclusion that "no conventional international law regulates [military] activities in outer space."[164] This comes from the recognition of the "specificities of the space environment"[165] and the fact that the current law of armed conflict was formed with terrestrial hostilities in mind.

Nevertheless, the contrary view submits that terrestrial law provides "potential similarities to means and methods of space combat" even if only as a "means of interpreting the general *corpus juris spatialis* to fit specific legal issues relating to the military use of

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157 BOOTHBY, *supra* note 17, at 157.

158 *Id.*

159 Waldrop, *supra* note 13, at 351.

160 NASU & MCLAUGHLIN, *supra* note 1, at 2.

161 WILLIAM BOOTHBY, WEAPONS AND THE LAW OF ARMED CONFLICT 363 (2d ed. 2016).

162 *Id.*

163 JAMES CLAY MOLTZ, CROWDED ORBITS: CONFLICT AND COOPERATION IN SPACE, 181 (2014); Maogoto & Freeland, *supra* note 31, at 185; Ramey, *supra* note 22, at 3.

164 Boothby, *supra* note 69, at 224.

165 Martin, *supra* note 66 at 761; Blount, *supra* note 34; Steven Freeland, *The Laws of War in Outer Space*, *in* HANDBOOK OF SPACE SECURITY 102 (Schrogl et al. eds., 2015).

outer space."[166] Efforts could certainly be made to apply existing laws and principles insofar as they could be applied with the consideration that "the largely unprecedented nature of such circumstances means that more specific rules will almost certainly be required."[167] It must further be noted that "the progressive development of space law has not emerged in a legal vacuum [and] '[t]here is, in certain respects, a catena of notions which justifies a comparison between the concepts applicable to outer space with those of other environments.'"[168] In such a case, recourse may be made to the existing law of armed conflict as far as possibility permits.

The foregoing view is not unheard of as space warfare, in a way, shares some characteristics with aerial warfare. As with the aerial environment, "space uniformly overlays land and sea, and air" and as it is without "breaks or junctures" it has "a uniformity that is global."[169] Likewise, it permits the "rapid bypassing of slower, more environmentally-limited land-based and sea-based movement, access, and reach."[170] It allows for an "even more rapid global access than is possible by air, whereas even the oceans are ultimately land-delimited."[171]

Moreover, it could be argued that "military roles and missions for space assets . . . have developed along lines similar to those of airpower during the beginning of [the last] century."[172] As with aerial operations, "intelligence-gathering and support operations [in outer space] came first, followed by . . . means of transportation [and delivery of weapons], and [finally], offensive and defensive combat roles followed."[173] Further, similar to outer space, aerial warfare during its infancy was also not subject to specific regulations.[174] The early days of aerial warfare, just like the early days of outer space

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[166] Ramey, *supra* note 22, at 124. *See also* TERRY GILL & DIETER FLECK, HANDBOOK OF THE INTERNATIONAL LAW OF MILITARY OPERATIONS 7 (2010); NASU & MCLAUGHLIN, *supra* note 1, at 2.

[167] *See* Freeland, *supra* note 14, at 285.

[168] Ramey, *supra* note 22, at 65 (citing NICOLAS MATEESCO MATTE, SPACE ACTIVITIES AND EMERGING INTERNATIONAL LAW 13 (1984)).

[169] Kleinberg, *supra* note 38, at 11.

[170] *Id.*

[171] *Id.*

[172] Ramey, *supra* note 22, at 126 (citing JOHN M. COLLINS, MILITARY SPACE FORCES: THE NEXT 50 YEARS, 1 (1989)).

[173] *Id.* at 126.

[174] Gómez, *supra* note 82, at 348.

operations, were marked with the following characteristics: relative newness of the technology, rapid technological advances, and dual-purpose nature of the aircraft.[175]

Some methods were implemented to address lack of regulation in the air. In some cases, the rules of terrestrial warfare were conditionally applied to aerial warfare. In other words, "the rules of war on land [were applied] to air warfare when it was being waged over land or in support of ground forces, and the rules of war at sea would apply when the air force was fighting over the sea or in support of [naval forces]."[176] One example pertains to the question of bombardment, which was considered to be closely related to ground fighting. Drawing from the rules on terrestrial warfare, it was believed that "the military objective must be sufficiently identified by the attacking force, and that any loss of civilian life must be proportionate to the military advantage to be secured."[177] Extending the analysis, attacks on terrestrial targets, even if directed from the air, were frequently discussed under the laws of land warfare. It was argued that "modern technology makes attacks on a given target by the air force, missiles, or artillery interchangeable."[178] On the other hand, beyond the confines of the coasts, the regulations on naval power were theorized to be applicable considering that States considered the air force as "necessary for extending naval power over land."[179]

In other cases, the rules of aerial warfare were subordinate to the rules of terrestrial warfare in such a way that "two weapons that produce a similar effect [were] evaluated in a similar fashion."[180] For instance, during the infancy of the laws on aerial warfare, "there [was] no special law governing the dropping of bombs

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[175] *Id.* at 350 (internal citations omitted).

[176] Gómez, *supra* note 82, at 352. *See also* JULIUS STONE, LEGAL CONTROLS OF INTERNATIONAL CONFLICTS, 609 (1959); Herbert F. Manisty, *Aerial Warfare and the Laws of War*, 7 TRANSACTIONS GROTIUS SOC'Y 33, 37 (1921); Picciotto, *supra* note 2, at 155.;

[177] Hamilton DeSaussure, *The Laws of Air Warfare: Are There Any?*, 5 Int'l Law. 527, 536 (1971).

[178] MARCO SASSÒLI ET AL, HOW DOES LAW PROTECT IN WAR? CASES, DOCUMENTS AND TEACHING MATERIALS ON CONTEMPORARY PRACTICE IN INTERNATIONAL HUMANITARIAN LAW 242 (1999).

[179] Gómez, *supra* note 82, at 351.

[180] *Id.*

from [aircrafts]."[181] Thus, the use of aircraft for bombing purposes was subjected to the "general rules of bombardment."[182] Another example pertains to the "recognition of air-vessels as a part of the public armed forces of the enemy, and the status of their crews as lawful combatants."[183] The rules for such activities were adopted from the rules of land and naval warfare. Thus, the use of aircraft for reconnaissance and for directing artillery fire were considered as part of a lawful military operation. This being the case, should the aircraft be brought down in the territory of the enemy, the crews were treated as prisoners of war.[184]

In the same vein, the principles applicable to land and naval warfare were emphasized in relation to the fledgling regulations on military aerial operations. Notably, the problems posed by air warfare "have far more to do with traditional concepts of the laws of war on land" such as: targeting, observance of the principle of proportionality and delineating civilian and military objectives.[185] In this regard, considering the effects of widespread violence and brutality – including that of napalm bombing in the conflicts in Korea and in Vietnam – UN Resolution 2444 "emphasized the necessity for applying basic humanitarian principles to all armed conflicts."[186] Affirming the conclusions of the UN Educational, Scientific and Cultural Organization on Human Rights in Teheran in April of 1968, the Resolution highlights three main points: "[f]irst, that the rights of the parties to a conflict to adopt means of injuring the enemy are not unlimited; second, that the launching of attacks against the civilian populations is prohibited; and third, that 'a distinction must be made between persons taking part in hostilities and the civilian population with the view of sparing the latter as much as possible.'"[187]

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[181] Picciotto, *supra* note 2, at 154. *See also* Manisty, *supra* note 176, at 33.

[182] Picciotto, *supra* note 2, at 154. *See also* DESAUSSURE, *supra* note 177, at 530; Hague Convention (IV) Respecting the Laws and Customs of War on Land with Annexed Regulations art. 25, Oct. 18, 1907, 36 Stat. 2277 [hereinafter Hague Convention (IV)]; DINSTEIN, *supra* note 175, at ¶16; MANISTY, *supra* note 176, at 41.

[183] Picciotto, *supra* note 2, at 154.

[184] *See id.* at 155.

[185] SASSÒLI, *supra* note 178, at 241.

[186] DeSaussure, *supra* note 177, at 528 (citing G.A. Res. 2444 (XXIII) (Dec. 19, 1968)).

[187] DeSaussure, *supra* note 177, at 527.

B. Guidance under Current Laws

Approaches similar to those of air warfare may be applied to armed conflicts in outer space. As with aerial warfare, conventional law may be conditionally applied to armed conflicts in outer space, or in the alternative, the latter may be subordinate to the former. It has been noted that "beyond the general principles, a number of specific international humanitarian law provisions may reach certain space operations."[188] To begin, while the Outer Space Treaty is relatively sparse when it comes to its provisions on the means and methods of warfare, it, nevertheless, makes clear that the "activities in the exploration and use of outer space, including the Moon and other celestial bodies," must be conducted in accordance with international law.[189] The importance of this provision lies in the fact that it requires, notwithstanding the absence of specific provisions, that the rules and principles of the conduct of war and the use of weapons should be extended to hostilities in outer space.[190] Correlatively, Article 35 of Additional Protocol I stresses that the right of the parties to the conflict to choose means and methods of warfare is not unlimited.[191] It thus reaffirms that the means and methods of war are limited,[192] even in outer space and despite the absence of specific regulations.

Flowing from the premise of Article 35, subsequent principles enshrined in Additional Protocol I have developed that affirm the limitations of military operations and enshrine the protections granted to civilians and civilian objects.[193] Like Article 35, these provisions, although general in nature, find some application to hostilities in space. For example, Article 48 makes it clear that the civilian population and civilian objects must be respected and protected in armed conflict, and, for this purpose, objects must be distinguished from combatants and military objectives.[194] Similarly,

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188 Schmitt, *supra* note 5, at 121.

189 Outer Space Treaty, *supra* note 60, at art. 3.

190 Boothby, *supra* note 69, at 201.

191 Protocol I, *supra* note 99, art. 35(1).

192 INT'L COMM. RED CROSS, COMMENTARY ON THE ADDITIONAL PROTOCOLS OF 8 JUNE 1977 TO THE GENEVA CONVENTIONS OF 12 AUGUST 1949 390 (Sandoz et al. eds., 1987) [hereinafter COMMENTARY TO GENEVA CONVENTION].

193 *See* FLECK, *supra* note 98, at 122.

194 COMMENTARY TO GENEVA CONVENTION, *supra* note 192, at 598.

Article 51 explicitly confirms the customary rule that "innocent civilians must be kept outside hostilities as far as possible and enjoy general protection against danger arising from hostilities."[195] Accordingly, Article 52 safeguards civilian objects while Article 54 does the same for objects indispensable to the survival of the civilian population.[196]

More specifically, considering the potential effects of hostilities in outer space, whether intentional or incidental, Article 35(3) prohibits the use of methods or means of warfare that are intended or may be expected to cause widespread, long-term and severe damage to the natural environment.[197] This provision takes into account the inevitable overflow effect inherent in military operations and the resulting "transnational" aspect of this problem.[198] Similarly, Article 55(1) prohibits indiscriminate means and methods that "thereby prejudice the health or survival of the population."[199] With these two provisions, and in the context of outer space hostilities, the problem of orbital debris comes into mind.

As previously mentioned, an attack against a space asset has the possibility of causing a wide debris field that may, in turn, cause damage to other space objects thereby creating a "never-ending cascade of damage."[200] Thus, non-destructive methods may be considered, such as those that could paralyze or render a space asset inoperable yet leaves the object physically intact.[201] Related to these Articles is the Environmental Modification Treaty, which proscribes "military or any other hostile use of modification techniques having widespread, long-lasting or severe effects as the means of destruction, damage or injury."[202] Notably, the Treaty is made expressly applicable to outer space in its definition of "environmental modification techniques" as the "deliberate manipulation of natural processes such as 'the dynamics, composition or structure of the

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[195] *Id.* at 615.

[196] *See id.* at 629-38, 651-60.

[197] *See id.* at 389, 410-20.

[198] *Id.* at 410.

[199] Boothby, *supra* note 69, at 191.

[200] Stephens, *supra* note 116, at 101; Blount, *supra* note 34, at 20; Martin, *supra* note 66, at 761.

[201] Boothby, *supra* note 69, at 209; Blount, *supra* note 34, at 21; Maogoto & Freeland, *supra* note 31, at 187.

[202] *See* Convention on the Prohibition of Military or Any Other Hostile Use of Environmental Modification Techniques, Dec. 10, 1976, 31 U.S.T. 333, 1108 U.N.T.S. 151.

Earth', including its biota, lithosphere, hydrosphere and atmosphere, or of outer space."[203]

Another provision of the Protocol worth mentioning is Article 36. In anticipation of emerging technologies, Article 36 obliges parties to conduct reviews in relation to the development, acquisition, or adoption of new means and methods of warfare to determine if their employment is consistent with international law.[204] It is said that the provision is an implied rule requiring States "to determine whether the employment by it of a new weapon would in some or all circumstances breach the rules of international law applicable."[205] Moreover, the provision also asks States to "assess whether existing law . . . prohibits the use of the weapon or method, or restricts those general intended circumstances of use."[206] Phrased differently, in the employment of weapons in outer space, States are required to consider "the generic effects that [weapons] are intended to have on the kinds of target [they are] designed to engage when used in [their] normal or designed way and circumstances."[207] It should also be determined whether those effects are "unconscionable and inhumane" – a question that can only be answered "by reference to comparable methods of achieving the same generic military purpose."[208]

Of course, it is recognized that the foregoing laws apply to armed conflicts of the international kind. However, as previously mentioned, a consideration of non-international armed conflicts is also essential in the discussion of hostilities in outer space. Notwithstanding the seeming gap in the regulations, there are some conventional laws that, nevertheless, apply to hostilities of the non-international armed variety. For instance, Additional Protocol II, like common Article 3 provisions, explicitly protects "[a]ll persons who do not take a direct part or who have ceased to take part in

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[203] *Id.* at art. 3.

[204] Protocol I, *supra* note 99, at art. 36.

[205] Hague Convention (IV), *supra* note 182, art. 1. *See also* Boothby, *supra* note 69, at 203-04 (citing Hague Convention (II) with Respect to the Laws and Customs of War on Land art. 1, July 29, 1899, 32 Stat. 1803, T.S. No. 403).

[206] Boothby, *supra* note 69, at 205. *See also* COMMENTARY TO GENEVA CONVENTION, *supra* note 192, at 425.

[207] WILLIAM H. BOOTHBY, WEAPONS AND THE LAW OF ARMED CONFLICT 351 (2d ed., Oxford University Press, 2016).

[208] *Id.* at 369.

hostilities."[209] Because of the expansive geographical framework of reference for non-international armed conflict,[210] the foregoing protection likewise applies to hostilities in outer space. Article IV of the Additional Protocol II further confirms this by explicitly stating that the Protocol applies to "all persons affected by an armed conflict" of the non-international kind.[211] This indicates that the "rules contained in Article 3 also apply outside the narrow geographical context of the actual theatre of combat operations."[212]

In cases not covered by conventional law, there could be recourse to the general principles of international humanitarian law.[213] For instance, the "continuing vitality of the doctrine expressed by the Martens' Clause will be particularly important for space warfare."[214] The Clause, found in a number of Conventions, including the Preamble to Hague Convention IV, stresses that though treaties do not contain specific provisions to address "particular evils of war," such does not imply that no protection exists.[215] Specifically, the Clause provides that "inhabitants and belligerents remain under the protection and empire of the principles of international law, as they result from the usages established between civilized nations, from the laws of humanity, and the dictates of the public conscience."[216]

The Clause recognizes that international humanitarian law treaties are not comprehensive and that they "cannot be insulated from developments occurring in other fields of international law."[217] The effect, then, is two-fold: first, in areas where "treaties are silent, customary international law governs the situation"; second, "during

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[209] Prosecutor v. Tadić, Case No. IT-94-1-I, Decision on Defence Motion for Interlocutory Appeal on Jurisdiction, ¶ 69 (Int'l Crim. Trib. for the Former Yugoslavia Oct. 2, 1995).

[210] *Id.*

[211] Protocol Additional to the Geneva Conventions of 12 August 1949 and Relating to the Protection of Victims of Non-International Armed Conflicts (Protocol II) art. 4, June 8, 1977, 1125 U.N.T.S. 609.

[212] *Tadić*, Case No. IT-94-1-I at ¶ 69.

[213] Freeland, *supra* note 14, at 280.

[214] Maogoto & Freeland, *supra* note 31, at 173.

[215] *See* BOOTHBY, *supra* note 206, at 14, 58, 77; Theodor Meron, *The Martens Clause, Principles of Humanity, and Dictates of Public Conscience*, 94 AM. J. INT'L L. 78 (2000).

[216] Hague Convention (IV), *supra* note 182, Preamble.

[217] Iain Scobbie, *The Approach to Customary International Law in the Study*, *in* PERSPECTIVES ON THE ICRC STUDY ON CUSTOMARY INTERNATIONAL HUMANITARIAN LAW 18 (Elizabeth Wilmhurst & Susan Breau eds., 2007).

the conduct of hostilities what is not specifically prohibited is not necessarily permitted."[218] Moreover, as "the doctrine is phrased 'dynamically', implicitly anticipating the need to regulate means and methods of warfare developed through technological advances, it will always operate to limit the [means and methods] of space warfare."[219] Thus, while the law sometimes appears outdated and irrelevant, it can be argued that the law of armed conflict is in fact "relatively dynamic, agile, flexible, and most certainly not belittled in an age of rapid technical advance."[220]

Caution, however, is "required before seeking to argue for the existence of a specific customary rule exclusively based on those principles applied to new technological circumstances."[221] The Clause does not "constitute additional standards for judging the legality of means or methods of warfare."[222] This knowledge notwithstanding, the customary rules and principles may continue to apply to new methods of warfare including outer space warfare.[223] As "there are no treaties that establish specific *jus in bello* principles for space combat[,] . . . customary and conventional principles provide the most authoritative source for application to activities in outer space."[224] Thus, the principles of international law - principle of distinction, norm of humanity, the requirement of necessity and the rule of proportionality – must be applied by the parties to hostilities in outer space.

The principle of distinction requires parties to the armed conflict to exercise diligence in the selection of methods, weaponry and targets.[225] Based on this principle, parties to an armed conflict are

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[218] Bourbonnière, *supra* note 133, at 51.

[219] MAOGOTO & FREELAND, *supra* note 31, at 174. *See also* DOCUMENTS ON THE LAWS OF WAR, 44 (Adam Roberts & Richard Guelff eds., 1989); *Nuclear Weapons*, *supra* note 135, at 409 (Shahabudeen, dissenting).

[220] BOOTHBY, *supra* note 206, at 369.

[221] BOOTHBY, *supra* note 17, at 89

[222] DINSTEIN, *supra* note 125, at 9.

[223] *See* BOOTHBY, *supra* note 206, at 443.

[224] Maogoto & Freeland, *supra* note 31, at 173.

[225] *See, e.g.,* Prosecutor v. Bosco Ntaganda, ICC-01/04-02/06, Confirmation, ¶¶ 45-46 (June 9, 2014); Prosecutor v. Pavle Strugar, Case No. IT-01-42-A, Appeal Judgement, ¶¶ 270-71 (July 17, 2008); Prosecutor v. Dario Kordic and Mario Cerkez, Case No. IT-95-14, Judgement, ¶ 182 (March 11, 2005); Prosecutor v. Dragoljub Kunarac, Case No. IT-96-23& IT-96-23/1-A, Appeal Judgement, ¶ 91 (June 12, 2002); Prosecutor v. Zoran Kupreskić, Case No. IT-95-16, Trial Judgement, ¶¶ 441, 883 (Jan. 14, 2000); Prosecutor v. Milan Martić, Case No. IT-95-11, Review of Indictment, ¶¶ 437, 552 (Mar. 8, 1996).

required to distinguish between combatants and non-combatants, such that attacks are limited only to targets that are military in nature and advance the tactical, operational or strategic position.[226] In the context of space hostilities, one application of the principle of distinction requires that belligerents verify the identity of space-based assets and refrain from using indiscriminate weapons. Of course, as previously discussed, such verification may be arduous considering the nature of space, in which objects are in constant motion; the lack of effective regime in the marking and registration of space objects; and the proliferation of dual-use objects.[227]

The norm of humanity principle "accounts for several efforts at outlawing means and methods of warfare deemed to cause unnecessary suffering."[228] Thus, it prohibits the infliction of suffering, injury or destruction not actually necessary for the accomplishment of any legitimate military purpose. The critical factor is "whether the weapon has been designed, or is used, to cause unnecessary suffering or aggravation of wounds, and not the degree of suffering it actually causes."[229] A possible application of the norm lies in the use of directed energy weapons, which may be used to cause blindness which is banned under Protocol IV of the Conventional Weapons Conventions.[230]

The two abovementioned principles interweave with the requirement of necessity, which imposes "the requirement that attackers have identified the prospective target in advance of attack as one that is militarily legitimate."[231] This being the case, the measures to be employed in hostilities in outer space are those which are necessary to accomplish a legitimate military purpose and are not otherwise prohibited by international humanitarian law. In the case of an armed conflict, the only legitimate military

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[226] Ramey, *supra* note 22, at 37.

[227] *See* Vermeer, *supra* note 121, at 76; Blake, *supra* note 4, at 100; Stephens, *supra* note 116, at 99.

[228] Prosecutor v. Tadić, Case No. IT-94-1-I, Decision on Defence Motion for Interlocutory Appeal on Jurisdiction, ¶ 119 (Int'l Crim. Trib. for the Former Yugoslavia Oct. 2, 1995). *See also* DINSTEIN, *supra* note 125, at 73; RAMEY, *supra* note 22, at 56.

[229] U.C. Jha, *Prohibited Weapons in Armed Conflicts*, 4 ISIL Y.B. INT'L HUMAN. & REFUGEE L. 56, 57 (2004).

[230] *Id.*; *See* Legality of the Threat or Use of Nuclear Weapons, Advisory Opinion, *supra* note 156 at 484, (Weeramantary, dissenting).

[231] Ramey, *supra* note 22, at 35. *See also* Prosecutor v. Tihomir Blaskić, Case No. IT-95-14, Trial Judgement, ¶ 239 (Mar. 3, 2000).

purpose is to weaken the military capacity of the other parties to the conflict.[232]

Finally, the rule of proportionality prohibits attacks "which may be expected to cause incidental loss of civilian life, injury to civilians, damage to civilian objects, or a combination thereof, which would be excessive in relation to the concrete and direct military advantage anticipated."[233] Parties to hostilities are thus required to take precautions to avoid mistaken attacks and to minimize collateral damage to civilian objects and incidental injury to civilians.[234] Moreover, parties are also mandated to consider that weapons may be considered indiscriminate in the sense that "although they can be directed at a military objective, they may have otherwise uncontrollable effects that cause disproportionate civilian injuries or damage."[235] As such, the effects of military operations taking place in the outer space will be subject to the regulations not only pertaining that specific operation, but "also as to its effects elsewhere, including on Earth."[236]

The primary application of the abovementioned principle pertains to the creation of space debris that results from attacks against space-based assets. Considering the potential result, parties may be required to employ a "soft kill" technique in lieu of kinetic-energy means, which would result in less collateral damage while yielding a similar military advantage.[237] However, the analysis does not stop there. As previously mentioned, though an attack against a space-based object does not result to its physical destruction, the result may still have harmful effects on civilians considering that some of the objects in space are "dual use."[238] For instance, an attack against a communication or navigation satellite may have

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[232] SASSÒLI, *supra* note 178, at 200 (*citing* St. Petersburg Declaration of 1868, Preamble, ¶2).

[233] Prosecutor v. Callixte Mbarushimana, ICC-01/04-01/10-465-Red, Confirmation, ¶ 142 (Dec. 16, 2011), Legality of the Threat or Use of Nuclear Weapons, Advisory Opinion (Higgins, dissenting*), 1996 I.C.J. 259, ¶30 588*; Prosecutor v. Germain Katanga, ICC-01/04-01/07-717, Confirmation, ¶274 (Sept. 30, 2008), https://www.icc-cpi.int/CourtRecords/CR2011_22538.pdf.

[234] Schmitt, *supra* note 5, at 121.

[235] Jha, *supra* note 229, at 57.

[236] Freeland, *supra* note 14, at 282.

[237] Schmitt, *supra* note 5, at 121; Bourbonnière, *supra* note 133, at 56.

[238] Maogoto & Freeland, *supra* note 31, at 184.

reverberating effects on the civilian population.[239] Special care must be taken even in the case of attacks that cause deprivation of functionality on dual-use objects.

V. CONCLUSION

The question of the regulation of armed conflicts in outer space is fraught with complexities. The rapid technological advances over the past century have enhanced the capacity for means and methods of warfare and heralded the potential use of the means and methods for armed conflicts in outer space. However, the relative newness of technology makes such regulation difficult. Laws cannot be expected to address every concern that may arise from the use of new technology nor can laws predict, with any degree of reliability, the humanitarian concerns that accompany the use or deployment of such technology. These problems are made more complex by the nature of outer space, intricacies of the operation of space assets and relative reluctance of States, in a consensus-based system, to negotiate technology-specific and context-based regulations.

The law of armed conflicts in space needs to be developed in more detail covering the specificities of the outer space environments. Nevertheless, in the absence of such a regulation, humanity and public conscience dictate that employment of such means and methods cannot be considered as unregulated. Wisdom derived from the countless array of conflicts fought in the past dictates that steps have to be made – if only to make the means and methods of conducting warfare more humane. In this regard, experiences from the emergence of new means and methods of waging armed conflicts – such as that of aerial warfare – suggest that recourse may be taken to existing laws and principles. Points would, of course, emerge that would reveal the limitations of such a resort. Nonetheless, at present, these laws and principles provide a semblance of rules for humanitarian rights to be protected and upheld.

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[239] *See* Cotter, *supra* note 139, at 302.

LAW WITHOUT GRAVITY: ARBITRATING SPACE DISPUTES AT THE PERMANENT COURT OF ARBITRATION AND THE RELEVANCE OF ADVERSE INFERENCES

Stefan Pislevik[*]

ABSTRACT

In outer space, human capabilities are rapidly evolving, taking humankind further and further beyond what was ever thought possible. The law with respect to outer space, however, appears to always follow the event instead of preceding the development and use of new technologies. This lag is likely due in part to the fact that to be effective, laws relating to outer space would ideally have global application. The difficulty in achieving widespread acceptance of any proposed law in the international domain is self-evident. Arguably, what is most important to support a dynamic international legal regime is to have a framework which can be readily adapted and applied to the resolution of space disputes. Unfortunately, the international community has been unable to develop, much less implement, a space-specific permanent form of dispute settlement despite discussing its utility for decades. The Permanent Court of Arbitration is the most recent actor to enter this realm with the introduction of its Optional Rules for Outer Space Activities. As this paper illustrates, these rules do not take major steps to advance the development of a structure to address the settlement of space disputes. This paper examines how the application of adverse inferences, given the nature of space technology used, is likely to give rise to the withholding of information on grounds of security or protection of commercial investments.

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I. INTRODUCTION

Outer space activity was once the exclusive domain of sovereign States. Technological advancement, a reduction of costs and an easing of restrictions, however, have allowed private actors to become heavily involved in space activities.[1] The adequacy of mechanisms for the settlement of disputes arising from space activities is an issue that has long been discussed.[2] In 2011, the Permanent Court of Arbitration (PCA) sought to address this issue through the introduction of its Optional Rules for Arbitration of Disputes Relating to Outer Space Activities (Optional Rules).[3] This paper examines the Optional Rules, focusing on its key features. While the Optional Rules have been praised for their confidentiality mechanisms, this paper argues that the Rules should be considered in light of the imposition of the principle of adverse inferences, which continues to be the subject of topical debate in arbitration today. Ultimately, this paper concludes that while the Optional Rules make progress on pre-existing dispute settlement mechanisms, more is needed to accommodate an expected future increase in disputes involving space activities.

II. SPACE LAW DISPUTES: A HISTORICAL BACKGROUND

In the early years of space exploration, outer space activity was dominated by the United States (US) and the former Soviet Union. Currently, however more than 30 countries have significant space industries.[4] Nevertheless, existing conventions focusing on

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[1] Fabio Tronchetti, *The PCA Rules for Dispute Settlement in Outer Space: A Significant Step Forward,* 29 SPACE POL'Y 181, 181 (2013).

[2] *See* Karl-Heinz Böckstiegel, *Arbitration and Adjudication Regarding Activities in Outer Space*, 6 J. SPACE L. 3, 17 (1978).

[3] Optional Rules for Arbitration of Disputes Relating to Outer Space Activities, Dec. 6, 2011, *available at* https://pca-cpa.org/wp-content/uploads/sites/6/2016/01/Permanent-Court-of-Arbitration-Optional-Rules-for-Arbitration-of-Disputes-Relating-to-Outer-Space-Activities.pdf [hereinafter Optional Rules].

[4] *See* GÉRADINE MEISHAN GOH, DISPUTE SETTLEMENT IN INTERNATIONAL SPACE LAW: A MULTI-DOOR COURTHOUSE FOR OUTER SPACE 164 (2007); Fausto Pocar, *An Introduction to the PCA's Optional Rules for Arbitration of Disputes Relating to Outer Space Activities*, 38 J. SPACE L. 171, 175 (2012); Chia-Jui Cheng, *International Arbitration System as a Mechanism for the Settlement of Disputes Arising in Relation to Space Commercialization*, 2001 SING. J. INT'L & COMP. L. 165, 165; Tronchetti, *supra* note 1, at 182.

the space realm and space activities[5] have focused on maintaining peaceful relations among spacefaring nations,[6] rather than creating dispute resolution mechanisms. This is understandable given that at the time the treaties were drafted, problems related to outer space disputes appeared to be more academic than actual.[7] Moreover, States were likely hesitant to commit themselves to binding dispute settlement given the strategic relevance of space exploration and space activities.[8] As will be shown below, the utility of the space law conventions in resolving disputes has been limited. These limitations are compounded by the fact that the development of international space law has arguably stagnated since the negotiation of the so-called Moon Agreement in 1979.[9] The sufficiency of space law for the settlement of disputes, in particular, has been questioned from as early as 1978,[10] and today, those same questions persists.

A. Settling Disputes Under Existing Space Law Mechanisms

Though no specific venue or method tailored to space law disputes appears to currently exist, mechanisms for dispute settle-

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[5] There are five major treaties governing sovereign activities in space. These are: 1) the Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space Including the Moon and Other Celestial Bodies art. II, Jan. 27, 1967, 18 U.S.T. 2410, 610 U.N.T.S. 205 [hereinafter Outer Space Treaty]; 2) The Agreement on the Rescue of Astronauts, The Return of Astronauts and The Return of Objects Launched into Outer Space, Apr. 22, 1968, 672 U.N.T.S. 119; 3) the Convention on International Liability for Damage Caused by Space Objects, Mar. 29, 1972, 961 U.N.T.S. 187 [hereinafter Liability Convention]; 4) the Convention on Registration of Objects Launched into Outer Space, June 6, 1975, 1023 U.N.T.S. 15 [hereinafter Registration Convention]; and 5) the Agreement Governing the Activities of States on the Moon and Other Celestial Bodies, Dec. 5, 1979, 1363 U.N.T.S. 3 [hereinafter Moon Agreement].

[6] Rachael O'Grady, *Star Wars: The Launch of Extranational Arbitration?* MAYER BROWN INT'L LLP (Nov. 2016), https://www.mayerbrown.com/-/media/files/news/2016/11/star-wars-the-launch-of-extranational-arbitration/files/artogradystarwarsnov0416/fileattachment/artogradystarwarsnov0416.pdf.

[7] *See* Karl-Heinz Böckstiegel, *Commercial Space Activities: Their Growing Influence on Space Law*, 12 ANNALS AIR & SPACE L. 175, 190 (1987).

[8] *See* Lotta Viikari, *Towards More Effective Settlement of Disputes in the Space Sector*, 1 LAPLAND L. REV. 226, 226 (2011).

[9] Moon Agreement, *supra* note 5. *See generally* Arthad Kurlekar, *Space - The Final Frontier: Analysing Challenges of Dispute Resolution Relating to Outer Space*, 33 J. INT'L ARB. 379, (2016).

[10] *See* Böckstiegel *supra* note 2, at 17.

ment are not by any means limited in number. Some authors suggest there are more than 57 treaties providing for non-binding dispute settlement that could be applicable.[11] A substantive review of all these mechanisms, however, is beyond this paper's scope, which is confined to a brief mention of the major treaties.

Before highlighting the subject-specific mechanisms for dispute settlement, it is worth reiterating that States, as subjects of international law, are required to settle differences in a peaceful manner pursuant to the United Nations Charter (Charter).[12] In this regard, the Charter also proposes a number of means by which States can resolve disputes peacefully,[13] and some of these, whether in their ordinary or modified form, are employed in space law conventions.

While the Convention on International Liability for Damage Caused by Space Objects (Liability Convention) provides a means to resolve conflicts relating to damage by space objects,[14] its utility has been highly criticized.[15] The Liability Convention's major drawbacks include the use of a commission instead of a court to resolve disputes[16] and its failure to ensure binding decisions.[17] Further, despite the extension of State liability to States which procure or facilitate launches,[18] non-State parties cannot initiate dispute settlement under the provisions of the Liability Convention.[19] Described as the most elaborate dispute resolution procedure for State-to-

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[11] *See* Karl-Heinz Böckstiegel, *Developing a System of Dispute Settlement Regarding Space Activities*, 35 PROC. L. OUTER SPACE 27, 28-30 (1992) (identifying 57 instruments related to space activities that contain dispute settlement arrangements and finding that binding settlement dispute mechanisms only exist in "very specific instruments for highly limited areas of space activities.").

[12] U.N. Charter art. 2 ¶ 3.

[13] U.N. Charter art. 33 ¶ 1.

[14] Liability Convention, *supra* note 5, arts. IX-XX.

[15] Camilo Guzmán Gómez, The Optional Rules of Arbitration of Disputes Relating to Outer Space Activities of the Permanent Court of Arbitration, A Real Option for the Solution of Conflicts in Space Matter? 63rd Int'l Astronautical Congress, Paper No. IAC-12, 7-B3 8.9, x14708 (2012), at 1.

[16] Liability Convention, *supra* note5, art. XIV; *see* Guzmán Gómez, *supra* note 15 at 1.

[17] Liability Convention, *supra* note 5, art. XIX(2) ("[t]he decision of the Commission shall be final and binding if the parties have so agreed"); *see* Meishan Goh, *supra* note 4, at 76.

[18] Liability Convention, *supra* note 5, art. I(c)(ii).

[19] *See* Tronchetti, *supra* note 1, at 182-83.

State matters in space, the Liability Convention is specifically confined to claims for compensation for damage caused by space objects.[20]

Another mechanism through which parties can resolve disputes arising from space activities is the International Telecommunications Union (ITU).[21] The ITU maintains its own arbitration rules, which appear to be seldom used. Indeed, they "have never been used by parties involved in Outer Space-related conflicts. . . ."[22] The majority of disputes that arise under the auspices of the ITU typically relate to harmful interference of radio frequencies and appear to be resolved primarily through "negotiation and diplomacy."[23]

The Outer Space Treaty of 1967[24] has been referred to as the constitution of international space law.[25] Despite being the most substantive treaty related to space law, the Outer Space Treaty's dispute settlement procedures are quite minimal and go no further than emphasizing cooperation and consultation.[26] The Outer Space Treaty governs only State actors and not private entities. Significant emphasis, however, is placed on the obligation of States to apply space law rules to private entities within their sovereign bounds.[27] As indicated briefly above, existing treaties on activities in space regulate dispute settlement in limited areas, and outside

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[20] Liability Convention, *supra* note *5,* art II.

[21] The International Telecommunications Union is the specialized agency of the United Nations in charge of telecommunications and information communication technology. It comprises 193 member States as well as non-State entities, including universities, industries and educational organizations. *See About International Telecommunication Union (ITU)*, INT'L TELECOMM. UNION, https://www.itu.int/en/about/Pages/default.aspx (last visited Nov. 22, 2019).

[22] *See* Juliana Macedo Scavuzzi dos Santos, The PCA's Optional Rules for the Arbitration of Disputes Relating to Outer Space Activities and Dispute Resolution in the ITU Regulatory, ,63rd Int'l Astronautical Congress, Paper No. IAC-13, E7.2, 5x18771 (2013), at 6; Viikari, *supra* note 8, at 226-27 n.4.

[23] Macedo Scavuzzi dos Santos, *supra* note 22 at 6.

[24] Outer Space Treaty, *supra* note 5.

[25] Viikari, *supra* note 8, at 227.

[26] *See* Outer Space Treaty, *supra* note 5, art. IX; Böckstiegel, *supra* note 2, at 6.

[27] *See* Outer Space Treaty, *supra* note 5, art. VI ("States Parties to the Treaty shall bear international responsibility for national activities in outer space . . . whether such activities are carried on by government agencies or by non-governmental entities, and for assuring that national activities are carried out in conformity with the provisions set forth in the present Treaty.").

of this, compulsory dispute settlement is non-existent.[28] Not only are existing mechanisms of dispute settlement relating to outer space limited in effect, they also fail to provide for the involvement of all affected parties.

B. The Need for Expanded Dispute Settlement Procedures

Private space activity has a broader scope than that of State-sponsored missions, which results in "more complicated legal consequences"[29] and disputes. Today, private space activities can range from developing a means to mine asteroids to sending ordinary citizens into space as tourists.[30] The major problem with respect to dispute resolution, is that private parties are in one way or another confined to a framework which was only designed to regulate activities of public entities.[31] Space related disputes can – and do – arise amongst States, State agencies, intergovernmental organizations and private entities.[32] Nevertheless, given space law was initially conceptualized as being only in the realm of public international law, the involvement of private actors necessitates the inclusion of private international law.[33]

In this regard, proponents for new dispute settlement mechanisms contend that such mechanisms are necessary in order to handle technologically and scientifically controversial cases among different parties.[34] This necessity is perhaps best substantiated by the recognition that space, as well as aviation, activities call for design and manufacturing of technologically advanced equipment that must meet high standards and strict requirements.[35] While international and regional organizations such as the European Space

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[28] *See* Böckstiegel, *supra* note 2, at 6.

[29] George Khoukaz, *ADR That Is Out of This World: A Regime for the Resolution of Outer-Space Disputes*, 2018 J. DISP. RESOL. 265, 266 (2018).

[30] *See id.*

[31] *See* Tronchetti, *supra* note 1, at 183.

[32] *See* Franz von der Dunk, *Space for Dispute Settlement Mechanisms - Dispute Resolution Mechanisms for Space? A Few Legal* Considerations, 44 PROC. L. OUTER SPACE 442, 443-47 (2001).

[33] *See* Cheng, *supra* note 4, at 166.

[34] *See id.* at 167-68.

[35] *See* Michel G. Bourely, *Creating an International Space and Aviation Arbitration Court*, 36 PROC. L. OUTER SPACE 144, 146 (1993).

Agency,[36] have developed their own dispute settlement procedures,[37] a full examination of their procedures is beyond the focus of this paper.

What is clear is that arbitration can and does provide an effective means to resolve disputes, and is viewed as the most promising measure with respect to the resolution of space-related disputes.[38] What must always be remembered is that arbitration is voluntary and parties must agree to arbitrate, typically in the form of an agreement, a treaty, or a special "comprimis."[39] However, given the fact that there have been very few publicly known disputes arising from space activities over the last fifty years of spaceflight,[40] it is reasonable to ask whether there is a need to further establish arbitration for the purposes of space disputes. It is also important to note that since arbitration is a predominantly confidential means of dispute resolution,[41] the extent of its current use in resolving space disputes remains somewhat unclear.

C. The Draft Convention on the Settlement of Outer Space Disputes

The adoption of the PCA Optional Rules should not entail a presumption that no prior attempt has been made to introduce frameworks for dispute settlement. Indeed, the most comprehensive proposal to date is the Final Draft of the Revised Convention on the Settlement of Disputes Related to Space Activities (Draft Convention) adopted by the International Law Association (ILA) in

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[36] European Space Agency, Convention and Council Rules of Procedure art. XVII, ESA SP-1317/EN (Dec. 2010) [hereinafter ESA Convention and Council Rules of Procedure].

[37] Tronchetti, *supra* note 1, at 183. Additionally, numerous proposals have been put forward to formally direct disputes related to matters of space law to the International Court of Justice. *See e.g.,* George Paul Sloup, *Peaceful Resolution of Outer Space Conflicts Through the International Court of Justice: The Line of Least Resistance,* 20 DEPAUL L. REV. 3, 618, 688 (1971). Consideration of these proposals is beyond the scope of this paper.

[38] *See* Viikari, *supra* note 8, at 226.

[39] Macedo Scavuzzi dos Santos, *supra* note 22, at 2.

[40] *See* Stephan Hobe, *The Permanent Court of Arbitration Adopts Optional Rules for Arbitration of Disputes Relating to Outer Space Activities*, 61 ZEITSCHRIFT FUR LUFT- UND WELTRAUMRECHT 4, 4 (2012).

[41] *See* Stefan Pislevik, *Precedent and Development of Law: Is It Time for Greater Transparency In International Commercial Arbitration?* 34 ARB. INT'L 241, 242-43 (2018).

1998, after some twenty years of development.[42] The Draft Convention proceeded on the premise that there would be mandatory non-binding forms of dispute settlement, but that parties would have to agree to at least one binding form of dispute settlement.[43] The goal was to encourage a first attempt at informal settlement before escalating to a binding decision on the parties.

While the Draft Convention foreshadowed the creation of an International Tribunal for Space Law, such a tribunal has not come into existence.[44] Even so, the proposed tribunal would not have had exclusive jurisdiction over space disputes and disputing parties would have remained able to refer matters to the International Court of Justice (ICJ) (excluding non-States) or ad hoc arbitration.[45] Finally, parties could also resort to arbitration where the non-binding methods of dispute resolution proved unsatisfactory, or if each party has nominated a different form of binding dispute settlement.[46] The Draft Convention was also not limited strictly to State parties. Indeed, it was open to both States and International Intergovernmental Organizations.[47] Most importantly, the Draft Convention afforded access to its dispute settlement mechanisms to entities private parties, provided matters had not already been referred to the ICJ.[48] Unfortunately, little is to be made of the Draft Convention as it has not been signed or ratified by any State. Fabio Tronchetti succinctly describes some of what he calls the Draft Convention's shortcomings:

For example, it should have given more weight to issues of accessibility and standing for individuals and small commercial enterprises engaged in space activities. It should have also foreseen some means of universal applicability instead of resorting to the traditional country and intergovernmental organization dichotomy. Furthermore, the approach chosen by the Draft Convention with

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[42] *See* Final Draft Convention on the Settlement of Space Law Disputes, Space Law Comm., 68 Int'l L. Ass'n Rep. Conf. 239, 249 (1998) [hereinafter ILA Draft Convention]; O'Grady, *supra* note 6, at 7; Kurlekar, *supra* note 9, at 392-93.

[43] ILA Draft Convention, *supra* note 42, arts. 3-6. *See also* Karl-Heinz Böckstiegel, *Proposed Draft Convention on the Settlement of Space Law Disputes*, 12 J. SPACE L. 136, 142 (1984).

[44] ILA Draft Convention, *supra* note 42, art. 37.

[45] *See id.* at art. 6. *See also* Kurlekar, *supra* note 9, at 393.

[46] *See* FABIO TRONCHETTI, FUNDAMENTALS OF SPACE LAW AND POLICY 53 (2013).

[47] ILA Draft Convention, *supra* note 42, art. 1.

[48] *Id.* at art. 10(2).

regard to the possibility of selecting different binding means for dispute settlement appears, nowadays, a bit outdated. Especially, the establishment of an International Tribunal for Space Law and submission of cases to the International Court of Justice do not seem viable options.[49]

D. The International Court of Aviation and Space Arbitration

Proposals for international space courts have persisted for quite some time, with the first apparently proposed in 1962.[50] There has, however, been significant State opposition to such courts because it would require States to cede some of their sovereignty.[51] Nonetheless, such a specialized court was conceived by the Société Française de Droit Aérien et Spatial in the mid-1990s.[52] Known as the International Court of Aviation and Space Arbitration (ICASA),[53] ICASA was the only specialized tribunal for space disputes until the Optional Rules were introduced. Nevertheless, both instruments were motivated by the same objective: "to fill a gap resulting from the fact that international disputes occurring in the aerospace field present specific characteristics that national or arbitration courts have difficulty taking into account."[54] Furthermore, ICASA was not intended as a replacement for existing State-to-State dispute mechanisms, but rather to provide an avenue for individuals or legal entities, public or private, to have an alternative means to resolve disputes arising out of aviation and space activities.[55]

The ICASA arbitration rules themselves are not only hard to find, but also differ significantly from the now-heralded Optional Rules.[56] The ICASA rules provide for the selection of arbitrators and experts based on expertise and specialization in the field.[57] Like

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[49] TRONCHETTI, *supra* note 46, at 53.

[50] Aldo Armando Cocca, *Law Relating to Settlement of Disputes on Space* Activities, *in* SPACE LAW: DEVELOPMENT AND SCOPE 191, 201 (Nandasiri Jasentuliyana ed., 1992).

[51] Bourely, *supra* note 35, at 145.

[52] *See id.* at 144.

[53] *See id.*

[54] *Id.* at 148. S*ee* O'Grady, *supra* note 6 at 5; Pocar, *supra* note 4, at 171.

[55] *See* Bourely, *supra* note 35, at 144.

[56] The author relies on the description of the ICASA rules provided in detail by Bourely, *supra* note 35.

[57] *See* Bourely, *supra* note 35, at 144.

the PCA Optional Rules, ICASA maintained a list of such arbitrators and experts for parties to choose from, while also leaving open the option of selecting others not mentioned on the list.[58] Although it seems enforcement of ICASA awards would proceed under the New York Arbitration Convention on the Recognition and Enforcement of Foreign Arbitral Awards[59] (New York Convention), the ICASA rules also provide that awards are final, not subject to appeal and are to be enforced within 30 days.[60] What truly sets ICASA apart from not only the PCA Optional Rules, but also from other popular arbitral and institutional rules, is that they presciently provided for "emergency arbitration" and "temporary measures."[61]

Despite ICASA appearing an attractive settlement option at first, information about ICASA is difficult to obtain and its very existence today is somewhat unclear. The author's research also indicates that ICASA does not appear to have presided over any disputes.[62] It is important to remember that this could be due to the confidential nature of arbitral disputes. Whether or not space law is to be considered as "*lex specialis*"[63] and whether or not a complimentary specialized court or "self-contained" regime[64] is desirable are issues that deserve greater attention. Greater transparency regarding ICASA's existence and operation would provide a strong basis to predict the utility of the PCA Optional Rules as a means to resolving space disputes both now and in future.

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[58] *See id*. at 147.

[59] *Id*. at 148. The New York Arbitration Convention on the Recognition and Enforcement of Foreign Arbitral applies to "the recognition and enforcement of arbitral awards made in the territory of a State other than the State where the recognition and enforcement of such awards are sought." Convention on the Recognition and Enforcement of Foreign Arbitral Awards, June 10, 1958, 21 U.S.T. 2517, 330 U.N.T.S. 3 [hereinafter New York Convention]. The Convention has 161 States parties. *Commercial Arbitration and Mediation*, U.N., https://treaties.un.org/Pages/ViewDetails.aspx?src=IND&mtdsg_no=XXII-1&chapter=22&clang=_en (last visited Jan. 13, 2020).

[60] Bourely, *supra* note 35, at 147.

[61] *Id*. Viikari, *supra* note 8, at 238.

[62] *See* Viikari, *supra* note 8, at 239; O'Grady, *supra* note 6, at 5.

[63] FRANCIS LYALL & PAUL LARSEN, SPACE LAW 574 (2009).

[64] *See Conclusions of the Work of the Study Group on the Fragmentation of International Law: Difficulties Arising from the Diversification and Expansion of International Law*, [2006] 2 Y.B. Int'l L. Comm'n 179 ("A group of rules and principle concerned with a particular subject matter may form a special regime ('self-contained regime') and may be applicable as *lex specialis*.").

III. THE PCA OPTIONAL RULES: A NEW BREAKTHROUGH OR LONG TIME IN THE MAKING?

Some commentators suggest the PCA Optional Rules address a substantial *lacuna* in extra-territorial arbitration.[65] At least one has suggested that existing eminent arbitral institutions are well equipped to deal with space disputes, albeit with a minor need to update arbitral rules.[66] The Optional Rules are adapted from the Arbitration Rules of the United Nations Commission on International Trade Law[67] (UNCITRAL), the most widely used procedural rules in international commercial arbitration.[68] While maintaining familiarity of terminology for arbitration practitioners, where necessary, the Optional Rules depart to ensure relevance and appropriateness for space-related disputes.[69] Thus it is fair to question whether the Optional Rules have furthered pre-existing mechanisms of dispute settlement, or whether they merely appear to offer unparalleled expertise? This question deserves attention, particularly as limited disputes have arisen from space activities.[70]

The major barrier facing private parties today is that they operate within a framework originally designed to regulate activities of public entities.[71] Of course, space related disputes inevitably do arise amongst States, State agencies, intergovernmental organizations and private entities.[72] However, with an expansion in space actors, it is reasonable to predict the number of space-related disputes, private or public, or a combination of both, will increase. Therefore, existing mechanisms should be updated accordingly.

Broadly speaking, the Optional Rules are to be praised for their arbitrator selection provisions,[73] award enforceability,[74] lower

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[65] Pocar, *supra* note 4, at 175; Tronchetti, *supra* note 1, at 183; Macedo Scavuzzi dos Santos, *supra* note 22, at 7.

[66] O'Grady, *supra* note 6, at 9.

[67] Optional Rules, *supra* note 3, Introduction. *See* United Nations Commission on International Trade Law, UNCITRAL Arbitration Rules, *available at* https://uncitral.un.org/en/texts/arbitration/contractualtexts/arbitration; Macedo Scavuzzi dos Santos, *supra* note 22, at 8.

[68] *See* Pocar, *supra* note 4, at 180.

[69] *See* Optional Rules, *supra* note 3, Introduction; Pocar, *supra* note 4, at 180.

[70] *See* Hobe, *supra* note 40, at 4.

[71] *See* Tronchetti, *supra* note 1, at 183.

[72] *See* von der Dunk, *supra* note 32, at 443-47.

[73] Optional Rules, *supra* note 3, arts. 7-14.

[74] *Id.* art. 34.

costs and the binding force of arbitral decisions, which may not be appealed.[75] Rightly, some recognize this as inherently part of international arbitrations,[76] while others appear to mischaracterize this as being unique to the Optional Rules.[77] What is consistent, however, is an apparent consensus in academia for the need to establish a sectorialized mechanism for resolving space disputes.[78] Arguably, consensus stems from increased commercial use of outer space, which includes satellite communications, remote sensing and private offering of launch services.[79] The great utility of arbitration is twofold: first, it does not require standing acceptance by States in treaty or convention form; and second, mechanisms are open to all space actors, public and private.[80] This is, however, a feature of most forms of arbitration and thus not unique to the Optional Rules.

Equally important, and briefly mentioned above, arbitration operates on the basis of voluntary consent.[81] In this regard, arbitration is similar to public international law. The latter involves the recognition and acceptance of legal authority as between States,[82] typically in the form of ICJ jurisdiction, as derived from a number of methods specified in its statute.[83] The former is premised on the recognition and acceptance of legal authority that is granted to a particular dispute resolution provider, whether institutional or ad-

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[75] Optional Rules, *supra* note 3, arts. 33-39.

[76] *See* Tronchetti, *supra* note 1, at 184-85 (noting that the Advisory Group created to design the Optional Rules recognized that "international arbitration was the most suitable method for the resolution of space-related disputes" in part because it is open, voluntary and results in final and binding decisions that are enforceable across borders.).

[77] *See* Kurlekar, *supra* note 9, at 386.

[78] Pocar, *supra* note 4, at 174.

[79] Cheng, *supra* note 4, at 167.

[80] *See* Susan Cone Kilgore, *Arbitration Rules for Disputes Arising from Outer Space Activity*, 65 FED. LAW. 58, 61 (2018).

[81] *See* Macedo Scavuzzi dos Santos, *supra* note 22, at 1; Tronchetti, *supra* note 1, at 184.

[82] *See* Kilgore, *supra* note 80, at 61.

[83] The States parties to the Statute of the International Court of Justice "may at any time declare that they recognize as compulsory ipso fact and without special agreement, in relation to any other state accepting the same obligation, the jurisdiction of the Court in all legal disputes concerning: a) the interpretation of a treaty; b) any question of international law; c) the existence of any fact which, if established, would constitute a breach of an international obligation; d) the nature or extent of the reparation to be made for the breach of an international obligation." Statute of the International Court of Justice art. 36(2).

hoc.[84] This recognition proceeds on the basis of referral or submission, as parties can agree before a dispute arises to refer certain or all disputes to arbitration, or agree to submit a dispute to arbitration once it arises.[85] Distinct from public international law disputes before the ICJ, the same jurisdictional issues and thresholds typically associated with State disputes appear to be precluded under the Optional Rules. Article 1, in particular, establishes the scope of application of the Optional Rules.[86] As expected, an arbitration agreement referring disputes to the PCA is necessary in order for dispute resolution to proceed under the Optional Rules.[87]

The validity of a referral is not affected by a decision of the parties to modify the Optional Rules and their application as desired.[88] Additionally, the dispute between parties need not be characterized as relating to outer space in order for the PCA to hear it, effectively making irrelevant the legal basis of the dispute.[89] The dispute need only fall within the confines of what the parties have agreed to settle by way of the Optional Rules.[90] While a subject matter jurisdictional test was considered for the Optional Rules, it was ultimately excluded to ensure the greatest use of the mechanism and not unnecessarily limit its scope.[91] As such, the Optional Rules have disposed of a potentially troublesome problem, having to also adjudicate what is, and is not, a dispute that relates to outer space.[92]

Arguably the most significant aspect of the Optional Rules, is their express waiver of immunity where a party agrees to their application.[93] Waiver in this context refers to the availability to state a means under customary international law by which a party can

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[84] *See* Kilgore, *supra* note 80, at 61.

[85] *See id*.

[86] Optional Rules, supra note 3, art. 1.

[87] *See id. Annex.* The Optional Rules offer a model arbitration clause for contracts as an annex.

[88] Optional Rules, *supra* note 3, art. 1(1). S*ee* Kilgore, *supra* note 80, at 62.

[89] Optional Rules, *supra* note 3, art. 1(1). *See* FRANZ VON DER DUNK, DISPUTE SETTLEMENT IN THE AREA OF SPACE COMMUNICATION 106 (Mahulena Hofmann ed., 2d ed. 2015).

[90] *Id*.

[91] *See* Pocar, *supra* note 4, at 181.

[92] *See* O'Grady, *supra* note 6, at 6.

[93] Optional Rules, *supra* note 3, art. 1(2).

refuse to yield sovereignty to judicial processes, which would include arbitral tribunals.[94] Article 1(2) of the Optional Rules does not confine the type of immunity which is being waived, but extends to ". . . any right of immunity from jurisdiction . . . ."[95] While not explicit, the motivation for this provision appears to have been primarily focused on countering both sovereign immunity and the immunity of intergovernmental organizations.[96] A pertinent example of the latter can be seen with reference to immunity enjoyed by the European Space Agency (ESA). Under the ESA Convention and Council Rules of Procedure, ESA, its staff, experts and any representatives of its Member States "shall enjoy . . . immunities as provided for in Annex I" to the Convention.[97]

This Annex I is quite extensive. However, it warrants here briefly mentioning that rather than confining immunity of the ESA to positively ascribed circumstances, the Convention is, instead, framed negatively in that it provides the exceptions to which immunity will not extend.[98] In contrast, immunities of Member State Representatives, ESA staff members and experts other than staff members are confined to expressly defined circumstances.[99] Whether or not the inclusion of waiver in the Optional Rules is a welcomed achievement is questionable since waivers already exist under customary international law.[100] The agreement to arbitrate itself constitutes a jurisdictional waiver of immunity,[101] with waiver extending to jurisdiction of the court of the seat that supervises the arbitration.[102] The acceptance of this general proposition varies from State to State, and therefore deserves its own analysis

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[94] *See* United Nations Convention on Jurisdictional Immunities of States and Their Property, U.N. GAOR, 59th Sess., Annex I art. 17, Supp. No. 22 (A/59/22) (2004); Kurlekar, *supra* note 9, at 386.

[95] Optional Rules, *supra* note 3, art. 1(2).

[96] *See* Pocar, *supra* note 4, at 182.

[97] ESA Convention and Council Rules of Procedure, *supra* note 36, art. XV.

[98] *Id.* Annex I, art. IV.

[99] *Id.* Annex I, arts. XIV, XVI, XVII.

[100] United Nations Convention on Jurisdictional Immunities of States and Their Property, U.N. GAOR, 59th Sess., Annex I art. 17, Supp. No. 22 (A/59/22) (2004).

[101] *See* VON DER DUNK, *supra* note 89, at 106.

[102] *See* NIGEL BLACKABY ET AL., REDFERN AND HUNTER ON INTERNATIONAL ARBITRATION 657 (6th ed. 2015).

when determining whether immunity has been tacitly waived by an arbitration agreement.[103]

Of greater concern is the sentence following the express jurisdictional waiver in Article (1)(2): "A waiver of immunity relating to the execution of an arbitral award must be explicitly expressed."[104] This provision appears to indicate that an agreement to arbitrate will only constitute a waiver for the purposes of jurisdiction. Under this provision, obtaining enforcement of an award, where the order is against a party who holds a right to immunity, will require an express waiver of immunity against enforcement. This is distinct from the waiver of jurisdictional immunity discussed above, and only becomes problematic where a party wishes to evade its obligations resulting from an arbitration award. Otherwise, the award will likely be carried out voluntarily.

Once again, immunity with respect to enforcement differs at a State-to-State level.[105] For example, the United Kingdom's statute requires a separate waiver for both jurisdiction and execution.[106] The obvious problem highlighted here is that where immunity is concerned, there is no guarantee of uniformity in State practice in either permitting or resisting enforcement. This will only be an issue where there is a State party to proceedings, and is in direct contrast to what parties are familiar with in arbitration, as typically enforcement will occur in accordance with the New York Convention. This highlights a drawback to the utility of the Optional Rules. If they are to be utilized, it is more likely than not that a State will be in a position of greater bargaining power over a private party, or another State, and may dictate the terms on which a contract is concluded. As made clear above, a waiver of State immunity is a complex topic which requires more detailed examination. What this brief discussion should convey is that the Optional Rules leave open uncertainty as to enforcement of awards, particularly where State parties are involved and immunity is in question.

The Optional Rules have achieved great progress in outer space dispute settlement, and proponents appear very optimistic

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[103] *Id*.

[104] Optional Rules, *supra* note 3, art. 1(2).

[105] *See* BLACKABY ET AL., *supra* note 102, at 657-58.

[106] State Immunity Act 1978, c. 33, § 13(3) (Eng.).

about the confidentiality provisions they contain.[107] Others, however, approach the matter with cautious optimism, waiting to see "whether this procedural novelty causes more damage to the due process than it helps bring about solutions of intricate satellite communications disputes."[108] It should be recalled that infringements of due process may provide an avenue for refusing recognition and enforcement of an award under the New York Convention.[109] Despite being modelled on the UNCITRAL Rules, the confidentiality provisions of the Optional Rules have been described as "unique."[110] Article 17(6) of the Optional Rules enables a party to apply to the tribunal to have information classified as confidential, by way of a notice containing reasons as to why confidentiality measures are sought.[111]

In making a decision regarding confidentiality, the tribunal determines whether the absence of protective measures would likely cause serious harm to the party invoking confidentiality.[112] If the answer to this question is in the affirmative, the tribunal will direct under what conditions, and to whom such information may be disclosed, in whole or in part, and requires parties privy to the information to sign a confidentiality agreement.[113] Furthermore, either at its own initiative or at the request of a party, the tribunal may appoint an expert as a "confidentiality adviser" to report to the tribunal on specific issues, without disclosing confidential information to parties or to the tribunal.[114] Arguably, the parties most interested in these provisions will be space companies who incur significant costs in the research and development of their technology.[115] At the same time, confidentiality provisions encourage the use of international arbitration by downplaying fears that entering

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[107] *See* Giugi Carminati, *The Optional Rules for Arbitration of Disputes Relating to Outer Space Activities: A Comparison to the UNCITRAL Rules*, 1 L.A. COUNTY B. ASS'N 1, 12 (2012); Macedo Scavuzzi dos Santos, *supra* note 22, at 8; Tronchetti, *supra* note 1, at 185-86.

[108] VON DER DUNK, *supra* note 89, at 110.

[109] New York Convention, *supra* note 58, art. V(1)(b).

[110] *See* Carminati, *supra* note 107, at 112.

[111] Optional Rules, *supra* note 3, art. 17(6).

[112] *Id.,* art. 17(7).

[113] *Id.*

[114] *Id.* art. 17(8).

[115] *See* Carminati, *supra* note 107, at 13.

a dispute necessitates disclosure of documents and a threat to competitive advantage in the market.[116]

Importantly, and explored in more detail below, confidentiality may encourage production of documents which would otherwise remain undisclosed.[117] Pre-existing arbitral institutions, in comparison, have been said to offer little opportunity to ensure confidentiality of information, which is particularly desirable with respect to matters of security and commercial sensitivities.[118] Security concerns will often arise as a result of disclosure of information which relates to dual-use technology. Under both domestic and international frameworks, severe sanctions may apply where violations occur.[119] Frans von der Dunk has suggested that exchange of dual-use or security-related information in the course of an arbitration setting may trigger application of those regimes.[120] While such concerns have some merit, this train of thought overlooks that parties generally have capacity to amend and modify applicable rules to a dispute, which, in this instance, can account for heightened confidentiality concerns. If anything, confidentiality provisions in the Optional Rules appear to be more of a convenience than necessity, particularly as the prevalence of confidentiality in ordinary arbitration, has led to a tendency to automatically associate arbitration with confidentiality.[121]

Few disputes relating to space activities have been submitted to third party mechanisms for settlement.[122] As of November 2019,

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[116] *See id*.

[117] *See id*.

[118] *See* VON DER DUNK, *supra* note 89, at 12.

[119] *See e.g.,* 22 U.S.C. §2778(c) (2018) (imposing fines up to US$1,000,000 or imprisonment up to 20 years). Council Regulation 428/2009, 2009 O.J. (L134/10) art. 24 (requiring States to "lay down penalties . . . . [that are] effective, proportionate and dissuasive"); Wassenaar Arrangement on Export Controls for Conventional Arms and Dual-Use Goods and Technologies, Best Practices for Effective Enforcement, Agreed at the WA Plenary, 1 December 2000, Art 14; Wassenaar Arrangement on Export Controls for Conventional Arms and Dual-Use Goods and Technologies, Best Practices for Implementing Intangible Transfer of Technology Controls, Agreed at the 2006 Plenary, Art C (5).

[120] *See* VON DER DUNK, *supra* note 89, at 115 n.91.

[121] *See* Mark C. Weidemaier, *Toward a Theory of Precedent in Arbitration*, 51 WM. & MARY L. REV. 1895, 1899 (2010); Laurie Kratky Dore, *Public Courts versus Private Justice: It's Time to Let Some Sun Shine in on Alternative Dispute Resolution,* 81 CHI.-KENT L. REV. 463, 483 (2006); Yves Fortier, *The Occasionally Unwarranted Assumption of Confidentiality*, 15 ARB. INT'L 131, 137 (1999).

[122] *See* Tronchetti, *supra* note 1, at 186.

it cannot be ascertained by publicly available materials whether the Optional Rules have been tested.[123] Arguably, mechanisms for international dispute settlement should be measured not "by the number of times [they are] used but rather by the quality and adequacy of [their] rules and of the decisions [they] may provide."[124] The Optional Rules make progress on pre-existing mechanisms of dispute settlement of space law. Ultimately, their utility should be evaluated on the basis of effective dispute resolution as between State and non-State actors.[125]

IV. ADVERSE INFERENCES IN SPACE DISPUTES

Adverse inferences at simplest, are an evidentiary rule by which tribunals create indirect evidence of fact,[126] as opposed to direct evidence which is typically received by document production. The inference itself is a proposition reached by considering the unjustified failure of a party to adhere to an evidentiary request.[127] A party may choose to withhold documents where it considers the requested information is damaging to its case.[128] Adverse inferences arise in arbitration precisely because a tribunal does not have the same coercive powers, the force *jure imperii*,[129] as a domestic court to enforce compliance with document production requests.[130] A domestic court in this instance would have the power to hold a party

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123 *See* Kilgore, *supra* note 80, at 62.

124 Macedo Scavuzzi dos Santos, *supra* note 22, at 9.

125 *See* Tronchetti, *supra* note 1, at 188.

126 *See* Vera van Houtte, *Adverse Inferences in International Arbitration*, *in* WRITTEN EVIDENCE AND DISCOVERY IN INTERNATIONAL ARBITRATION: NEW ISSUES AND TENDENCIES 195 (Teresa Giovannia & Alexis Mourre eds., 2009); Alexander Sevan Bedrosyan, *Adverse Inferences in International Arbitration: Toothless or Terrifying,* 38 U. PA. J. INT'L L. 241, 247 (2016).

127 *See* Menalco J. Solis, *Adverse Inferences in Investor–State Arbitration*, 34 ARB. INT'L 79, 87 (2018).

128 *See* Simon Greenberg & Felix Lautenschlager, *Adverse Inferences in International Arbitral Practice*, *in* INTERNATIONAL ARBITRATION AND INTERNATIONAL COMMERCIAL LAW: SYNERGY, CONVERGENCE AND EVOLUTION 179, 181 (Stefan Kroll et al. eds., 2011).

129 Solis, *supra* note 127, at 85.

130 *See* Jeremy Sharpe, *Drawing Adverse Inferences from the Non-Production of Evidence,* 22 ARB. INT'L 549, 550 (2006); Bedrosyan, *supra* note 126, at 241; Greenberg & Lautenschlager, *supra* note 128, at 180.

in contempt.[131] Such a coercive measure is effective in domestic litigation in deterring parties from withholding information.[132] Conversely, while arbitral tribunals have the power to impose monetary sanctions and order costs of proceedings,[133] their most effective quasi-coercive power in this regard is the ability to draw an adverse inference.[134]

Even with an emphasized need for caution in the imposition of adverse inferences, tribunals appear reluctant to rely on them.[135] Nonetheless, adverse inferences are held to be the "most effective sanction arbitrators have to impose upon parties negligent or recalcitrant in the production of evidence."[136] However, when considering the imposition of adverse inferences, tribunals try to be pragmatic and reach the same conclusion on existing evidence,[137] effectively avoiding the need to determine an adverse inference.[138] This section: first explores the basis of an arbitrator's authority to impose adverse inferences; and second, the process by which they are drawn. Ultimately, it must be recognized that the rule of adverse inferences is far from settled in respect of any industries. Therefore, analogies to other areas of international law, are not helpful as they offer little certainty.

A. Tribunal Authority to Impose Adverse Inferences

Arbitration rules do not commonly instil tribunals with power to draw adverse inferences outright. Indeed, neither the

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131 Bedrosyan, *supra* note 126, at 241.

132 *Id*.

133 *Id*. at 249.

134 *See, e.g.,* Waste Mgmt., Inc. v. Mex., ICSID Case No. ARB(AF)/00/3, Procedural Order Concerning Disclosure of Documents, ¶ 6 (Oct. 1, 2002).

135 Greenberg & Lautenschlager, *supra* note 128, at 180.

136 Durward V. Sandifer, EVIDENCE BEFORE INTERNATIONAL TRIBUNALS 101 (1939).

137 Greenberg & Lautenschlager, *supra* note 128, at 181.

138 LAWRENCE CRAIG, WILLIAM PARK & JAN PAULSSON, INTERNATIONAL CHAMBER OF COMMERCE ARBITRATION 456 (3d ed. 2001).

UNCITRAL nor the International Centre for Settlement of Investment Disputes[139] (ICSID) rules convey such power.[140] Instead, ICSID tribunals establish their authority to draw adverse inferences by virtue of Article 34(3) of the ICSID Arbitration Rules which indicates that "the Tribunal shall be the judge of the admissibility of any evidence adduced and of its probative value."[141] Contrarily, international commercial arbitration tribunals rely on the inherent power of the tribunal[142] and well-established arbitral practice in order to draw adverse inferences.[143] Additionally, the International Bar Association Rules on the Taking of Evidence in International Arbitration (IBA Rules) despite being non-binding, are also typically consulted to establish tribunal authority to draw adverse inferences.[144]

Arguably, adverse inferences are considered part of the *lex evidentia* of international arbitration.[145] Consequently, tribunals have power to decide on admissibility of evidence, the relevance to be attributed, and the value it should hold. The Arbitration Rules of the International Chamber of Commerce provide the tribunal with power to request evidence from parties.[146] The shortcoming

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[139] The International Centre for Settlement of Investment Disputes was established to "provide facilities for conciliation and arbitration of investment disputes." Convention on the Settlement of Investment Disputes Between States and Nationals of Other States art. 1, *as amended and effective* Apr. 10, 2006, *available a* http://icsid-files.worldbank.org/ICSID/ICSID/StaticFiles/basicdoc/main-eng.htm [hereinafter ICSID].

[140] Solis, *supra* note 127, at 81.

[141] ICSID, *supra* note 139, Rules of Procedure for Arbitration Proceedings art. 34.

[142] 'Bundesgericht,'I. Zivilrechtliche Abteilung, Urteil Vom 28. März 2007, 4A_2/2007, X. GmbH (Deutschland), Beschwerdeführerin, Gegen A. (Iran/Schweiz), Beschwerdegegner. *Bundesrichter Corboz, (Präsident), Bundesrichter Kolly, Bundesrichterin Kiss. Gerichtsschreiberin Sommer*, 25(3) ASA Bull. 610, 616 (2007).

[143] Guilherme Amaral, *Burden of Proof and Adverse Inferences in International Arbitration: Proposal for an Inference Chart*, 35 J. INT'L ARB. 1 (2018); Greenberg & Lautenschlager, *supra* note 128, at 181.

[144] International Bar Association, Newly Revised IBA Rules on the Taking of Evidence in International Arbitration (May 29, 2010), *available at* https://www.ibanet.org/ENews_Archive/IBA_30June_2010_Enews_Taking_of_Evidence_new_rules.aspx [hereinafter IBA Rules]. The rules do not have any binding effect on an arbitration unless the parties expressly agree to such application.

[145] Michael Polkinghorne, *The Withholding of Documentary Evidence in International Arbitration: Remedies for Dealing with Uncooperative Parties,* 2 TRANSNAT'L DISP. MGMT. 1, 5 (2005).

[146] International Chamber of Commerce, Arbitration Rules, art. 25(5) (Mar. 1, 2017).

however, is that these rules do not express the consequences of any non-compliance. The Singapore International Arbitration Centre Rules, in comparison, go one step further. They provide the tribunal with power to order a party to produce a document for inspection[147] and direct a party or person to give evidence.[148] If it encounters a failure or refusal to comply, it is authorized to proceed with the arbitration.[149]

Of the major arbitral institutions, only the American Arbitration Association's Commercial Arbitration Rules provide express recognition for the power to draw adverse inferences. "The arbitrator shall have the authority to . . . without limitation: . . . in the case of wilful non-compliance with any order issued by the arbitrator, [draw] . . . adverse inferences . . . ."[150] Additionally, there are domestic regimes which enable arbitrators with the power to draw adverse inferences. One example is the English *Arbitration Act*, which provides the tribunal with the power to "draw such adverse inferences from the act of non-compliance as the circumstances justify."[151] Explicit recognition in domestic legislation acts to confirm adverse inferences as inherent to the power of a tribunal. Such power is not exclusive to arbitration and is found in public international law. The ICJ for instance, recognized its ability to draw adverse inferences on multiple occasions,[152] albeit most prominently in the *Corfu Channel Case*.[153]

In *Corfu Channel*, it was held a State has power to determine for itself what disclosures it considers detrimental to its interests, and on that basis claim privilege.[154] The court either accepts that

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147 Singapore International Arbitration Centre, Arbitration Rules of the Singapore International Arbitration Centre, Rule 27(f) (Aug. 1, 2016), *available at* http://www.siac.org.sg/our-rules/rules/siac-rules-2016.

148 *Id*. Rule 27(h).

149 *Id*. Rule 27(i).

150 American Arbitration Association's Commercial Arbitration Rules and Mediation Procedures, Rule 23(d).

151 Arbitration Act 1996, c. 23, § 41(7)(b) (Eng.).

152 Barcelona Traction, Light & Power Co. Ltd (Belg. v. Spain), 1970 I.C.J. Rep. 3, 215, ¶ 97 (separate opinion of Jessup, J.); South-West Africa Case, Judgment, 1966 I.C.J. Rep. 6, 430 (July 18) (Dissenting opinion of Jessup, J.); Certain Norwegian Loans (Fr. v. Nor.), Judgment, 1957 I.C.J. Rep 9, 35 (July 6) (separate opinion of Sir Hersch Lauterpacht).

153 Corfu Channel Case, Judgment, 1949 I.C.J. Rep. 4, 18 (Apr. 9).

154 Ali Z. Marossi, *The Necessity for Discovery of Evidence in the Fact-Finding Process of International Tribunals*, 26 J. INT'L ARB. 511, 523 (2009).

explanation, or it may draw an adverse inference. The ICJ, however, is further empowered by its rules to draw adverse inferences where a party refuses to disclose evidence, by way of taking a formal note.[155] Like some arbitral tribunals, the ICJ can infer that evidence withheld is adverse to the interests of that non-producing party.[156] *Corfu Channel* established that a party seeking the inference must be unable to furnish proof by virtue of the opposing party having exclusive control over evidence. [157] It also established that inferences may only furnish proof of a fact where there is no room for reasonable doubt.[158]

In determining whether to draw an adverse inference, there is no overarching test in international commercial arbitration.[159] Broadly speaking, there are two non-binding guides, the first being the IBA Rules, and the secondly a five prong test proposed by Jeremy Sharpe, which has been examined in detail elsewhere.[160] The IBA Rules first introduced adverse inferences in the 1999[161] and reaffirmed them in the most recent 2010 version.[162] Article 9.5 of the IBA Rules provides that where a party fails without satisfactory explanation to produce a requested document, or fails to object to such request, the tribunal may infer the withheld document to be adverse to that party's interests.[163] Article 9.6 is of similar effect,

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[155] Statute of the International Court of Justice art. 49.

[156] Michael P. Scharf & Margaux Day, *The International Court of Justice's Treatment of Circumstantial Evidence and Adverse Inferences,* 13 CHI. J. INT'L L. 123, 127 (2012).

[157] *Corfu Channel Case*, 1949 I.C.J. Rep. at 18. *See also* Arif Hyder Ali & Tatiana E Sainati, *Adverse Inferences: A Proposed Methodology in the Light of Investment Arbitrations Involving Middle Eastern States*, 3 BCDR INT'L ARB. REV. 293, 303 (2016).

[158] *Corfu Channel Case*, 1949 I.C.J. Rep. at 18.

[159] Greenberg & Lautenschlager, *supra* note 128, at 188.

[160] *Id*. *See also* Sharpe, *supra* note 130 at 551 (". . . the following [are] requirements for drawing inferences leading to an adverse award: (1) the party seeking the adverse inference must produce all available evidence corroborating the inference sought; (2) the requested evidence must be accessible to the inference opponent; (3) the inference sought must be reasonable, consistent with facts in the record and logically related to the likely nature of the evidence withheld; (4) the party seeking the adverse inference must produce prima facie evidence; and (5) the inference opponent must know, or have reason to know, of its obligation to produce evidence rebutting the adverse inference sought.").

[161] International Bar Association, Rules on the Taking of Evidence in International Commercial Arbitration, art. 9.4 (June 1, 1999), *available at* https://www.ibanet.org/Document/Default.aspx?DocumentUid=60EFAF2E-0308-4005-8244-9CE793B37EA9.

[162] IBA Rules, *supra* note 144; Greenberg & Lautenschlager, *supra* note 128, at 188.

[163] IBA Rules, *supra* note 144, art. 9.5.

albeit with respect to other evidence.[164] Importantly, the IBA Rules do not provide guidance as to when inferences should be drawn.[165] Although useful, the necessity to refer to and rely on IBA Rules is questionable, given that in 33 International Chamber of Commerce awards dealing with adverse inferences, only 3 expressly considered the rules.[166]

Ultimately, the strength of an adverse inference will depend on the relevance of the information not produced, and the nexus it shares with the inference sought by a party. It is also important to keep in mind, "an adverse inference with respect to one fact will not automatically substitute for all the other elements of a claim as to which the party bearing the burden of proof will have to provide sufficient and satisfactory evidence."[167] Ultimately the adverse inference power is most useful where respondents exclusively hold evidence forming the basis of a claimant's case.[168] This assumes relevance with application of the Optional Rules, given the extent to which they allow for withholding of information by way of the confidentiality provisions.

B. Process in drawing adverse inferences

As highlighted above, there is no mandatory test tribunals must follow to establish adverse inferences. Typically, however, there must be a prior request or order which directs a party to produce specific information before an adverse inference can be drawn. This understanding is drawn from the nature in which the IBA rules are drafted, noting that Article 9(5) and 9(6) are premised on a party's non-compliance.[169] Therefore, only upon failure to comply with an order or request will a tribunal enter considerations as to whether non-compliance is justifiable or, instead, merits imposition

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[164] *Id*. art. 9.6.

[165] Greenberg & Lautenschlager, *supra* note 128, at 189.

[166] *Id*. Given a significant number of tribunals have drawn adverse inferences without reference to the IBA rules, it would suggest that they are comfortable relying on their inherent power to do so. It would also appear to suggest that concern of a subsequent challenge to their forthcoming award does not appear to be at the forefront of a tribunals mind.

[167] Case No. 11770 of 2004, 22 ICC Int'l Ct. Arb. Bull. 66, ¶ 42 (ICC Int'l Ct. Arb.).

[168] Sharpe, *supra* note 130, at 549.

[169] Solis, *supra* note 127, at 92.

of an adverse inference. The act of making a request or order requiring production of information serves to put a party on notice that failing to do so may attract the risk of drawing an adverse inference.[170] A procedural order inviting a party to produce evidence appears to satisfy the requirement that sufficient notice has been provided,[171] as per the IBA Rules.[172]

How a tribunal reacts to the failure or refusal to produce information varies as a result of the "principles and prejudices of the tribunal."[173] Despite being able to look beyond their own experience, an arbitrator's domestic background will likely permeate into their decision making.[174] Nonetheless, a party seeking an adverse inference bears the burden of proving that there is a factual nexus between the inference sought and the information requested. It has been suggested that this must amount to prima facie evidence of a claim,[175] and that the nexus be logical by way of "the probable nature of the documents withheld and the inference derived therefrom.".[176] The prima facie threshold, however, is set quite low. All that is required is that, without the adverse inference, the material put forward by the claimant would be insufficient for establishing their case.[177] As such, making a general assertion that by refusing to produce documents a party is hiding something will be insufficient to persuade a tribunal to make an adverse inference.[178]

While a tribunal may make an adverse inference on its own motion,[179] the tribunal is under no obligation to ask parties to explain their non-production.[180] A party may however, have legiti-

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[170] Greenberg & Lautenschlager, *supra* note 128, at 189.

[171] NATHAN O'MALLEY, RULES OF EVIDENCE IN INTERNATIONAL ARBITRATION: AN ANNOTATED GUIDE ¶ 7.42(e) (2012).

[172] IBA Rules, *supra* note 144, arts. 9.5, 9.6.

[173] Polkinghorne, *supra* note 145, at 4.

[174] *Id*.

[175] O'Malley, *supra* note 171, ¶ 7.42(d).

[176] Craig, Park & Paulsson, *supra* note 138, at 42.

[177] Greenberg & Lautenschlager, *supra* note 128, at 187.

[178] Michael Polkinghorne & Charles B. Rosenberg, *The Adverse Inference in ICSID Practice*, 30 ICSID REV. 741, 746 (2015).

[179] Greenberg & Lautenschlager, *supra* note 128, at 187.

[180] Wojciech Giemza, *The Principle of "Adverse Inferences" In International Arbitration: Is Cour d'Appel Paving The Way For Civil Law Jurisdictions?* MONDAQ (Jan. 24,

mate reasons for non-production, such as confidentiality. Non-production on the basis of confidentiality is indeed justifiable under the IBA Rules.[181] Confidentiality as a means of resisting production is likely to arise under the Optional Rules, not just because of the subject matter – outer space and possibly lucrative space technologies – but because of the extensive confidentiality protections offered. Should a respondent remain silent in response to a document request, a tribunal will, of course, pay consideration to due process before imposing an adverse inference.[182] Failing to do so may expose the eventual award to challenge on the basis that the respondent could not present its case.[183] Should a party succeed in disputing an order to produce documents, however, this will not create a positive inference in favour of that party, but rather will discharge its burden of proof.[184]

Although the Optional Rules are tailored to support both State and non-State actor involvement, tribunals are reluctant to impose adverse inferences against States.[185] States in commercial arbitration have previously claimed national security precludes document disclosure, and instead have produced amended public summaries.[186] A tribunal has refuted the legitimacy of such an explanation, while still resisting the imposition of an adverse inference.[187] Should an adverse inference be drawn, its effectiveness will be ultimately determined with reference to the entire evidentiary record and not in isolation.[188] The weight given to an adverse inference is quite unlikely to be overstated, given tribunals are reluctant to rely

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2018), http://www.mondaq.com/x/610888/Arbitration+Dispute+Resolution/The+Principle+of+Adverse+Inferences+In+International+Arbitration+Is+Cour+dAppel+Paving+The+Way+For+Civil+Law+Jurisdictions.

[181] IBA Rules, *supra* note 144, art. 9.2.

[182] Greenberg & Lautenschlager, *supra* note 128, at 187.

[183] New York Convention, *supra* note 59, art. V.

[184] *See* Apotex Holdings Inc. & Apotex Inc. v. U.S. (2014) ICSID Case No. ARB(AF)/12/1, ¶ 8.72 (Aug. 25, 2014).

[185] Ali & Sainati, *supra* note 157, at 293.

[186] Case No. 19299 of 2015, Int'l Comm. Arb (ICC Int'l Ct. Arb.).

[187] *See id*. The Tribunal provided the Respondent's with the opportunity to explain why such information had been withheld from production. Having failed to provide adequate reasons as to why such documents affect national security, the tribunal would be justified in relying on other evidence in the record to draw inferences as a result of that non-production.

[188] Solis, *supra* note 127, at 91.

on them as the basis of an award.[189] Reliance on an adverse inference is also downplayed by a preference for direct evidence.[190] As highlighted above, a tribunal will not place reliance on an inference where the claim can be upheld based on material tendered before the tribunal.

Is there any way of resolving the uncertainty that comes with the imposition or withholding of adverse inferences? One avenue which deserves further attention is the possibility of rendering partial awards which require the production of documents.[191] Such an approach has been accepted in the United States as enforceable under the New York Convention, on the basis that the award was sufficiently "final" on the issue of document production.[192] The use of partial awards would go a long way toward preparing for a future of increased space disputes. In the context of space law, one must remember the involvement of a sovereign State or intergovernmental organization as a potential party to proceedings. The discussion of waiver highlighted above, and, in particular, waiver as to enforcement, may prove to be particularly problematic when one seeks to enforce a partial award requiring document production in domestic courts. Perhaps the difficulty and efficiency to this process will only be known if or when it is attempted.

C. Effect of drawing an adverse inference

By now it has been established that the finding of an adverse inference does not ensure the success of a claim. Caution is exercised by tribunals in order to avoid an award being challenged on any grounds, including but not limited to procedural fairness. A study of ICC awards may offer some support for this proposition. Of 36 awards studied where adverse inferences were requested, in 12 instances the tribunal drew an adverse inference, and in only seven of those cases was the inference critical for the case outcome.[193] In each of the 12 cases where the tribunal drew an adverse inference,

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189 GARY B. BORN, INTERNATIONAL COMMERCIAL ARBITRATION 1920 (2009).
190 Sharpe, *supra* note 130, at 550.
191 Polkinghorne, *supra* note 146, at 8.
192 *See* Publicis Comm. v. True North Comm. Inc., 206 F.3d. 725 (7th Cir. 2000).
193 Greenberg & Lautenschlager, supra note 128, 191.

the basis was as a result of the non-production of documents following a tribunal order for document production.[194]

Due process has indeed been raised as a challenge to awards in domestic courts on the basis of adverse inferences.[195] Beginning with the failure to draw an adverse inference, the Singapore High Court has upheld an award in which the claimant contended the tribunals failure to draw an adverse inference amounted to a limitation on the presentation of its case.[196] The respondent in the matter had refused to provide documents to the tribunal which were protected by a confidentiality clause between itself and a third party. The tribunal not only rejected the respondent's confidentiality objection, it proceeded with imposing an order to produce documents. In breach of that order, the respondent did not comply. Importantly, and for the purpose of respecting due process, the tribunal had sought submissions from the parties as to whether to impose an adverse inference.[197]

Ultimately the tribunal upheld the respondent's non-production on grounds of confidentiality. It does indeed appear that the opportunity provided to the parties by the tribunal, to plead for or against the adverse interest was central to the High Court's refusal to set aside the award.[198] The High Court further emphasized that even if the decision not to impose an adverse inference was incorrect, it was a tribunal decision on the basis of law or fact which is not an avenue under which the court can set aside the award.[199] Similar findings have been held outside of Singapore, where courts also refused to set aside an award based on a tribunals reluctance to draw an adverse inference.[200]

The Paris Court of Appeal on the other hand has expressly endorsed the use of adverse inferences in international arbitration. In the *Dresser Rand Case*,[201] Dresser Rand "objected to production of due diligence reports" on the grounds that information within "was

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[194] *Id*.

[195] Solis, *supra* note 127, at 102-103.

[196] *Dongwoo Mann + Hummel Co Ltd v. Mann + Hummel GmbH* [2008] SGHC 67 (Sing.).

[197] *Id.* at 72.

[198] *Id.*

[199] *Id.* at 77.

[200] *See, e.g.,* Page Int'l Ltd. v. Adam Mar. Corp., 53 F. Supp. 2d 591, 596-98 (1999).

[201] Cour d'appel [CA] [Paris], Feb, 28, 2017, RG No.15/06036.

protected by attorney-client privilege."[202] Dresser Rand did not produce documents, nor was a request made by the opposing party for the tribunal to make an order requesting document production or the drawing of an adverse inference.[203] The tribunal, having provided no warning that it would be making an adverse inference proceeded to do so. Dresser Rand contested in the Paris Court of Appeal that an adverse inference could not be drawn against a non-producing party in accordance with the IBA rules, unless parties were previously consulted as to the application of such rules.[204]

Furthermore, it was alleged consultation with parties was necessary as the use of the IBA rules was a procedural matter outside of what is included in the ICC Arbitration Rules and the Terms of Reference.[205] In rejecting the challenge, the Court noted that the tribunal in its first Procedural Order made known, and the parties accepted, that it could refer to the IBA Rules which encompass Article 9.5.[206] Finally, it was held that the adverse inference was not determinative to the ruling but was only referred to in passing in the tribunals final decision.[207] The takeaway is that parties have been put on notice that: first, there is no need for a party to request an adverse inference before a tribunal proceeds to draw one; and second, there is no need to invite party comments if the tribunal proceeds to draw an adverse inference.

V. RECOMMENDATIONS AND CONCLUSION

Dispute settlement mechanisms have been unable to keep up with the rapid development of the use of outer space. In seeking to address this issue the PCA introduced its Optional Rules in 2012. While the Optional Rules do make some progress, it is limited progress on the pre-existing arbitral regimes. Moreover, the issue of adverse inferences in international arbitration are likely to be of greater interest to the space industry, given the heightened confidentiality in space activities and complimentary procedures in the

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[202] *See* Elsa Ortega, *France: The Recent Decision by the Paris Court of Appeal in the Dresser Rand Case: An Endorsement of the Use of Adverse Inferences in International Arbitration*, 3 ICC DISP. RES. BUL. 58, 58 (2017).

[203] *Id.*

[204] *Id.*

[205] *Id.*

[206] *Id.* at 59.

[207] *Id.*

Optional Rules. All progress in this area of law should be applauded, however, to ensure effective dispute resolution in the future, greater discussion needs to take place on this issue in the interim period.

THE LEGAL IMPERATIVE TO MITIGATE THE PLUME EFFECT: AN "AGGRAVATION AND FRUSTRATION" THAT IMPERILS OUR HISTORY AND OUR FUTURE

Michelle L.D. Hanlon[*] *and Bailey Cunningham*[**]

ABSTRACT

Research indicates that upon approach and landing, lunar lander engine exhaust will blow, rocks, soil and dust at high velocities. This lander ejecta can severely damage hardware even tens of kilometers away from the landing site. Building berms or using terrain obscuration to obstruct or curtail the ejecta each offer only partial solutions to this potentially mission-ending issue because large landers can send ejecta into high trajectories that cannot be successfully blocked. Indeed, it has been shown that it is even possible for ejecta to damage or destroy spacecraft orbiting the Moon. This article maintains that because of these effects, it is necessary to construct landing pads on the Moon to protect all ongoing operations as well as sites of historic significance from destructive ejecta. This article commences by introducing the challenges posed by lunar landing ejecta and summarily describing the detrimental effects on operational hardware and historic sites. The article suggests that obligations and responsibilities as set forth in the Outer Space Treaty and the Liability Convention make the construction of common landing pads a legal, economic and moral imperative. The article further argues that the development and establishment of a common landing pad regime is a vital first step in obtaining the level of international agreement and cooperation that will be needed to assure the successful and sustainable exploration and use of space and its resources.

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I. INTRODUCTION

> There is shadow under this red rock, // (Come in under the shadow of this red rock), // And I will show you something different from either // Your shadow at morning striding behind you // Or your shadow at evening rising to meet you; // I will show you fear in a handful of dust.
>
> T.S. Eliot, *The Waste Land*

On April 17, 1967, the United States (US) National Aeronautics and Space Agency's (NASA) Surveyor 3 launched from Cape Canaveral Air Force Station in Florida and began its voyage to the Moon.[1] The Surveyor missions were precursors to the crewed Apollo missions, intended to gather data to assure the feasibility of lunar surface landings.[2] Surveyor 3 landed on the Moon on April 20 and returned more than 6,000 photos to Earth. In addition, the spacecraft confirmed that the Moon's surface was "solid enough to support and Apollo Lunar Module."[3] Surveyor 3 transmitted information for two weeks before making "last contact" on May 4, "two days after the lunar night began."[4] But its contribution to history and space exploration was not over yet.

A little more than two years later, on November 19, 1969, the spacecraft received a visit from the crew of Apollo 12.[5] A "secondary" mission objective of Apollo 12 "was to retrieve portions of the

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[1] Sarah Loff, *Astronauts Pay a Visit to Surveyor 3*, NASA (Apr. 17, 2014), https://www.nasa.gov/content/astronauts-pay-a-visit-to-surveyor-3.

[2] *Id.* In total, there were seven Surveyor missions. Five Surveyor spacecraft successfully soft-landed on the Moon and provided data necessary to support the Apollo missions. *See The Surveyor Program*, LUNAR & PLANETARY INST., https://www.lpi.usra.edu/lunar/missions/surveyor/ (last visited Dec. 17, 2019).

[3] ASIF A. SIDDIQI, BEYOND EARTH: A CHRONICLE OF DEEP SPACE EXPLORATION, 1958-2016 66 (2018).

[4] NASA Science, *Surveyor 3,* SOLAR SYSTEM EXPLORATION, https://solarsystem.nasa.gov/missions/surveyor-3/in-depth/ (last visited Jan. 27, 2020).

[5] Mike Wall, *Happy Anniversary, Apollo 12! 'Pinpoint' Moon Mission Returned Home 50 Years Ago Today,* SPACE.COM (Nov. 24, 2019), https://www.space.com/apollo-12-moon-mission-landing-50-years-ago.html. Apollo 12 was humanity's second crewed mission to the Moon notable for, among other things, its "pinpoint" landing and the deployment by the crew of "the most advanced scientific gear ever carried to another world…" *Id.*

Surveyor 3 spacecraft . . . ."[6] Thus, Apollo 12's Lunar Module, *Intrepid*, purposefully landed just 535 feet away from Surveyor 3.[7] The intent was to obtain parts of the older spacecraft for analysis on Earth in order to examine the effects of long-term exposure to the lunar environment.[8]

The landing was swathed in Moon dust. As the Apollo 12 Mission Report indicates:

> During the final phase of the lunar module descent, the interaction of the descent engine exhaust plume with the lunar surface resulted in the top layer of the lunar soil being eroded away. The particles were picked up by the gas stream and transported as a dust cloud for long distances at high speeds. Crew visibility of the surface and surface features was obscured by the dust cloud.[9]

This "surface obscuration" was not unique to Apollo 12 and indeed, much time has been devoted to understanding the effects lunar dust will have on future missions to and activities on the Moon.[10] An equally worrisome phenomenon was discovered only after the Apollo 12 astronauts returned to Earth with parts of Surveyor 3, including its camera.[11]

Initial terrestrial analysis indicated that Surveyor 3 suffered from sandblasting from the direction of the Lunar Module.[12] In fact, "white craters" were found on the camera.[13] And it was "readily shown that the [Lunar Module] was the most probable origin for

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[6] *The Apollo Program: Apollo 12 (AS-507)*, SMITHSONIAN NAT'L AIR & SPACE MUSEUM, https://airandspace.si.edu/explore-and-learn/topics/apollo/apollo-program/landing-missions/apollo12.cfm.

[7] Mission Evaluation Team, Apollo 12 Mission Report, at ¶ 1.0 (Mar. 1970) [hereinafter Apollo 12 Mission Report].

[8] SMITHSONIAN NAT'L AIR AND SPACE MUSEUM, *supra* note 6.

[9] Apollo 12 Mission Report, *supra* note 8, at ¶ 6.1.

[10] *See e.g.,* Sandra A. Wagner, The Apollo Experience Lessons Learned for Constellation Lunar Dust Management, NASA/TP-2006-213726 (Sept. 2006).

[11] The parts retrieved are listed as "a cable, a painted tube, an unpainted tube, the television camera, and the scoop." Apollo 12 Mission Report, *supra* note 8, at ¶ 3.0.

[12] The initial report indicates "patterns of . . . light- and dark-colored areas [which] can be traced to a lightening mechanism that apparently originated above and behind the camera in the general direction of the [Lunar Module]." R.E. Benson et. al., *13. Preliminary Results from Surveyor 3 Analysis*, *in* Apollo 12 Preliminary Science Report, NASA SP-235, 218 (1970).

[13] *Id.* at 221.

these craters."[14] In short, the preliminary report indicated that the Surveyor spacecraft had suffered significant damage as a result of the Apollo 12 Lunar Module landing – something that took place more than 200 meters away.

In all, more than 36 studies of the Surveyor 3 parts have been conducted by more than 80 investigators.[15] Almost all of the exposed surfaces on the camera retrieved from Surveyor 3 were at least partially covered with a layer of lunar dust.[16] The dust distribution on the hardware indicated that the lunar dust was disturbed and implanted both upon the initial landing of Surveyor 3 and the landing of the Apollo 12 Lunar Module.[17] More significantly, the "Surveyor's surface facing the Apollo [Lunar Module] had been sandblasted thoroughly, with more than 1 cm2 of impacting dust per 1 cm2 of target surface."[18] Dust even reached Surveyor's mirror which, it was determined by examining trajectories, "must have occurred while the [Lunar Module] was about 300 m or more from it landing site."[19] Thus, it was definitively established that the approach of the Lunar Module contributed additional material to the surface of the spacecraft.[20]

In addition to the lunar dust layers on exposed surfaces, the Surveyor 3 camera's exterior surface seemed to be fading and had a series of shadows that did not correspond to solar illumination.[21] An examination of the metal surfaces from the camera provided a direct indication that lunar dust was responsible for a major part of the observed discoloration.[22] Ultimately, the transport of lunar dust induced by landings – which we will refer to as "lunar ejecta" or

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[14] *Id.*

[15] N.L. Nickel & W.F. Carroll, *Summary and Conclusions*, *in* Analysis of Surveyor 3 Material and Photographs Returned by Apollo 12, 9 NASA SP-284 (1972).

[16] *Id.*

[17] *Id.* at 10.

[18] P.T. Metzger et. al., Dust Transport and its Effects Due to Landing Spacecraft (forthcoming presentation at Workshop on the Impact of Lunar Dust on Human Exploration (Feb. 11-13, 2020)) (on file with author).

[19] W.F. Carroll & P.M. Blair, Jr., *Spacecraft Changes, Part A. Lunar Dust and Radiation Darkening of Surveyor 3 Surfaces*, *in* Analysis of Surveyor 3 Material and Photographs Returned by Apollo 12, 28 NASA SP-284 (1972).

[20] *Id.*

[21] *Id.* at 24.

[22] *Id.* at 26.

"plume ejecta" – and the effects of such dust on hardware was concluded to provide significant constraints on future lunar operations.[23] In other words, every time a spacecraft lands on the Moon it has the potential to cause severe damage to any objects already on the Moon – or, as will be shown below, to objects orbit around the Moon.

This article argues that nations engaging in – or whose nationals are engaging in – activities on the Moon have a legal obligation to mitigate the potentially devastating effects of lunar ejecta. It further argues that the most expeditious, beneficial and efficient way to mitigate this risk is to design and construct common landing pads on the Moon using in situ resources. These landing pads should be a product of international collaboration, established in internationally agreed locations that afford requisite access to areas of the Moon significant for further exploration, analysis, or resource development. In support of these arguments, Part II provides an introduction to the challenges posed by lunar landing ejecta and summarily describes the detrimental effects on objects on the Moon including both operational hardware and material of historic significance. Part III reviews legal obligations and responsibilities under general international law as set forth in the Outer Space Treaty, the Liability Convention and other relevant instruments. This Part concludes with the argument that working together to mitigate the potential damage caused by lunar ejecta is a legal, economic and moral imperative. Part IV suggests the best solution is for States and private entities to work together to develop and construct shared lunar landing pads. Ultimately, this article concludes that the establishment of a common landing pad regime is a vital first step in obtaining the level of international agreement and cooperation that will be needed to assure the long-term success and sustainability of all space activity.

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[23] Nickel & Carroll, *supra* note 15, at 20-21.

II. THE PROBLEM: "ONE OF THE MOST AGGRAVATING, RESTRICTING FACETS OF THE LUNAR SURFACE"[24]

A. Lunar Regolith

> One of the surprises of the Apollo experience was how troublesome the lunar dust turned out to be. It obscured their vision on landing, clogged mechanisms, abraded the Extravehicular Mobility Suits (EMS), scratched the instrument covers, degraded the performance of radiators, compromised seals, irritated their eyes and lungs, and generally coated everything with surprising tenacity.[25]

Lunar dust can be characterized as regolith: the "layer of unconsolidated rocks, pebbles, and dust" that exists on the "primordial lunar bedrock." [26] It is estimated that "the entire lunar surface is regolith to a depth of at least several meters."[27] Lunar regolith in particular results from "meteoroid bombardment."[28] As a result, lunar regolith particles are sharp and angular in nature, resulting in a much more abrasive material than their terrestrial counterparts.[29]

Not only is lunar regolith abrasive, it is also adhesive,[30] both mechanically and electrostatically.[31] Mechanical adhesion occurs because of the barbed shapes of the grains of dust.[32] Electrostatic adhesion is caused by the charging of objects by various sources, such as solar wind plasma and photoionization.[33]

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[24] Eugene Cernan, *Apollo 17 Technical Crew Debriefing* 27-27 (Jan. 4, 1973), http://an.rsl.wustl.edu/apollo/data/A17/resources/a17-techdebrief.pdf

[25] James R. Gaier, *The Effects of Lunar Dust on EVA Systems During the Apollo Missions*, NASA/TM-2005-213610 1 (Mar. 2005), https://history.nasa.gov/alsj/TM-2005-213610.pdf.

[26] J. E. Colwell et al., *Lunar Surface: Dust Dynamics and Regolith Mechanics*, 45 REV. OF GEOPHYSICS 1 (2007).

[27] *Id.*

[28] *Id. See also* David McKay et al., *The Lunar Regolith*, *in* THE LUNAR SOURCEBOOK 287, 307 (1991).

[29] Colwell, *supra* note 26, at 4.

[30] *See* Otis R. Walton, *Adhesion of Lunar Dust*, NASA/CR-2007-214685 (Apr. 2007), https://ntrs.nasa.gov/archive/nasa/casi.ntrs.nasa.gov/20070020448.pdf.

[31] Timothy J. Subbs et al., *Impact of Dust on Lunar Exploration*, ESA-SP 643 240 (Jan. 2007).

[32] *Id.*

[33] *Id.*

The experience of the Apollo astronauts illustrates the frustrating, and potentially dangerous, effect of the lunar dust on human activity:

> Problems were experienced during Lunar Roving Vehicle (LRV) excursions, with much dust being kicked-up and covering exposed areas . . . leading to increased friction at mechanical surfaces. The resulting abrasive effect of dust increased wear and tear, which significantly limited the lifetime of surface equipment.[34]

Dust coating is a precursor to myriad other problems, which have been sorted into nine main categories by James Gaier. These are: "vision obscuration, false instrument readings, dust coating and contamination, loss of traction, clogging of mechanisms, abrasion, thermal control problems, seal failures, and inhalation and irritation."[35] During Apollo 12, the landing velocity trackers gave false readings when they locked onto moving dust and debris during descent.[36] All environmental sample and gas sample seals failed due to dust, and by "the time they reached Earth the samples were so contaminated as to be worthless."[37] There were reports of equipment being clogged and mechanisms jammed in every Apollo mission.[38]

Apollo 17 commander Gene Cernan remarked that "dust is probably one of our greatest inhibitors to a normal operation on the moon."[39] In his view:

> One of the most aggravating, restricting facets of lunar surface exploration is the dust and its adherence to everything no matter what kind of material, whether it be skin, suit material, metal, no matter what it be and its restrictive friction-like action to everything it gets on . . . For instance . . . By the middle or end of the third EVA, simple things like bag locks and the

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[34] *Id.* Apollo 12 astronauts also observed that regolith was very hard to rub off. Al Bean et al., *Crew Observations*, *in* Apollo 12 Preliminary Science Report, NASA SP-235 36 (1970).

[35] Gaier, *supra* note 25, at 2.

[36] *Id.* at 4.

[37] *Id.* at 6.

[38] *Id.* at 5.

[39] Cernan, *supra* note 24, at 20-12.

> lock which held the pallet on the Rover began not only to malfunction but to not function at all.[40] (internal citations omitted).

B. The Plume Effect

i. Generally

As Gaier notes, "[i]n order for the dust to cause problems, it must be transferred" or transported to the surface in question.[41] This transfer can occur naturally – from, for example, a meteor or micrometeor collision with the lunar surface – or anthropogenically – that is, as a result of human activity.[42] Gaier analyzed three anthropogenic mechanisms: "astronaut walking, rover wheels spinning up dust, and landing and take-off of spacecraft."[43] He determined that "[b]y far the most dust is transported by the landing and take-off of spacecraft."[44]

The interaction of exhaust plumes with loose regolith material was first studied in anticipation of the Apollo crewed lunar landing missions. "NASA investigated the blowing of lunar soil by rocket exhaust plumes in order to ensure safe landings for the Lunar Modules."[45] Of course much was learned after the Apollo landings themselves. The "lack of visible craters under the landed spacecraft . . . [indicates that] a high velocity flow of dust, sand, and possible small gravel moves beneath the standoff shockwave of the plume in a nearly horizontal direction."[46] Put more simply, the rocket exhaust from any lander will blow a significant amount of soil and dust particles in a horizontal sheet along the surface away from the lander, creating significant impacts to the surrounding areas.[47] This expulsion of ejecta is also known as the plume effect, a phenomenon that will occur on Mars as well.[48]

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[40] *Id.* at 27-27, 27-28.

[41] Gaier, *supra* note 25, at 2.

[42] *Id.* The natural mechanisms are not expected to transfer significant amounts of dust as a general matter.

[43] *Id.*

[44] *Id.*

[45] Philip T. Metzger et al., *ISRU Implications for Lunar and Martian Plume Effects*, *in* AM. INST. OF AERONAUTICS & ASTRONAUTICS 4 (Jan. 2009).

[46] *Id.*

[47] *See id.*

[48] *Id.* at 6.

Paul J. van Susante and Philip T. Metzger, writing in the journal *Earth and Space* in 2009, described the effects of space-craft landings:

> During the final moments of lunar landings, the rocket exhaust forms a region of pressurized stagnant gas on the soil beneath the engine nozzle. The gas accelerates horizontally away from the centerline and becomes supersonic, lifting and ejecting an abrasive fine dust spray at upwards of 1000 m/s or faster along with rocks that accelerate to 10 m/s or higher . . . .[49]

After further study, researchers in 2011 determined that particles "can achieve ejection velocities between 300 and 2000 meters per second with the smaller particles generally traveling faster."[50] Building on this work, studies now show that the "finest dust particles can be accelerated up to exit velocity of the rocket propellant, which is 3.1 km/s for the [Lunar Module's] Aerozine/N2O propellants."[51] Since the lunar atmosphere is negligible, "the particles continue at that velocity until striking the lunar surface far away."[52] Indeed, it is hypothesized that some particles will "travel almost all the way around the Moon before impact."[53] Notably, "[l]arger particles generally go slower with sand-size particles travelling 100-1000 m/s, gravel ~30 m/s, and fist-sized cobbles ~10 m/s."[54] No matter where a vehicle lands on the Moon, it will produce ejected particles of varying sizes "that will impact at that distance."[55]

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[49] Paul J. van Susante & Philip T. Metzger, *Design, Test, and Simulation of Lunar and Mars Landing Pad Soil Stabilization Built with In Situ Rock Utilization*, EARTH &SPACE 642, 642 (Apr. 2016) (internal citations omitted).

[50] NASA, *NASA's Recommendations to Space-Faring Entities: How to Protect and Preserve the Historic and Scientific Value of U.S. Government Lunar Artifacts* 12 (Jul. 2011), https://www.nasa.gov/sites/default/files/617743main_NASA-USG_LUNAR_HISTORIC_SITES_RevA-508.pdf [hereinafter NASA Guidelines].

[51] Metzger et al., *supra* note 18.

[52] NASA Guidelines, *supra* note 50, at 12.

[53] *Id.*

[54] Metzger et al., *supra* not 18.

[55] NASA Guidelines, *supra* note 50, at 14.

ii. Consequences

The plume effect results in a number of significant consequences. As an initial matter, the plume ejecta can dangerously obstruct visibility in all directions when a vehicle is landing. Astronaut Pete Conrad reported that when the Lunar Module was at 300 feet, they "picked up a tremendous amount of dust . . . [which] went as far as [Conrad] could see in any direction and completely obliterated craters and anything else."[56] In fact, the dust was so invidious, Conrad could not tell what was underneath the Lunar Module' moreover, he could "obtain absolutely no attitude reference by looking at the horizon . . . ."[57]

The spray of the abrasive and adhesive regolith as a result of the plume effect can also damage the landing vehicle itself, as well as any surrounding hardware on the Moon.[58] For example, as noted in Part I, the surface of Surveyor 3 suffered hundreds of pits, or micro-craters, from the impact of high-velocity lunar particles produced by the landing of the Apollo 12 Lunar Module.[59] The spacecraft had pinholes where sand grains penetrated the paint and cracks that radiated away from the pinholes.[60] Notably, Surveyor 3 was not exposed to the direct spray of the Lunar Module, but instead experienced only the "fringes of the spray" because it was in a crater which kept it below the main spray. [61] Had Surveyor 3 been exposed to the direct spray, "it would have sustained several orders of magnitude greater surface damage, including dust implantation, scouring, pitting, cracking, and microscopic crushing of the surface materials."[62] The damage would also have been far greater if it had been struck by gravel or rocks, rather than smaller dust and soil

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[56] Peter Conrad, *Apollo 12 Technical Crew Debriefing* 9-11 (Dec. 1, 1969), https://www.hq.nasa.gov/alsj/a12/a12tecdbrf.html.

[57] *Id.* at 9-11, 9-12.

[58] Metzger et al., *supra* note 45, at 5.

[59] *See* B. G. Cour-Palais, *Part E. Results of Examination of the Returned Surveyor 3 Samples for Particulate Impacts*, *in* Analysis of Surveyor 3 Material and Photographs Returned by Apollo 12, NASA SP-284 (1972).

[60] *The Science of Plume Effects,* CTR. FOR LUNAR & ASTEROID SURFACE SCI., https://sciences.ucf.edu/class/landing-team/the-science-of-plume-effects/ (last visited Feb. 3, 2020).

[61] Christopher Immer et al., *Apollo 12 Lunar Module Exhaust Plume Impingement on Lunar Surveyor III*, 211 ICARUS 2, 1089, 1101 (Feb. 2011).

[62] NASA Guidelines, *supra* note 50, at 13.

particles.[63] Ultimately, what is clear is the recorded damage to Surveyor 3 "under-represents the degree of damage that could have occurred from [a Lunar Module-sized] vehicle's plume at that distance."[64] And indeed, "[e]xtrapolating to larger landers, simulations show that ejecta velocities increase logarithmically with vehicle mass so a 40 [ton] lander ejects material general 50% faster than a 5 [ton] lander."[65] For frame of reference, the Apollo lunar modules landing mass was five tons. Future landers are estimated to be 20 to 40 tons.[66]

The type of degree of damage forecasted will be catastrophic for functional hardware on the Moon. "The scouring effects of the spray may ruin surface coatings, reflective blankets, and optics, and the injection of dust into mechanical joints may cause increased friction, jamming and mechanical wear."[67] It will also have a devastating impact on objects of historic and cultural significance on the Moon.

The risks extend further than the lunar surface. "The smallest, dust-sized particles achieve near-lunar escape velocity, 2.37 [kilometers per second], and even exceed it by a significant margin, sending them into solar orbit. . . ."[68] Simulations have demonstrated that the ejected material from the Apollo landings was blown into ballistic trajectories that passed through the orbital altitudes of the Apollo command module.[69] This modeling suggests that ejected material can even reach the orbit of – and sandblast—the proposed Lunar Gateway.[70] In short, the potential for damage to the space vehicle itself, surface objects within a very wide radius and orbiting equipment cannot be ignored.

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[63] *Id.*

[64] *Id.*

[65] Metzger et al., *supra* note 18.

[66] *Id.*

[67] Metzger et al., *supra* note 45, at 5. In fact, "[r]ecent experiments blowing simulate lunar soil at spacecraft materials has shown that even at much slower velocities the abrasiveness of the particulates causes unacceptable damage." *Id.* (internal citations omitted).

[68] NASA Guidelines, *supra* note 50, at 13.

[69] Philip T. Metzger et al., *Cratering and Blowing Soil by Rocket Engines During Lunar Landings*, 6th Int'l Conf. on Case Histories in Geotechnical Engineering, Missouri University of Science and Tech. Scholars' Mine, Paper No. 10.01, 8 (2008).

[70] *Id. See also* Robert P. Mueller et al., *Launch and Landing Infrastructure on the Moon*, *in* THE SPACE CONGRESS PROC. (Dec. 2012).

In the upcoming years, there will be an increased level of lunar activity as plans for lunar resource extraction and even human communities on the Moon continue to grow more realistic.[71] These increasingly ambitious plans will require larger and more powerful lunar landers which will blow larger particles – including rocks – at even higher velocities than indicated by the Surveyor 3 studies.[72] In fact, it has even been suggested that aside from the particle ejecta, exhaust gases are

> . . . a phenomenon of concern. The Moon does not possess an atmosphere but rather an exosphere composed of particles that seldom collide. Its total mass is estimated at approximately 25mT but each Apollo mission is estimated to have added nearly 10 mT of gases to the lunar exosphere from engine exhaust alone, raising concerns about the long-lasting effects that vigorous lunar activity might have on the lunar exosphere or the creation of a long-lasting lunar atmosphere. A lunar atmosphere would disrupt scientific objectives and special industrial processes that demand the unique high-vacuum lunar surface environment. (citations omitted)[73]

C. Responses

The plume effect and its associated challenges have not been ignored by scientists. Numerous papers have been written about

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[71] *See* Mike Wall, *50 Years After Apollo 11, A New Moon Rush Is Coming,* SPACE.COM (Jul. 22, 2019), https://www.space.com/moon-exploration-plans-nasa-india-china-and-more.html, Robin McKie, *Everyone's Going Back to the Moon. But Why?,* THE OBSERVER, (Jul. 6, 2019), https://www.theguardian.com/science/2019/jul/06/everyones-going-to-the-moon-again-apollo-11-50th-aniversary.

[72] Tarik Malik, *Boeing Just Sent NASA Its Moon Lander Idea for Artemis Astronauts. Here It Is,* SPACE.COM, (Nov. 6, 2019), https://www.space.com/boeing-human-moon-lander-concept-nasa-artemis.html. According to Metzger, the landing mass of the Apollo Lunar Modules was 5 tons. Current models suggest that the landing mass of the Artemis vehicle will be 40 tons. Thus, where the ejected mass related to the Apollo missions was estimated to be 2.6 tons, ejected mass related to future vehicles could be as much as 470 tons. Philip Metzger, et. al., *Constructing Landing Pads from Lunar Materials,* presented at "What Next for Space Resource Utilisation?" Luxembourg (Oct. 11, 2019).

[73] Jeffrey Montes, et al., *Pad for Humanity: Lunar Space as Critical Shared Infrastructure,* PROC. OF THE 17TH INT'L CONF. ON ENG'G, SCI., CONSTR. & OPERATIONS IN CHALLENGING ENV'TS (forthcoming 2020) (on file with author Hanlon).

the effects of both regolith and the plume effect.[74] Further, the Center for Lunar & Asteroid Surface Science, headed by Dr. Daniel Britt at the University of Central Florida, boasts an entire team devoted to the study of planetary landing plume effects.[75]

Despite continuous scientific study of the plume effect after its discovery in 1972, it was not until 2010 that any formal steps were taken to address the potentially catastrophic effects lunar ejecta could have on objects on the Moon's surface. Even then, the actions taken were only a reaction to a private global competition. In 2007, the XPRIZE Foundation and Google LLC sponsored the GLXP Competition, offering a reward of $30 million USD to the first non-governmental team "to land a craft on the Moon, have it travel 500 metres [sic], and then send back high definition images."[76] The GLXP competition also included at least two "heritage" prizes:

The $4 million [USD] Apollo Heritage Bonus Prize is for the first team that takes imagery and video of an Apollo site and of a historical artifact associated with the Apollo mission. The $1 million [USD] Heritage Bonus Prize is for the first team that take imagery and video of a historical site of interest including footage of an artifact associated with a previous mission to the Moon other than the Apollo missions.[77]

As former GLXP judge Derek Weber observed, the sites "would certainly be an attractive target for hi-definition imagery. And once lunar surface tourism begins, it would seem highly probable that the lunar legacy sites, Apollo and others, would represent the 'must-see' destinations of a trip to the Moon."[78] Thus, not only would an initial trip to these venerable sites be likely, we must be prepared for repeat visits from tourists.

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[74] *See e.g.* Metzger et al., *supra* note 18, Gaier, *supra* note 25, Collwell, *supra* note 26, Walton, *supra* note 30, Stubbs, et al., *supra* note 31, Metzger et al., *supra* note 45, van Susante, *supra* note 49.

[75] , *Background*, CTR. FOR LUNAR & ASTEROID SURFACE SCI. https://sciences.ucf.edu/class/landing-team/background/ (last visited Jan. 12, 2020).

[76] Derek Webber, *Protecting Our Lunar Legacy,* ROOM SPACE JOURNAL 106 (Mar. 2019), https://www.forallmoonkind.org/wp-content/uploads/2019/05/098_Webber_lunarlegacy_mar19_DES.pdf.

[77] LUCIAN KAY, TECHNOLOGICAL INNOVATION AND PRIZE INCENTIVES: THE GOOGLE LUNAR X PRIZE AND OTHER AEROSPACE COMPETITIONS 78 (2012); *see also* Webber, *supra* note 76, at 106.

[78] Webber, *supra* note 76, at 106.

Even with only a cursory understanding of the destructive potential of the lunar plume effect, it is not difficult to contemplate the damage that these heritage sites would sustain if a spacecraft landed too close. Some of these sites support ongoing scientific experiments.[79] All of them "represent a cultural resource that preserves elements of life on Earth at the beginning of the Space Age."[80] Damage similar to the "sand-blasting" suffered by Surveyor 3 would not only be irreparable, it would be an incomprehensible assault on otherwise pristine records of humanity's first activities on the Moon.

Primarily in response to queries from certain of the GLXP contestants, in 2010 NASA organized a team solely to address questions regarding the protection of historic sites on the Moon.[81] The team developed and released its report, "NASA's Recommendations to Space-Faring Entities: How to Protect and Preserve the Historic and Scientific Value of U.S. Government Lunar Artifacts" (NASA Guidelines), in July 2011. [82]

The NASA Guidelines recommend the implementation of a two kilometer "exclusion radius" around significant lunar heritage sites. Essentially, per the NASA Guidelines, no vehicle should overfly or attempt to land on the Moon within a two-kilometer radius of any so-called United States Government heritage lander, defined to include the Apollo and Surveyor lunar landing sites.[83] To date, the NASA Guidelines are the only directives that attempt to address the destructive potential of the plume effect in a lunar environment that is about to become much busier.

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[79] Elizabeth Howell, *Why is the Apollo Reflector Experiment Still Operating, 50 Years Later?* SPACE.COM (Jul. 11, 2019), https://www.space.com/apollo-retroreflector-experiment-still-going-50-years-later.html. The crews of Apollo 11, 14 and 15 placed special retroreflectors on the lunar surface which are used to measure the distance between the Earth and the Moon. The reflectors do not require any power and continue to operate. *Id.*

[80] Webber, *supra* note 76, at 107.

[81] White House Office of Science and Technology Policy, *Protecting & Preserving Apollo Lunar Program Lunar Landing Sites & Artifacts*, EXEC. OFF. OF THE PRESIDENT 2 (Mar. 2018).

[82] NASA Guidelines, *supra* note 50. The NASA Guidelines were updated in October 2011 to include imagery from the Apollo missions.

[83] *Id.* at 7.

It is not difficult to argue that, as important as they are, the NASA Guidelines remain woefully inadequate. First, they are written assuming a one ton or smaller lander – the size being proposed by the GLXP contestants – hence they require only a two kilometer landing distance which is likely to be far too small to prevent mission-critical damage from the plume effect caused by much larger landers.[84] Second, they pertain only to a set of United States-owned objects which NASA considers to be artifacts;[85] they do not address heritage or operative objects from other nations. Third, they are not intended to be static, indeed, the authors assumed that the Guidelines would be a "living document" that would continue to evolve over time[86] – yet no changes have been made since 2011. Finally, the NASA Guidelines have no legal authority. They are nonbinding technical recommendations that are not enforceable against US entities and certainly do not purport to have any authority over other national space agencies or commercial entities.[87]

Efforts are being made in the US to strengthen the impact of the NASA Guidelines. The One Small Step to Protect Human Heritage in Space Act, which was passed unanimously by the US Senate in July 2019, requires any entity seeking a US license to conduct activity on the Moon to agree to abide by the NASA Guidelines.[88] It

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[84] E-mail from Philip Metzger, Univ. of Cent. Fla., to Authors (Jan. 26, 2020, 16:36 CST) (on file with author Hanlon).

[85] NASA Guidelines, *supra* note 50, at 5. The Guidelines itemize the artifacts as follows:

> A. Apollo lunar surface landing and roving hardware;
> B. Unmanned lunar surface landing sites (e.g., Surveyor sites);
> C. Impact sites (e.g., Ranger, S-IVB, LCROSS, lunar module [LM] ascent stage);
> D. USG experiments left on the lunar surface, tools, equipment, miscellaneous EVA hardware; and
> E. Specific indicators of U.S. human, human-robotic lunar presence, including footprints, rover tracks, etc., although not all anthropogenic indicators are protected as identified in the recommendations.

Id.

[86] *See* Philip Metzger, Protecting Apollo Sites, CTR. FOR LUNAR & ASTEROID SURFACE SCI., https://sciences.ucf.edu/class/landing-team/protecting-the-apollo-sites/ (last visited Jan. 20, 2020); *see* NASA Guidelines, *supra* note 50, at 6.

[87] NASA Guidelines, *supra* note 50, at 6.

[88] The One Small Step to Protect Human Heritage in Space Act, S. 1694, 116th Cong. § 3 (2019). Author Hanlon worked with the office of Senator Gary Peters on the development and language of this legislation.

remains to be seen if it will be enacted into law.[89] Even if it does, this legislation also falls far short of the types of protections that need to be instituted in order to assure that equipment, whether operational or considered an artifact, is protected from the destructive plume effect produced by future lunar landings. The One Small Step Act is a US national law that will have no bearing on non-US entities. While the NASA Guidelines indicate that "NASA has begun engaging in dialogue with [non-US] space agencies,"[90] bilateral arrangements are both inadequate and shortsighted. The plume effect knows no boundaries and the best, perhaps the only, way to manage and mitigate damage is to work multilaterally to develop not just a common understanding, but a common solution. Not only is this the common sense approach, it is one all but dictated by law. The failure by any landing entity to counter the potential damage posed by lunar ejecta will amount to a violation of international law and result in significant liability for the nation responsible. This is a liability that can and should be avoided.

III. THE IMPERATIVES: LEGAL, ECONOMIC AND MORAL

A. International Law

Space activities – like landing on the Moon – are not strictly supervised or otherwise regulated. The treaty regime governing outer space activities, a set of five agreements negotiated in the 1960s and 1970s, are for the most part aspirational. They are founded on three principal themes: a recognition that space must belong to all humankind, a belief that exploration must occur on the basis of freedom and equality and an admonition that space must be used for "peaceful purposes."[91] However, this freedom is not absolute. Accompanying these strictures is the understanding that

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[89] As of this writing, the companion bill, H.R. 3766 is awaiting passage in the House of Representatives. Once the House votes, the bill will be sent to the President for signature whose approval is required before the legislation becomes law. *See The Legislative Process*, U.S. HOUSE OF REPRESENTATIVES, https://www.house.gov/the-house-explained/the-legislative-process (last visited Jan. 13, 2020).

[90] NASA Guidelines, *supra* note 50, at 5.

[91] *See* 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, IV, Jan. 27, 1967, 18 U.S.T. 2410, 610 U.N.T.S. 205 [hereinafter Outer Space Treaty].

States conducting activities in space remain responsible for the objects they launch into space, especially if those objects cause harm to others.[92]

Of course, the space law treaties were not negotiated in a vacuum. Space law is "derived from" and can be viewed as a subset of international law.[93] And indeed, the Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, Including the Moon and Other Celestial Bodies[94] (OST) itself is clear that space activities shall be carried on "in accordance with international law."[95] Thus, the concept of responsibility and liability for activities in space is rooted in general international law, pursuant to which "[e]very internationally wrongful act of a State entails the international responsibility of that State."[96] An "internationally wrongful act" occurs when a State breaches "an international obligation."[97] And actions of private individuals or entities can be attributed to the State when the actions should have been subject to the State's exercise of authority.[98] This point is important as the OST, as its full name suggests, governs only the activities of States, and not private entities. Nevertheless, against this backdrop, the OST offers further elucidation of responsibility and liability related specifically to space activities of both States and their nationals.

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[92] *Id.* arts. VI & VII.

[93] Frans von der Dunk, *Liability Versus Responsibility in Space Law: Misconception of Misconstruction?* UNIV. NEB. COLL. OF L. SPACE, CYBER & TELECOM. L. PROGRAM FACULTY PUBS. 363 (1992).

[94] The Outer Space Treaty has been ratified 107 nations, including all current spacefaring nations. As such, this article focuses on the attachment of liability and responsibility as refined by the Treaty rather than simply the application of general international law. *See* Comm. On the peaceful Uses of Outer Space, Legal Subcomm., *Status of International Agreements Relating to Activities in Outer Space as at 1 January 2019,* 58th Sess., U.N. Doc. A/AC.105/C.2/2019/CRP.3 (Apr. 1, 2019).

[95] Outer Space Treaty, *supra* note 91, art. III.

[96] , G.A. Res. 56/83, annex, art. 1, Draft Articles on Responsibility of States for Internationally Wrongful Acts, U.N. Doc. A/RES/56/83/Annex (Jan. 28, 2002) [hereinafter Draft Articles on Responsibility].

[97] *Id.* art. 2.

[98] *Id.* art. 9. *See also* von der Dunk, *supra* note 93, at 364 ("[A] [S]tate can incur responsibility in case of private acts taking place on its territory or being perpetrated by its nations, and amounting to violations of international obligations, *if* the [S]tate could reasonably have prevented such acts." (emphasis in original) (internal citations omitted)).

B. Article VI of the Outer Space Treaty: Responsibility

Article VI of the OST is very clear that State Parties "bear international responsibility for national activities in space, including the moon and other celestial bodies, whether such activities are carried on by governmental agencies or by non-governmental entities . . . ."[99] Bin Cheng points out that this language gives rise to four specific responsibilities that each State Party to the OST assumes. First, "State activities in outer space [must] comply with" the terms and conditions of the OST.[100] Second, the State has a "[d]uty to assure that non-governmental national space activities comply with the Treaty."[101] Third, the State also has a duty "to subject non-governmental space activities to authorization and continuing supervision."[102] Finally, the State assumes direct "responsibility for non-governmental space activities."[103] The emphasis on non-governmental activities is key. A State not only bears responsibility for the

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[99] Draft Articles on Responsibility, *supra* note 96, art VI.

[100] Bin Cheng, *Article VI of the 1967 Space Treaty Revisited: "International Responsibility," "National Activities," and "The Appropriate State"*, 26 J. SPACE L. 7, 13 (1998).

[101] *Id.*

[102] *Id.*

[103] *Id.* at 14. Some scholars, including Laura Montgomery, argue that Article VI does not require the assumption of responsibility by the State for non-governmental activities.

> If Article VI truly meant that all activities had to be overseen, where would oversight stop? Life is full of activities, from brushing one's teeth to playing a musical instrument, which take place now without either federal authorization or continuing federal supervision. Just because those activities take place in outer space does not mean they should suddenly require oversight.

Regulating Space: Innovation, Liberty, and International Obligations Before the H. Comm. on Sci., Space, and Tech., 115th Cong. (2017) (testimony of Laura Montgomery), *available at* https://docs.house.gov/meetings/SY/SY16/20170308/105659/HHRG-115-SY16-Wstate-MontgomeryL-20170308.pdf. (However, this stance openly contradicts the plain language of the OST. Article VI makes it quite clear that all State Parties "bear international responsibility for national activities in outer space . . . whether such activities are carried on by government agencies or by non-governmental agencies." Moreover, Article VI requires unequivocally that "the activities of non-governmental entities in outer space, . . . shall require authorization and continuing supervision by the appropriate State Party to the Treaty." Outer Space Treaty, *supra* note 91, art. VI; *see also* Cheng, *supra* note 100, at 14. Ultimately, Montgomery's argument misses the point as it is in the best interest of each State Party to continue close supervision of their non-governmental national activities because the "international responsibility" that the State party bears in respect of its nationals pursuant to Article VII of the Outer Space Treaty, considered *infra,* can be onerous indeed.

acts of its nationals, it has an obligation to assure their nationals abide by the terms and conditions of the OST and a duty to properly authorize and supervise any activities by private actors that would fall under the OST.

C. Article VII – Launching State Liability

On top of the international responsibility imposed by Article VI, the Outer Space Treaty imposes, pursuant to Article VII, direct liability on each State Party "that launches or procures the launching of an object into outer space . . . and from whose territory or facility an object is launched, is internationally liable for damage to another State Party."[104] Taken in conjunction with Article VI, this provision makes the State Party liable for damages caused by any and every object it, or its nationals, launch into space – including objects that hard- or soft-land on the Moon. Furthermore, the State Party is responsible, and liable, if the object is simply launched from its facility or territory, even if it has no other connection with the space object. This is a broad burden which starkly emphasized the depth of the responsibility the State Parties expect each other to shoulder with respect to activities in space. If a State Party simply permits its territory to be used for launch, it has culpability in respect of the object launched, period.[105]

This burdensome responsibility is reinforced by the Convention on International Liability for Damage Caused by Space Objects[106] (Liability Convention) which states that the "launching State" is liable for damage caused by its space object. Liability is absolute if damage occurs on Earth or to aircraft in flight, but is fault-based if damage occurs elsewhere.[107] The definition of "launching State" parallels the OST and includes the "State which launches or procures the launching of a space object; . . . [and the] State from whose territory or facility a space object is launched."[108]

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[104] Outer Space Treaty, *supra* note 91, art. VII.

[105] Given this provision, whether Article VI imposes a requirement for State Parties to regulate private activities in space conducted by their nationals is a futile inquiry. The State Party will be liable and it is thus in the best interest of the State Party to properly and responsibly authorize and supervise any private national activity in space.

[106] Convention on the International Liability for Damage Caused by Space Objects, Mar. 29, 1972, 24 U.S.T. 2389, 961 U.N.T.S. 187 [hereinafter Liability Convention].

[107] *Id.* arts. II, III.

[108] *Id.* art. I(c).

While the term "space object" is not defined, extrapolating from the plain language of Article VI of the OST, it must mean any object that is launched into outer space.

Article VIII of the OST requires a "registry" to be maintained by each State Party and indicates, as a logical companion to the burden of liability, that the State "shall retain jurisdiction and control over such object while in outer space."[109] This registration process is further detailed in the Convention on the Registration of Objects Launched into Outer Space.[110] Further underscoring the duty of States with respect to their activities in space, the Registration Convention opens with a preamble that reminds States that they "bear international responsibility for their national activities in outer space."[111]

In sum, applying both Articles VI and VII of the OST, a State Party is responsible, or could be held responsible, for any damage caused by lunar ejecta created by a spacecraft landing on the Moon if the spacecraft is:

- Its own object.
- An object owned by its national.
- An object constructed by its national.
- An object operated by its national.
- An object carrying its payload.
- An object carrying the payload of its national.
- Any object for which it may be considered a launching State, that is
    - an object that was launched from its territory
    - an object that was launched from its facility
    - an object who launch was procured by it or its national
    - an object that it or its national launched.

In short, the permutations and implications for liability are manifold should a lunar lander cause damage to any *in situ* object.

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[109] Outer Space Treaty, *supra* note 91, art. VIII.

[110] Convention on the Registration of Objects Launched into Outer Space, Jan. 14, 1975, 28 U.S.T. 695, 1023 U.N.T.S. 15 [hereinafter Registration Convention].

[111] *Id.* Preamble. Note that this reiteration uses the term "their national activities" rather than simply "its activities," which again emphasizes the fact that a State is responsible for its nationals.

D. International Obligations Imposed by the OST

Based on the foregoing discussion, liability clearly attaches under Article VII. However, the OST contains at least three other relevant legal obligations, breach of which could also give rise to liability. These are encapsulated in Article IX, which indicates, in pertinent part, that State Parties . . . shall: 1) "conduct all their activities in outer space including the Moon and other celestial bodies, with due regard to the corresponding interests of all other States"; 2) "conduct exploration of them so as to avoid their harmful contamination"; and 3) refrain from activities which "would cause potentially harmful interference with activities of other States." [112] Thus, a State whose equipment is damaged as a result of plume ejecta generated by the landing of another State's spacecraft on the lunar surface potentially has recourse against:

- the entity whose spacecraft caused the damage, whether a State or a private entity;
- the State or States where the private entity or entities claim nationality as part of the international responsibility of that State pursuant to Article VI;
- the State or States where the private entity or entities are nationals for failure to assure that the national activities were carried out in conformity with the OST as required by Article VI;
- the State or States where the private entity or entities are nationals for failure to adequately authorize and supervise that entity as required by Article VI;
- the launching States pursuant to Article VII;
- the State or States where the private entity or entities are nationals for failure to act with due regard to the corresponding interests of all other States; and
- the State or States where the private entity or entities are nationals for failure to avoid the harmful contamination of the Moon.

Liability arises under Article VII of the OST, and under customary international law, wherein it is generally recognized that an illegal act, or the breach of an international obligation will give

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[112] Outer Space Treaty, *supra* note 91, art. IX.

rise to a responsibility to repair, or make a reparation.[113] That said, liability is not necessarily absolute. The victim of damage from plume ejecta related to a particular landing will have to show either that the damage occurred as a result of the fault of the accused perpetrator, or that an international legal obligation has been breached.

i. Fault

The Liability Convention imposes liability on a broad swath of potential defendants who may be considered a launching State. However, the term "fault" is not defined in any of the space treaties, nor has their arisen an opportunity for a court to determine its meaning within the scope of space activities. Turning to international law, Joel Dennerley suggests that the "principle obligation on [S]tates with a fault standard is arguably due diligence."[114]

Dennerley explains that "[d]ue diligence is a duty of conduct, not of result, meaning that the obligation incumbent on [S]tates is to use their best efforts to try to prevent damage or harm occurring to other [S]tates."[115] The duty extends to "cover elements under a [S]tate's jurisdiction and control that it has power over or has the capacity to influence."[116] In the context of damage as a result of lunar ejecta, it can be easily argued by the victim State – whether on its own behalf or on behalf of its national – that "best efforts" requires launching States to understand the environment into which their spacecraft are being deployed and to mitigate risks associated with landing on the loose regolith of the lunar surface. As a result, such States would likely be considered at "fault" for the damage caused. It is conceded that this is a theoretical argument and many different approaches may be taken in regard to the understanding of "fault." Nevertheless, the uncertainty in and of itself should be

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[113] Chorzów Factory Case (Ger. v. Pol.), Merits), 1928 P.C.I.J., (Ser. A) No. 17, at 47 (Sept. 13).

[114] Joel A. Dennerley, *State Liability for Space Object Collisions: The Proper Interpretation of 'Fault' for the Purposes of International Space Law,* 20 EUR. J. OF INT'L L. 281, 293 (2018).

[115] *Id.* at 294.

[116] *Id.* (citing Case Concerning Application of the Convention on the Prevention and Punishment of the Crime of Genocide (Bos. & Herz. v. Serb. & Montenegro), Judgment, 2007 I.C.J. Rep. 43, ¶ 430 (Feb. 26)).

enough to make States consider carefully their international obligations in respect of lunar landings.

ii. Due Regard

Article IX of the OST imposes an obligation on States to conduct activities in space, including on the Moon, with "due regard to the corresponding interests of all other States Parties."[117] It is a standard that remains undefined. However, it is also used in the United Nations Convention on the Law of the Sea which states that freedom of the high seas "shall be exercised by all States with due regard for the interests of the other States in their exercise of the freedom of the high seas."[118]An arbitral tribunal considered the meaning of "due regard" in 2015 and determined that:

> the ordinary meaning of "due regard" calls for the [first State] to have such regard for the rights of [the second State] as is called for by the circumstances and by the nature of those rights. *The Tribunal declines to find in this formulation any universal rule of conduct.* The Convention does not impose a uniform obligation to avoid any impairment of [the second State's] rights; nor does it uniformly permit the [first State] to proceed as it wishes, merely noting such rights. *Rather, the extent of the regard required by the Convention will depend upon the nature of the rights held by [the second State], their importance, the extent of the anticipated impairment, the nature and importance of the activities contemplated by the [first State], and the availability of alternative approaches.*[119] (emphasis added)

Under this interpretation, "due regard" requires a balancing test, taking into consideration the rights of the State that have been impinged by the contested activity, the extent of the impairment, the nature and importance of the contested activity, and the availability of alternative approaches. Again, while it is conceded that this balance will produce different outcomes on a case-by-case basis, the uncertainty in and of itself should be enough to make States

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[117] Outer Space Treaty, *supra* note 91, art. IX.

[118] United Nations Convention on the Law of the Sea art. 87(2), Dec. 10, 1982, 3 U.N.T.S 1833.

[119] The Chagos Marine Protected Area Arbitration (Mauritius v. U.K.), Case No. 2011-03, Award, ¶ 519 (Perm. Ct. Arb. 2015).

consider carefully their international obligations in respect of lunar landings.

iii. Harmful Contamination

Article IX of the OST also requires that States conduct their space activities so as to avoid the harmful contamination of the Moon and other celestial bodies.[120] Once again, the treaty declines to define what "harmful contamination" might entail. Relying on the work of the Committee on Space Research Panel on Planetary Protection suggests that contamination presupposes release of organic materials, as the Panel focuses on "possible effects of contamination of planets other than the Earth, and of planetary satellites within the solar system by terrestrial organisms."[121] It can also be argued, however, that "harmful contamination" includes making celestial bodies like the Moon even more inhospitable by creating massive plumes of regolith that could reduce visibility and render instruments inoperable over broad swatches of landscape. Taken to the extreme, if the plume effect does effectively create a "lunar exosphere" or a "long-lasting lunar atmosphere" that changes the "unique high-vacuum lunar surface environment," this could also be considered a harmful contamination.[122]

iv. Harmful Interference

Finally, Article IX of the OST also requires that States "avoid potentially harmful interference with activities of other States" when conducting their own activities. This is essentially a codification of a State's international responsibility to conduct due diligence in respect of its own activity and the activity of its nationals. There can be no question that creating a plume of regolith that physically damages or renders equipment otherwise inoperable is a "harmful interference" with the activity of another State. The duty to avoid this harmful interference includes understanding the environment into which a spacecraft is being deployed, and mitigating risks associated with that deployment and landing.

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[120] Outer Space Treaty, *supra* note 91, art. IX.

[121] *Panel on Planetary*, COSPAR COMM. ON SPACE RES., *https://cosparhq.cnes.fr/scientific-structure/panels/panel-on-planetary-protection-ppp/* (last visited Jan. 25, 2020).

[122] Montes et al., *supra* note 73.

Moreover, Article IX requires that:

> [i]f a State Party to the Treaty has reason to believe that an activity or experiment planned by it or its nationals in outer space, including the Moon and other celestial bodies, would cause potentially harmful interference with activities of other States Parties in the peaceful exploration and use of outer space, including the Moon and other celestial bodies, it *shall* undertake appropriate international consultation before proceeding with any such activity or experiment.[123] (emphasis added).

Given the potentially devastating consequences of the plume effect, it is reasonable to conclude that this language requires any State intending to land a spacecraft on the Moon, Mars or any other geologically similar celestial body to consult with every nation that has a space object on that body.

E. The Economic Imperative

The Liability Convention states that a claim for damages shall initially be presented through diplomatic channels.[124] Claims may also be pursued through "local remedies."[125] However, "a State shall not . . . be entitled to present a claim under [the] Convention in respect of the same damage for which a claim is being pursued in the courts or administrative tribunals or agencies of a launching State."[126] If no settlement is reached within one year "from the date on which the claimant State notifies the launching State" of the claim, "the parties *shall* establish a Claims Commission at the request of either party"[127] (emphasis added). The Claims Commission is to be composed of three members,[128] all of whom, presumably, will require payment. Ultimately, the decision of the Claims Commission "shall be final and binding," but only "if the parties have so agreed."[129] In other words, after one year of negotiations, one State

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[123] Outer Space Treaty, *supra* note 91, art. IX.
[124] Liability Convention, *supra* note 106, art. IX.
[125] *Id.* art. XI (1).
[126] *Id.* art. XI(2).
[127] *Id.* art. XIV.
[128] *Id.* art. XV(1).
[129] *Id.* art. XIX(2).

may compel all the other States involved to form a Claims Commission, whose decision will not necessarily be final and binding. One can easily imagine a scenario in which a State is forced to participate in the Claims Commission but refuses to agree that any decision will be enforceable. The amount of money and workforce hours involved in this process – State personnel, company personnel (if applicable), attorneys, diplomats, arbitrators, support staff, printing services and all other related expenses – is staggering. Not to mention the fact that focus – both financial and intellectual – on the claims process will detract from far more important goals related to space exploration. In short, costs to all parties involved are high, even before a decision about liability or damages is made.

As far as damages go, while the ideal reparation would be restitution to the original status of the damaged space object, if this is not possible, the responsible party should make "payment of a sum corresponding to the value which a restitution in kind would bear."[130] The question is, what is the corresponding value? If an instrument is destroyed or rendered inoperable, restitution must include all costs associated with repair – including the construction and launch of a replacement. Depending on the mission of the damaged object, the State which caused the damage could also be responsible for lost opportunity and lost data.

Additionally, the value of a lunar heritage site like the Apollo 11 landing area is incalculable. What reparation payment would be sufficient for damage to, or the destruction of, Neil Armstrong's footprints, or the bleached American flags planted during each of the Apollo mission, when such damage is likely to be irreparable?

Compounding the questions of liability and reparations is the fact that lunar ejecta may not cause immediately discernable damage to objects that a more distant from the landing site. An object that may be able to maintain functionality in the way of the plume effect once, may suffer cumulative damage over time as more and more landings occur. Engineers can attempt to develop materials that will be more resistant to sandblasting, but this material would

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[130] Chorzów Factory Case (Ger. v. Pol.), Merits), 1928 P.C.I.J., (Ser. A) No. 17, at 47 (Sept. 13) ("Restitution in kind, or, if this is not possible, payment of a sum corresponding to the value which a restitution in kind would bear; the award, if need be, of damages for loss sustained which would not be covered by restitution in kind or payment in place of it – such are the principles which should serve to determine the amount of compensation due for an act contrary to international law.")

likely be heavier and cost more to build – and launch. Who will determine at what point such precautions need to be taken? In short, the costs associated with damage from plume ejecta could become significant quite quickly, or over a span of time. The international community could prevent these losses by investing in a solution in advance – a path that would eliminate, or, at least, reduce, both uncertainty and cost.

F. The Moral Imperative

i. International Cooperation

The OST uses the word "cooperation" no less than seven times – twice in the preamble and five more times in the substantive terms and condition. The purpose of the Treaty, as set forth in its introduction is to "contribute to broad international co-operation" in the belief that "such co-operation will contribute to the development of mutual understanding and to the strengthening of friendly relations between States and peoples."[131] Articles I, III, X and XI each indicate a purpose to "encourage" or "promote" international cooperation.[132] And Article IX admonishes that the concept of due regard, discussed above, "shall be guided by the principle of co-operation."[133]

Recalling that the OST was negotiated at the height of a Cold War that turned "hot" in Vietnam by 1965,[134] it is indeed astonishing that the OST negotiators focused on the concept of international

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[131] Outer Space Treaty, *supra* note 91, Preamble.

[132] *Id,* arts. I, III, X & XI.

[133] *Id.* art. IX.

[134] President Kennedy sent more than 16,000 military advisers to Vietnam in the early 1960s noting, in 1963 that:

> In the final analysis, it is their war. They are the ones who have to win it or lose it. We can help them, we can give them equipment, we can send our men out there as advisers, but they have to win it, the people of Vietnam, against the Communists . . . .But I don't agree with those who say we should withdraw. That would be a great mistake . . . . [The United States] made this effort to defend Europe. Now Europe is quite secure. We also have to participate—we may not like it—in the defense of Asia.

Vietnam, JOHN. F. KENNEDY PRESIDENTIAL LIBR. & MUSEUM, https://www.jfklibrary.org/learn/about-jfk/jfk-in-history/vietnam (last visited Jan. 26, 2020). President Johnson authorized US troops to begin "military offensives" in 1965. *Id.*

cooperation. This remarkable effort demonstrates the deep-seated understanding that outer space is indeed a new frontier – one that will be best and most successfully utilized if States and their nationals work together. It is submitted that working together to reduce the potential of harm from the plume effect is precisely the kind of cooperation the OST and its negotiators desired and anticipated.

ii. Sustainable Exploration

In June 2019, after nearly a decade of discussion, the United Nations Committee on the Peaceful Uses of Outer Space (UNCOPUOS) "formally approved 21 guidelines for long-term sustainability of space."[135] While these guidelines are voluntary, it is noteworthy that the UNCOPUOS reaches agreement by consensus. Thus, while there is no formal voting process, these guidelines were tacitly approved the 95 State members of the Committee.[136] Among the articulated premises for these guidelines is:

> the understanding that outer space should remain an operationally stable and safe environment that is maintained for peaceful purposes and open for exploration, use and international cooperation by current and future generations, in the interest of all countries, irrespective of their degree of economic or scientific development, without discrimination of any kind and with due regard for the principle of equity.[137]

More specifically, the Guideline D.1 makes the following recommendations:

> 1. States and international intergovernmental organizations should promote and support research into and the development of sustainable space technologies, processes and services and

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[135] Jeff Foust, *Long-Awaited Space Sustainability Guidelines Approved by UN Committee*, SPACENEWS (Jun. 28, 2019), https://spacenews.com/long-awaited-space-sustainability-guidelines-approved-by-un-committee/.

[136] *See Members of the Committee on the Peaceful Uses of Outer Space*, U.N.OFF. FOR OUTER SPACE AFF., https://www.unoosa.org/oosa/en/members/index.html (last visited Jan. 26, 2020).

[137] Comm. on the Peaceful Uses of Outer Space, Guidelines for the Long-term Sustainability of Outer Space, ¶ I.5 Activities, A/AC.105/2018/CRP.20 (Jun. 27, 2018) [hereinafter LTS Guidelines].

> other initiatives for the sustainable exploration and use of outer space, including celestial bodies.
>
> . . .
>
> 4. States and international intergovernmental organizations *should consider appropriate safety measures to protect the Earth and the space environment from harmful contamination*, taking advantage of existing measures, practices and guidelines that may apply to those activities, and developing new measures as appropriate.[138] (emphasis added).

Having had the opportunity to study the plume effect, it is undeniable that sustainable exploration of the Moon requires the development of space technologies that would reduce the potential for harm, especially as plume ejecta could actually denigrate the lunar environment to such an extent as to make it impossible to conduct any useful operations.

iii. Cultural Heritage

Finally, it is submitted that the international community must work together to protect humanity's cultural heritage on the Moon; cooperatively developing ways to mitigate the potential harm of the plume effect would be a significant step towards necessary recognition and preservation. Currently, there are more than 100 historical archaeological sites on the Moon from the crash site of Luna 2 to Apollo 11's Tranquility Base to the tracks of Yutu and Yutu 2.[139] As noted by the non-profit organization For All Moonkind, each of these sites "bears witness to moments that changed, and advanced, our human civilization irrevocably. No longer are we tied to our Mother Earth. In incremental steps, the heavens have been opened for exploration, and celestial bodies for settlement."[140] Indeed,

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[138] *Id.* ¶¶ II.D.1, II.D.4.

[139] *Human Heritage in Outer Space*, FOR ALL MOONKIND, https://www.forallmoonkind.org/moonkind-mission/human-heritage-in-outer-space/ (last visited Jan. 26, 2020). Author Hanlon is the co-founder and President of For All Moonkind, Inc., a not-for-profit organization committed to protecting human heritage in outer space.

[140] *Id.*

> the robots and the astronauts who landed on the Moon were envoys of all humankind, propelled to the heavens on the ingenuity and perseverance of thousands of scientists, engineers, tool workers and dreamers from around the globe. The sites where they sit today are evidence of humanity's first tentative steps off our planet Earth. They mark an achievement unparalleled in human history, and one that is common to all humankind.[141]

Yet these sites and the objects they host enjoy no special stature under space law or international law. Article VIII of the OST is clear that objects in space remain under the jurisdiction, ownership and control of the State that was responsible for putting them there.[142] But the Treaty offers no further protection. While other States will be responsible for any damage done to such objects, two questions are immediately apparent. First, what kind of damage can be claimed to have occurred in respect of an object that is non-operational? Second, even if damage is recognized as having occurred, how would the value or extent of this damage be quantified? If a State, or its national, creates plume ejecta that damages the Apollo 11 Lunar Module, what would restitution look like? From a historical perspective, the Lunar Module is a priceless artifact; from a hardnosed practical or business perspective, however, it is simply a piece of outdated equipment with no current function. The OST is utterly silent with respect to features on these historic sites, like Neil Armstrong's bootprints, the first ever human steps taken on another celestial body. What is the cost if these sites are damaged or destroyed by lunar ejecta? Will their value be calculated based on their historical significance, or simply their objective economic cost? Here on Earth, the preservation of cultural heritage is identified as a fundamental human right; "damage to cultural heritage of any people constitutes damage to the cultural heritage of humanity as a whole."[143] Does the mere fact of being in outer space disqualify and object from being considered heritage?

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[141] *Id.*

[142] Outer Space Treaty, *supra* note 91, art. VIII.

[143] Resolution Adopted by the Human Rights Council on 30 September 2016, A/HRC/RES/33/20*, Preamble. *See also* Delhi Declaration on Heritage and Democracy, International Council on Monuments and Sites (Dec. 11-15, 2017), Preamble.

There are a number of difficult and complex legal issues which arise in respect of heritage in outer space, not the least of which results in a clash of sovereignty and the nonappropriation principle found in Article II of the OST.[144] On Earth, sites which are considered to be "of outstanding universal value from the historical, aesthetic, ethnological or anthropological point of view"[145] can be recognized and protected by the international community. However, a site can only be nominated by the State in whose territory it is found.[146] This model will not work on the Moon as "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."[147]

The nonprofit, nongovernmental organization, For All Moonkind, which is also a Permanent Observer to the UNCOPUOS, has built a diverse team of space lawyers and preservation lawyers who are working together on a volunteer basis to offer solutions that will address these legal issues.[148] In the meantime, the international community can, and should, immediately take steps to protect these sites by collaborating on efforts to mitigate the potential for damage from the plume effect.

IV. THE SOLUTION: SHARED LUNAR LANDING PADS

Having demonstrated the legal, economic and moral imperative to mitigate against the hazards of lunar ejecta, the question is how. One solution is to borrow from the NASA Guidelines to institute and enforce safety zones around both operational and heritage sites.[149] But in some cases, the safety perimeter required to assure safety may be extreme. Moreover, safety zones do little to dispel the visual landing hazards also created by the plume effect. It has also been suggested that lunar ejecta could be blocked using berms, fences or similar barriers. However, as Phil Metzger notes, plume

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[144] Outer Space Treaty, *supra* note 91, art. II.

[145] Convention Concerning the Protection of the World Cultural and Natural Heritage art. 1, Nov. 16, 1972, 27 U.S.T. 37, 1037 U.N.T.S. 151.

[146] *Id.* art. 4.

[147] Outer Space Treaty, *supra* note 91, art. II.

[148] *Legal Research and Strategy*, FOR ALL MOONKIND, https://www.forallmoonkind.org/about/legal/ (last visited Jan. 26, 2020).

[149] *See* NASA Guidelines, *supra* note 50.

ejecta are impossible to block with berms because "particles colliding in flight scatter over the barrier. Also, larger particles like rocks loft over the barrier and arc down into the other side, and the berms themselves scatter the particles in lunar vacuum."[150] Metzger and the Center for Lunar & Asteroid Surface Science (CLASS) aver that "full mitigation requires construction of a landing pad."[151] CLASS proposes the construction of landing pads using in situ resources[152] and, indeed, the Center has "prototyped and studied technologies including sintering lunar regolith with microwaves, sunlight, and/or infrared radiation, applications of polymers to regolith, the use of gravel and pavers, lunar concrete, and more."[153] Its work continues.

Landing pads, however, are not enough in and of themselves. In order to most efficiently and effectively mitigate the risks associated with the plume effect, shared lunar landing pads are a necessity. Why build individual landing pads, when the international community can work together to build and share common landing facilities? Shared landing sites have the potential to reduce the effects of regolith spray on both equipment and the environment. The landing sites should be conceived broadly as landing zones, which may include navigation beacons, lighting, accessibility to and from outposts, regular processes to offload equipment and supplies from landers, refueling systems and power stations.[154]

The concept of shared lunar landing pads is neither new nor outlandish as we can look to terrestrial examples for inspiration and guidance. Shared lunar landing pads could, theoretically, operate similarly to airports here on Earth. Airports have long provided a common place for aircrafts to land and take off, safe transport for

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[150] P.T. Metzger & D.T. Britt, Mitigating Lander and Plume Effects with Space Resources, presented to Developing a New Space Economy (2019), https://www.hou.usra.edu/meetings/lunarisru2019/pdf/5055.pdf.

[151] *Id.*

[152] In-situ resource utilization is the practice of turning indigenous materials into critical resources that would otherwise be brought from Earth. *In-Situ Resource Utilisation*, ESA, https://www.esa.int/Science_Exploration/Human_and_Robotic_Exploration/Exploration/In-Situ_Resource_Utilisation (last visited Jan. 26, 2020). This approach would allow for a practical and efficient method of construction on the lunar surface. *Id. See also* John A. Happel, *Indigenous Materials for Lunar Construction*, 46 APPL. MECH. REV. 313 (1993).

[153] ESA, *supra* note 152.

[154] *See* Metzger, *supra* note 45, at 17.

passengers on the ground and efficiency in the transference of freight. Likewise, the lunar landing pads would provide for safe and sustainable scientific expeditions and operations by various States and private entities.

Aircrafts must meet minimum requirements to safely operate in or out of a given airport.[155] To determine whether the requirements are satisfied, there must be an evaluation of the characteristics of both the aircraft and the landing area.[156] Specifically, the comparison of distances for the aircraft and the availability provided at an airport is imperative.[157] Additionally, airports are zoned to protect against the disturbance of adjoining areas.[158] Airport zoning may include physical requirements, such as height, as well as smoke, dust and electrical interference for surrounding areas.[159] In regards to shared lunar landing pads, it would be similarly necessary to zone the landing pads with the conservation and sustainability of the lunar environment in mind. There would also need to be consideration of the nature of the landing area in relation to the capabilities of the desired landing craft. In short, the example of airports provides us with a conceptual model of how lunar landing pads might work. The only difference, albeit a significant one, is the need for international cooperation.

The benefits of collaborating to build shared landing pads are legion. Among other things:

- States – and private entities – can share the cost of development and construction;
- cooperation will obviate questions of territorial appropriation that would arise should one State seek to build a permanent landing pad on the Moon or anywhere in space;
- the use of shared landing pads will greatly reduce the risk of damage to both operational equipment and objects of significance to our human history and heritage;
- shared landing pads will also decrease the risk of potentially significant costs of pursuing and defending against damage claims, not to mention the cost of reparations;

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[155] A.B. McMullen, *Airports: Development and Problems*, 9 J. AIR L. 649, 653 (1938).

[156] *Id.* at 653-54.

[157] *Id.* at 653.

[158] Erwin Seago, *The Airport Noise Problem and Airport Zoning*, 28 MD. L. REV. 120, 124 (1968).

[159] *Id.* at 130.

 working to develop shared lunar landing pads will also promote standardization of equipment which will not only increase efficiencies, but assure future commonalities in a harsh environment that will afford States and private entities more opportunity to assist each other when needed;

 the development of shared landing pads will provide invaluable practical experience as humans move beyond the Moon to other celestial bodies, including asteroids and Mars, which CLASS has determined also offers landing ejecta challenges.[160]

But perhaps most important, collaborating to develop and construct shared lunar landing pads provides a foundational agreement upon which other agreements can be built.

V. CONCLUSION

From the launch of Sputnik-1, the first human made object to complete an orbit around the Earth, we have understood that space is something different. The international agreement to assure that the realm of space is free for all to explore – and that it remains a realm of peace – feels, in retrospect almost instinctive. Since 1959, State delegates have met as the Committee for the Peaceful Uses of Outer Space specifically, as its name suggests, to preserve that peace. Today, we close 2019, a year in which we commemorated the 60th anniversary of the first human-made object to land on the Moon and the 50th anniversary of the first human to land on the Moon. And we embrace a 2020 in which we are already celebrating the one-year anniversary of humanity's first robotic foray to the far side of the Moon and anticipating many more trips to come. We look to the Moon as a testing ground for deeper exploration. We eagerly seek resources and challenge ourselves to establish a human community – a village – on our nearest celestial neighbor. In this time, the establishment of a common landing pad regime feels instinctive. It is the next logical step to help assure peace and freedom of access. And it is a vital first step in obtaining the level of international agreement and cooperation that will be needed to assure the long-term success and sustainability of all space activity.

It has been said that "what we do in space and how we do it reflects our values and not just our technologies." When Apollo 11

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[160] Metzger, *supra* note 45, at 1.

made its historic landing on the Moon, it left behind a disc containing messages of peace from the leaders of 74 nations. Every single one of those messages held out the hope that this great achievement – reaching the Moon – would signal "hope for better days for all [hu]mankind" (Costa Rica) and become "a glorious milestone along the road of all [hu]mankind towards the achievement of peace, freedom and justice" (Italy). Now 50 years later, it is our turn to make those hopes come true. We must work together to mitigate the plume effect so that we can all succeed in promoting the sustainable exploration of space and make the development of a collaborative human presence on the Moon a milestone to a future where "[hu]mankind will live in a universe in which peace, self-expression, and the chance of dangerous adventure are available to all." (Australia). Because those are the values that we should reflect.[161]

Together we can at least alleviate the fear in a "handful of dust."

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[161] *Messages of Peace*, FOR ALL MOONKIND, https://www.forallmoonkind.org/moonkind-mission/messages-of-peace/ (last visited Jan. 27, 2020) (providing transcripts of the Messages of Peace that were left on the Moon by Apollo 11 Astronauts Neil Armstrong and Buzz Aldrin).

WHEN GALAXIES COLLIDE: RESOLVING CRIMINAL JURISDICTION DISPUTES AMONG NATIONS IN SPACE

Caleb Ohmer[*]

ABSTRACT

As humanity's presence reaches further into space, so too should the laws and boundaries that govern human conduct on Earth also follow. Recently, an honored NASA astronaut, has entered uncharted space as her domestic troubles on Earth have raised criminal questions in outer space. While some have regarded this event as one of the first crimes ever committed in space, it is unlikely to be the last. As more individuals, astronauts and private nonprofessionals, make longer duration visits into space, the need for an international legal framework to manage crimes in space is essential. This paper addresses this multinational problem and encourages the reader to seriously consider the importance of criminal jurisdiction in space. Most importantly, this paper advocates for a modest, prospective approach by creating a multinational, space advisory board that leaves intact crucial international agreements while providing a solution for which countries have criminal jurisdiction over criminal acts.

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I. INTRODUCTION

On October 4, 1957, Sputnik's first "beep" inspired a whole generation of space activists.[1] The momentous occasion marked the beginning of a new era for humankind, an era of humans' cosmic existence. A dream, cherished for generations, became a reality on July 20, 1969, when two individuals landed on the Moon's lunar surface.[2] Making good on President Kennedy's words, "[w]e choose to go to the moon,"[3] since 1969 a total of 564 individuals have traveled to space.[4] And as of the time writing this, humans have spent an excess of 145.1 Earth-years in space.[5] These figures will only grow each passing year as humans gain more and more of a foothold in the heavens.

Nearly fifty years since the Moon landing, private citizens are now proclaiming: "I can tell you that *I* choose to go to the Moon!"[6] Yusaku Maezawa, a Japanese billionaire, intends to be the first private customer to fly around the Moon in 2023.[7] He will not be traveling alone; Maezawa intends to bring along six to eight artists with him aboard SpaceX's Big Falcon Rocket (BFR).[8] This venture,

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[1] Clara Moskowitz, *How Sputnik Changed the World 55 Years Ago Today*, SPACE.COM (Oct. 4, 2012), https://www.space.com/17894-sputnik-anniversary-changed-the-world.html.

[2] Brian Dunbar, *Apollo 11 Mission Overview*, NASA (Dec. 21, 2017), https://www.nasa.gov/mission_pages/apollo/missions/apollo11.html.

[3] President John F. Kennedy, Address at Rice University in Houston, Texas on the Nation's Space Effort (Sept. 12, 1962), *available at* https://www.jfklibrary.org/asset-viewer/archives/JFKWHA/1962/JFKWHA-127-002/JFKWHA-127-002.

[4] *Astronaut/Cosmonaut Statistics*, WORLD SPACE FLIGHT (Nov. 25, 2018), https://www.worldspaceflight.com/bios/stats.php According to the United States Air Force (USAF), space "begins" at 100km. However, according the Federation Aeronautique Internationale (FAI), only 558 people have been to space.

[5] *See id*.

[6] Loren Grush, *SpaceX Will Send Japanese Billionaire Yusaku Maezawa to the Moon*, THE VERGE (Sept. 17, 2018), https://www.theverge.com/2018/9/17/17869990/elon-musk-spacex-lunar-mission-ticket-moon-passenger-bfr-falcon-yusaku-maezawa.

[7] *Id.*

[8] *Id*. Elon Musk recently announced the name change from BFR to "Starship" on November 19, 2018. Elon Musk (@elonmusk), TWITTER (Nov. 19, 2018 8:42 PM), https://twitter.com/elonmusk/status/1064740713357750272?lang=en.

among others to colonize Mars[9] or mine asteroids,[10] raises crucial legal questions for nations governing their citizens: in the event a criminal offense occurs in outer space or on a celestial body, which nation's criminal jurisdiction will apply?

Considering the human element of all space flights, it is noteworthy that mission control has operated under one vital assumption: "the basic compliance of the traveler with the internal discipline of the crew and the mission."[11] This condition, essential to the heart of space missions, was based on the rigorous selection of early astronauts who typically were military test pilots and governed by a military code.[12] This position – that conflict can be avoided – can no longer be taken for granted as private nonprofessionals, scientists, artists and tourists go to space. Longer duration planetary missions to the International Space Station, lunar bases and Mars will inevitably require a legal framework to regulate criminal behavior such as theft, assault, rape, or murder of one country's citizen against another.

While critics may argue that these problems are premature, this article encourages the reader to seriously consider the importance of criminal jurisdiction in space. Additionally, it seeks to highlight relevant, recent changes in the space industry. These changes require a prospective approach to criminal jurisdiction through an international legal framework. If nations act retroactively in adopting a legal framework for criminal laws, then this could lead to unresolved conflicts among States regarding what criminal laws should apply. Worse, the lack of a legal framework could harm the international cooperation among nations that have transcended political boundaries for the last five decades since the signing of the Outer Space Treaty.

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[9] *See* Carmen Fishwick, *Mission to Colonise Mars: 'Columbus Didn't Wait; Nor Should We'*, THE GUARDIAN (Sept. 10, 2013), https://www.theguardian.com/science/2013/sep/10/mars-one-mission-space-travel-applicants.

[10] *See* Kathryn Nave, *Inside the Startup That Wants to Mine Asteroids and Transform Space Travel Forever*, WIRED (July 4, 2017), http://www.wired.co.uk/article/asteroid-space-mining-phoenix-mars-chris-lewicki-planetary-resources.

[11] Christopher J. Newman, *Exploring the Problems of Criminal Justice in Space*, 2(8) ROOM - SPACE J. OF ASGARDIA 87, 87–92 (2016)

[12] *Id*.

II. THE CONTEXT FOR LAW ENFORCEMENT ACTIVITIES IN SPACE

A. The Commercialization of Space and Human Expansion Beyond Earth

Private companies have been investing in outer space activities for decades and are constantly transforming the industry.[13] Beginning with satellite communications for telephone and television, newer forms of commercial activities focus on "weather and geological assessment, launching, remote sensing, and global positioning."[14] New initiatives include visionaries like Planetary Resources and Deep Space Industries seeking to mine near earth objects for rocket fuel and rare, expensive minerals.[15] Other initiatives like the once science-fiction concepts of space tourism, settling Mars and advertising on the lunar surface are now more realistic than ever before.[16] Those studying this trend have referred to the new changes as the "Space Race 2.0." [17]

Private companies and individuals have assumed larger roles previously reserved for state and federal governments.[18] Following the end of the space shuttle program in 2011, NASA has enlisted the help of private companies to build modern spacecraft.[19] The investment has paid off as tech billionaires Jeff Bezos's Blue Origin and Elon Musk's SpaceX have reduced launch costs through reusable rockets.[20] Other companies are diversifying the landscape by

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[13] Paul Stephen Dempsey, *National Laws Governing Commercial Space Activities: Legislation, Regulation & Enforcement*, NW. J. INT'L L. & BUS. 1, 3 (2016).

[14] *Id.*

[15] Elton Lossner, *The New Space Race*, HARV. POL. REV. (May 26, 2017), http://harvardpolitics.com/covers/the-new-space-race/.

[16] Joshua Cheetham, *The Billionaires Fuelling a Space Race*, BBC NEWS (Oct. 21, 2018), https://www.bbc.com/news/business-45919650; Neel Patel, *This Space for Rent*, SLATE (Dec. 18, 2017), https://slate.com/technology/2017/12/ispace-wants-to-advertise-on-the-moon-is-that-legal.html.

[17] Kristin Houser, *Private Companies, Not Governments, Are Shaping the Future of Space Exploration*, FUTURISM (June 12, 2017), https://futurism.com/private-companies-not-governments-are-shaping-the-future-of-space-exploration/.

[18] *The Space Race is Dominated by New Contenders*, THE ECONOMIST (Oct. 18, 2018), https://www.economist.com/graphic-detail/2018/10/18/the-space-race-is-dominated-by-new-contenders.

[19] Kevin Macwhorter, *Sustainable Mining: Incentivizing Asteroid Mining in the Name of Environmentalism*, 40 WM. & MARY ENVTL. POL'Y REV. 645, 650 (2016).

[20] *See* Michael Sheetz, *SpaceX President Knocks Bezos' Blue Origin: 'They Have a Billion Dollars of Free Money Every Year'*, CNBC (Oct. 25, 2019),

selling tickets for private space flights.[21] As celebrities like Katy Perry, Justin Bieber and Lady Gaga reserve their seats, many have described the new space race as "a playground for the rich."[22] One image that comes to mind is "Starman": the spectacle of a mannequin in a Tesla Roadster, launched into deep space with David Bowie playing on the speakers.[23] These spectacles give rise to questions on how space flight over private individuals should be regulated.

Many of these space companies are experiencing a wave of innovation as a result of supportive public policy. In 2015, Congress passed the US Commercial Space Launch Competitiveness Act ("SPACE Act"), which granted entities ownership rights over the resources extracted from extraterrestrial bodies.[24] While this bipartisan legislation is a potential catalyst for private space travel, some thinkers suggest the SPACE Act is in direct violation of the 1967 U.N. Outer Space Treaty's (OST) prohibition on sovereignty claims over celestial bodies.[25] Last year, the National Space Council was resurrected by the Trump Administration, after nearly a quarter century, and now it is tasked with guiding the US agenda for

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https://www.cnbc.com/2019/10/25/spacex-shotwell-calls-out-blue-origin-boeing-lockheed-martin-oneweb.html ("SpaceX has steadily reduced its prices . . . ."); Alex Knapp, *Jeff Bezos Unveils Blue Origin's Lunar Lander, Announces Launch Of Next-Gen Rocket in 2021*, FORBES (May 9, 2019), https://www.forbes.com/sites/alexknapp/2019/05/09/jeff-bezos-unveils-blue-origins-lunar-lander-announces-new-glenn-first-launch-for-2021/#696e453435aa ("New Glenn will reduce costs by having a first stage that can be reused 25 times and use liquid natural gas as a propellant."). *See also* Loren Grush, *SpaceX Launches and Lands its First Used Rocket for NASA*, THE VERGE (Dec. 15, 2017), https://www.theverge.com/2017/12/15/16759416/spacex-nasa-used-falcon-9-rocket-launch-live-stream (SpaceX launched cargo to the International Space Station for NASA, becoming the first time a company flew "a used rocket for one of its NASA resupply missions."); Houser, *supra* note 17.

[21] Houser, *supra* note 17.

[22] John Harris, *We Once Marvelled at Neil Armstrong. Now Space Is a Playground for the Rich*, THE GUARDIAN (Oct. 17, 2018 1:00 PM), https://www.theguardian.com/commentisfree/2018/oct/17/race-for-space-greed-nasa.

[23] Bonnie Malkin, *SpaceX Oddity: How Elon Musk Sent a Car Towards Mars*, THE GUARDIAN (Feb. 7, 2018), https://www.theguardian.com/science/2018/feb/07/space-oddity-elon-musk-spacex-car-mars-falcon-heavy.

[24] 51 U.S.C. § 51303 (2018); Lossner, *supra* note 15.

[25] *See* Lossner, *supra* note 15. While property rights in outer space is an important issue, this issue is not addressed in this paper.

space development.[26] During the fourth public meeting, US Vice President Mike Pence announced the creation of the sixth branch of the military known as the US Space Force to advance US national security in space—"a war-fighting domain."[27]

Lastly, there is a floating city in space: "a place where we [have] learn[ed] to live and work 'off planet' alongside our international partners."[28] Crew from the United States, Canada, Europe, Japan, Russia and others all cohabit the International Space Station (ISS).[29] In 2001, American Denis Tito became the first space tourist to visit the ISS as a paying guest of the Russian government.[30] One year later, South African Mark Shuttleworth became the second space tourist to visit the ISS.[31] Like any small city, the ISS creates legal questions about human behavior, including what nation can claim criminal jurisdiction over acts committed on the ISS.[32] The minds behind the ISS knew human conflict was unavoidable, so they included provisions on managing criminal jurisdiction in the 1998 Intergovernmental Agreements on the Space Station Cooperation ("1998 IGA").[33] This agreement will be discussed in more detail in section III.C below.

B. Why There is a Need for Law Enforcement in Space

Naturally, one may wonder whether there is truly a need for criminal law in space. The simple answer is yes, and there are at least four reasons. Author Lee Seshagiri in "Spaceships Sheriffs

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[26] Loren Grush, *Mike Pence is Meeting with Industry Leaders Today to Figure out America's Space Agenda*, THE VERGE (Oct. 5, 2017), https://www.theverge.com/2017/10/5/16424580/nasa-national-space-council-vice-president-mike-pence-policy-moon.

[27] Sarah Lewin, *Plans for Space Force Laid Out at National Space Council Meeting*, SPACE.COM (Oct. 23, 2018), https://www.space.com/42237-national-space-council-space-force-meeting.html.

[28] *The International Space Station: Improving Life on Earth and in Space*, NASA 5 (1998), https://spaceflight.nasa.gov/station/science/ISS_final.pdf.

[29] *Id.*

[30] Lee Seshagiri, *Spaceships Sheriffs and Cosmonaut Cops: Criminal Law in Outer Space*, 28 DALHOUSIE L.J. 473, 476 (2005).

[31] *Id.*

[32] Stacy J. Ratner, *Establishing the Extraterrestrial: Criminal Jurisdiction and the International Space Station*, 22 B.C. INT'L COMP. L. REV. 323, 323 (1999).

[33] *Id.*

and Cosmonaut Cops: Criminal Law in Outer Space" describes the first, third and fourth reasons in detail.[34]

First, being in space for extended periods of time is excruciating on the body and mind.[35] Expecting that humans crammed into close quarters, confined by steel in an environment trying to kill them, and asked to live and work together could suppress their stress is incredibly unrealistic.[36] When space tourism and space hotels become achievable (possibly by as early as 2022[37]), there may not be only astronauts screened for "'major characterological issues or neurotic issues"'[38] in space. Instead, anyone who can pay the $9.5 million will be able to access orbit and beyond.[39] These space tourists will likely not be as prepared for the precarious conditions of a dangerous environment as their professionally-trained predecessors.[40]

There are many psychological and physiological concerns space travelers will face in space. NASA's Human Research Program has been studying this question for several years.[41] A NASA report describes that close confinement on long term missions leads to several issues:

> NASA has learned that behavioral issues among groups of people crammed in a small space over a long time, no matter how well trained they are, are inevitable. . . . The types of problems you may encounter are a decline in mood, cognition, morale, or interpersonal interaction. You could also develop a sleep disorder because your circadian rhythm might be thrown off [by different lengths of day] . . . or by a small, noisy environment, or

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[34] See Seshagiri, *supra* note 30 at 478-480.

[35] Neel V. Patel, *Space Psychology 101: How NASA Keeps Its Astronauts Sane*, INVERSE (Aug. 6, 2016), https://www.inverse.com/article/19326-space-psychology-nasa-astronauts-mental-health-mars.

[36] *See id.*

[37] Maureen O'Hare, *Look Inside the First Luxury Space Hotel*, CNN (Apr. 6, 2018), https://www.cnn.com/travel/article/aurora-station-luxury-space-hotel/index.html.

[38] Liz Tung, *How Do Astronauts Deal with Conflict in Cramped Quarters?* WHYY (Nov. 23, 2017), https://whyy.org/segments/how-do-astronauts-deal-with-conflict-in-cramped-quarters/.

[39] O'Hare, *supra* note 37.

[40] *See id.* ("[I]t has 'taken what was historically a 24-month training regimen to prepare travelers to visit a space station and streamlined it to three months, at a fraction of the cost.'").

[41] Kelli Mars, *The Human Body in Space*, NASA (June 11, 2018), https://www.nasa.gov/hrp/bodyinspace.

> the stress of prolonged isolation and confinement. Depression could occur. Fatigue is inevitable . . . . Misunderstandings and impaired communications with your team members might impact performance and mission success.[42]

Because many of these behavioral issues are ingrained into human interaction, crimes will likely be as prevalent in outer space as they are on Earth.[43] Unfortunately though, crimes or criminal negligence will have more significant consequences in space than on Earth, because 1) they have the potential to create situations of no escape for victims,; 2) they can jeopardize an entire ship; and 3)their victims and other travelers lack the ability to obtain immediate help. These dangerous possibilities require that the "bounds of acceptable human behavior, and responses available when such bounds are breached, be clearly defined" before takeoff.[44]

Second, the administration of justice while on interplanetary missions raises several potential problems for social order. For one, the crew or authority on a space station or spacecraft have a heavy burden of determining what actions do or do not constitute an infraction.[45] Furthermore, living in space is costly and every section of a space station is used for storage, which means there is likely no cell or other location in which to confine perpetrators of crimes.[46] Another potential problem could be getting those perpetrators back to Earth for proper confinement. For reference, "[t]he transit time from the ISS to the surface of Earth is around three and a half hours . . . ."[47] On long duration spaceflights, and considering the cost of additional rooms, it does not seem likely that areas will be preserved for isolated detention facilities.[48] More importantly, it is possible that a perpetrator might perform exclusive duties essential to the function of the ship.[49] If such a perpetrator were isolated or confined, the crew may never make it safely to their destination.

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[42] *Id*.; *see also* Patel, *supra* note 35 (discussing the mental rigors astronauts experience during missions in space).

[43] Seshagiri, *supra* note 30, at 478.

[44] *Id.*

[45] Newman, *supra* note 11.

[46] *Id*.

[47] *Id.*

[48] *Id*.

[49] *Id*.

Third, law enforcement is needed in space because it would otherwise "be contrary to the political and economic interests [of all nations] if space were seen as a lawless vacuum."[50] Imagine, a small criminal act that quickly escalates into a major catastrophe. Investors would be less willing to make their multibillion-dollar investments in the already risky business of commercializing space. These extraterrestrial incidents involving regular citizens in space could lead to negative publicity, especially if citizens of different nations are affected. Imagine if the newly emerging, commercial forum was tarnished by reports of unruly travelers or space pirates exercising unauthorized control over spacecraft.[51]These actions could destroy satellites that affect cellphone coverage, an airliners' ability to navigate or a hospitals' access to crucial health data.[52] Not to mention, if the perpetrators or victims involved were of different nationalities, this could layer on political and cultural strife.

Fourth, Seshagiri convincingly notes that the imbalance of power among nations demonstrates a need for criminal law in outer space, "beyond the political, economic, and cultural considerations."[53] Specifically, when criminal behavior occurs in space, there may be ambiguity as to which nation's laws apply. One nation may assert that its laws and procedures apply to citizens from other nations.[54] If this is successful, then there is the possibility that a foreign nation might pursue harsher penalties than the citizen's own government or pursue more lenient penalties for their own citizen perpetrator who commits a crime against a foreign victim. As a result, the victim may feel that he or she is unprotected under the law, which could lead to revictimization through biased law enforcement favoring the offender.[55] Furthermore, there is the risk that countries with more resources – transportation, funding, or ownership of most of the station – might aggressively negotiate with other

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[50] Seshagiri, *supra* note 30, at 478.

[51] *See* Michael Viets, *Piracy in an Ocean of Stars: Proposing a Term to Identify the Practice of Unauthorized Control of Nations' Space Objects*, 54 STAN. J. INT'L L. 159, 161 (2018) (discussing the concept of space piracy).

[52] *Id.*

[53] Seshagiri, *supra* note 30, at 479.

[54] *Id.*

[55] *Id.*

countries into applying their regime.[56] This power dynamic was the primary reason for a change in the 1998 IGA discussed at section III.C below. An international legal framework that all nations can agree upon may be the solution to preventing the power imbalance issues that are discussed above as nations expand further into the new frontier.

C. Reasons for More Developed Laws in Space

Since space is such a different environment from Earth, one should question whether general common law concepts on Earth should be applied in space. Consider the concept of *mens rea. Mens rea*, or a guilty mind, "implies that the actor's mental state coincides with the mental state required by the law for a particular offense."[57] *Mens rea* is comprised of four states of mind: (1) purposeful, (2) knowing, (3) reckless and (4) negligent.[58] When looking at a negligent state of mind under Pennsylvania's definition, for example, the court reviews whether "[t]he risk must be of such a nature and degree that the actor's failure to perceive it . . . involves a gross deviation from the standard of care that a *reasonable person* would observe in the actor's situation."[59] Applying this test, it's unclear whether the reasonable person standard for negligence would be the same in space. The average reasonable person has not traveled to space (yet), experienced weightless gravity or been confined to an aircraft longer than a day. As a result, it is possible that some substantive criminal standards in space may need to be reevaluated.

This common law concept, among others, such as theories of punishment – deterrence and justice – will not have the same value in space. The secluded nature of space and the confined environment could lead to new possible defenses in space, such as "space stress" or a new *mens rea*. Judges addressing crimes in space will need to tailor instructions for jurors that specifically address the unique aspects of space. These detailed instructions are necessary for a criminal to have an effective trial by jurors, because jurors

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[56] *See id*. (discussing one country imposing their legal system on another through "blunt use of power").

[57] Julian Hermida, *Convergence of Civil Law and Common Law in the Criminal Theory Realm*, 13 U. MIAMI INT'L & COMP. L. REV. 163, 200-01 (2005).

[58] *Id*. at 203.

[59] *Id*. at 207.

have never experienced space-like environments. Further, these instructions might include defining what is a "reasonable astronaut" or similar topics.

Given these serious concerns, it would be advantageous for nations to agree upon an international legal framework for criminal law in space. Addressing this problem head on, specifically jurisdiction, will prevent a potential catastrophe in space before it even arises. A proactive, rather than retroactive, approach will create safeguards for the crew and identify the rights of the perpetrator on long term spaceflights. The unique nature of space requires the minds of all nations working together to resolve a problem that does not fit into any traditional understanding of criminal law. The next section of this Article will examine the legal context for criminal law in outer space.

III. THE CENTRAL BUCKET OF SPACE LAW

To create a workable solution to criminal law away from Earth, the drafters from various nations must comply with the current "bucket of space law."[60] The term is defined as: "a bucket that contains many different types of rules and regulations rather than as denoting a conceptually coherent single form of law."[61] The bucket of law contains hybrids of law from public international elements to domestic law elements.[62] And more recently, there is now a body of hybrid public-private arrangements.[63] These specific arrangements will be discussed briefly in detail as it relates to the structure of international criminal law, specifically criminal jurisdiction.

A. The Outer Space Treaty

On October 10, 1967, the Exploration and Use of Outer Space, Including the Moon and Other Celestial Bodies (OST) went into effect.[64] The treaty was created to diffuse potential conflicts of claim

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[60] FRANCIS LYALL & PAUL B. LARSON, SPACE LAW: A TREATISE 2 (2d ed. 2018).

[61] *Id.*

[62] *Id.*

[63] *Id.* at 27.

[64] Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, Including the Moon and Other Celestial Bodies, Jan. 27, 1967, 18 U.S.T 2410, 610 U.N.T.S. 205 [hereinafter Outer Space Treaty].

or sovereignty in space amidst the Cold War era.[65] The treaty was the first treaty that codified "customs, practices, and responsibilities of spacefaring nations."[66] As a result, the OST is considered the most influential of all the space treaties, which has earned it the nickname of the "Magna Carta of Space."[67] Currently, the OST has been ratified by 105 nations, including all spacefaring nations.[68]

The preamble to the OST describes the purpose and major concerns behind the agreement. These concerns include an emphasis on the common interest of humankind in the exploration of space, and the use of outer space for peaceful purposes.[69] The use should benefit all persons, and it is encouraged "that . . . co-operation will contribute to the development . . . and to the strengthening of friendly relations between States . . . ."[70] Cooperation, however, has proved difficult among nations, unless a result of economic or political considerations rather than for aspirations described in the OST.[71] Fortunately, over the decades, some States have shown an ability to work together and create cooperative institutions, like the International Space Station (ISS), discussed at section III.C. below.

There are fundamental principles captured in the OST. First, parties should carry on "activities in the exploration and use of outer space . . . in accordance with international law."[72] In short, this means space is not lawless and international law, including customary international law will apply. Two more fundamental principles, found in Articles I and II, declare that the exploration and use of outer space shall be carried out for "the benefit and in the interests of all countries . . . without discrimination of any kind" and that space is "not subject to national appropriation by claim of sovereignty, by means of use or occupation, or by any other means."[73] If the negotiators of the treaty anticipated things such as

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[65] John Myers, *Extraterrestrial Property Rights: Utilizing the Resources of the Final Frontier*, 18 SAN DIEGO INT'L L. J. 77, 90 (2016).

[66] Viets, *supra* note 51, at 165.

[67] Myers, *supra* note 65, at 91.

[68] Jill Stuart, *Is the Outer Space Treaty Fit for the Modern Age?* CBS NEWS (Feb. 20, 2017), https://www.cbsnews.com/news/is-the-outer-space-treaty-fit-for-the-modern-age/.

[69] Outer Space Treaty, *supra* note 64, art. IV; *see also* LYALL & LARSON, *supra* note 60, at 53.

[70] Outer Space Treaty, *supra* note 64, Preamble

[71] LYALL & LARSON, *supra* note 60, at 53.

[72] Outer Space Treaty, *supra* note 64, art. III.

[73] Outer Space Treaty, *supra* note 64, arts. I, II.

mining or settling planets would be possible, perhaps they intended those activities to be a unified effort among nation States. Unfortunately, the treaty provides little practical guidance for how the States should implement any of the OST's edicts.[74]

Likewise, the provisions of the OST offer little guidance or even discussion on how to appropriately allocate criminal jurisdiction to the States. Article VI, paragraph 1 of the treaty states that "[p]arties to the Treaty bear international responsibility for national activities [governmental or nongovernmental] in outer space."[75] Additionally, the OST provides that jurisdiction and control over objects belongs to the State in which the objects or personnel in outer space are registered.[76] Thus, while discussing jurisdiction and liability generally, the OST does not refer specifically to criminal jurisdiction.

The OST clearly designates international law as applicable to space activities but falls short of providing more concrete explanations of State responsibilities.[77] Nonetheless, when creating an international legal framework to address criminal jurisdiction, it should incorporate the general purpose and major principles OST: the use of outer space for the benefit of all nations and as a vehicle to strength ties between nations.

B. Decades of Space Treaties Have Added Nothing to Our Understanding of Jurisdiction

Despite the fact that humanity has weathered more than fifty years since the adoption of the OST, the legal boundaries of criminal acts in space have yet to be clarified by later treaties. The Liability Convention of 1972 provides a little assistance in addressing civil liability for a launching State whose property causes damage to "elsewhere than on the surface of the earth."[78] The Convention provides a mechanism where two States are joint and severally lia-

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[74] Christopher C. Miller, *To The Moon & Beyond: The United States and the Future of International Space Law*, 35 SUFFOLK TRANSNAT'L L. REV. 121, 130 (2012).

[75] Outer Space Treaty, *supra* note 64, art. VI.

[76] Outer Space Treaty, *supra* note 64, at art. VIII.

[77] Mary B. McCord, *Responding to the Space Station Agreement: The Extension of U.S. Law into Space*, 77 GEO. L.J. 1933, 1936 (1989).

[78] Convention on International Liability for Damage Caused by Space Objects art. III, Mar. 29, 1972, 24 U.S.T. 2389, 961 U.N.T.S. 187.

ble for damage caused to an object. In this situation, claimants present their claims through diplomatic channels, and if no settlement is reached after a year, "either party may request that a Claims Commission be established to decide the case."[79] While addressing civil liability, the Liability Convention essentially translates responsibilities recognized under Article VII of the OST into actual liability.[80] Furthermore, the Convention provides a means to effectively resolve disputes among nations, albeit focused on civil rather than criminal law.

Other treaties also incorporate the general principles of the OST but provide little guidance on criminal jurisdiction. The 1975 Registration Convention requires the State sending objects into outer space to register the object in its appropriate registry.[81] If two States join together to launch a space object, they must determine which country will register the craft.[82] However, this determination does not affect a party's jurisdiction claim and control over the space object.[83] As a result, the effect of this provision is to encourage nations to dispute the merits of jurisdiction at all opportunities. A later treaty addresses a separate issue of requiring signatory States to take steps to return astronauts or space objects that fall in their territory back to their launching State.[84] The final relevant treaty is the Moon Agreement. Opened for signature in the 1979, the treaty currently has less than 20 States parties.[85] The Moon Agreement was an attempt to create a legal framework governing property claims in space.[86] The Moon Treaty was rejected by all spacefaring nations for embracing the "equitable sharing" of extracted

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[79] *Id.,* at art. XIV.

[80] Viets, *supra* note 51, at 168.

[81] McCord, *supra* note 77, at 1936-37.

[82] *Id.* at 1937.

[83] *Id.*

[84] *See* Agreement on the Rescue of Astronauts, the Return of Astronauts and the Return of Objects Launched into Outer Space, Apr. 22, 1968, 19 U.S.T. 7570, 672 U.N.T.S. 119.

[85] Craig Foster, *Excuse Me, You're Mining My Asteroid: Space Property Rights and the U.S. Space Resource Exploration and Utilization Act of 2015*, 2016 U. ILL. J.L. TECH. & POL'Y 407, 417 (2016).

[86] Myers, *supra* note 65, at 102.

resources in space.[87] Because the Moon Treaty is not widely embraced, it is unlikely its principles will be adopted to a legal framework for criminal jurisdiction in space.

These treaties have more to do with civil liability than they have to do with criminal liability. Building on the vague language of the OST, the Liability Convention attempts to create a solution for a situation in which two or more States dispute civil liability for damages caused to property or person by a space object. The Convention's solution includes the employment of diplomatic channels and, should such effort not succeed, through the creation of a Claims Commission. And the registration requirement found in the Registration Agreement encourages the potential for frequent jurisdictional disputes among nations. The problems that arise in respect of national civil liability disputes are paralleled with criminal jurisdiction concerns. There needs to be an international solution to address these concerns.

C. The International Space Station Intergovernmental Agreement

Space stations present several problems for countries regarding jurisdiction, not to mention additional issues of registration, control and liability. In 2016, there were three space stations still in orbit: the Tiangong-1 and Tiagong-2, registered to China, and the International Space Station (ISS).[88] When these space stations are constructed and then used by the nationals of the station's State of registry, then there are no problems of international law. However, when space stations are built as a cooperative undertaking between States with citizens from different countries, then jurisdictional lines are blurred, and a formal agreement is necessary.[89]

The International Space Station Intergovernmental Agreement of 1998 ("1998 IGA") is the closest application available of criminal law jurisdiction in space.[90] Since the implementation of

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[87] *See* Agreement Governing the Activities of States on the Moon and Other Celestial Bodies art. 11, Dec. 18, 1979, 18 U.S.T. 2410, 1363 U.N.T.S. 22. *See also* Foster, *supra* note 85, at 417; Myers, *supra* note 65, at 102.

[88] LYALL & LARSON, *supra* note 60, at 110.

[89] *Id.*

[90] Agreement Concerning Cooperation on the Civil International Space Station, Jan. 29, 1998, 1998 U.S.T. 212 [hereinafter 1998 IGA].

this agreement, the ISS has hosted over 200 researchers, scientists and even tourists from at least nineteen countries.[91] Canada, the European Space Agency (ESA), Japan and the USA entered into an agreed to construct the space station in 1988.[92] When Russia joined the multilateral endeavor in 1998, a new agreement replaced the 1988 version. While the OST contains seventeen provisions dealing with nation-state activities in space, the 1998 IGA includes twenty-eight.[93] The most important of the topics discussed in the 1998 IGA are Article XXII, "Criminal Jurisdiction," and Article XI, "Crew."[94]

Article XXII of the 1998 IGA explicitly explains that "Partner States" to the agreement retain criminal jurisdiction over their respective nationals.[95] There are two scenarios where a Partner State may prosecute, when: 1) misconduct in orbit "affects the life or safety of a national of another Partner State"; or 2) misconduct "occurs in or on or causes damage to the flight element" (e.g., module or equipment) of another party.[96] Additionally, the affected State can exercise criminal jurisdiction, only after *consulting* with the State of the alleged perpetrator, and the perpetrator's State agrees or fails to agree within ninety days of consultation.[97] The form of jurisdiction under the Article XXII is a mix between two traditional forms of jurisdiction discussed before: nationality and territorial.[98] And in the case of a dispute, the nations are presumably supposed to resolve the dispute after consulting.

The 1998 IGA is a vast improvement in international from its 1988 predecessor. During the drafting of the 1988 version of the intergovernmental agreement, the US was the dominant partner in terms of spending, equipment and expertise; it had significant bargaining power.[99] As a result of this power discrepancy over other Partner States, the 1988 agreement included a blanket grant of US jurisdictional power. Section 2 of the 1988 agreement stated that

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[91] Marc Garcia, *Visitors to the Station by Country*, NASA (Sept. 25, 2019), https://www.nasa.gov/feature/visitors-to-the-station-by-country/.

[92] LYALL & LARSON, *supra* note 60, at 111–12.

[93] 1998 IGA, *supra* note 90.

[94] *Id.*

[95] *Id.* at art. 22(1).

[96] *Id.* at art. 22(2).

[97] *Id.*

[98] Viets, *supra* note 51, at 202.

[99] Ratner, *supra* note 32, at 334.

the US "may exercise criminal jurisdiction over misconduct committed by a non-US National in or on a non-US element of the manned base or attached to the manned base."[100] Many believed this exclusive grant of jurisdiction to be unprecedented, a flagrant disregard of the cooperative nature of the ISS experiment and out of character with the international purpose of the OST signed decades earlier.[101] However, once Russia joined the agreement in 1998, the United States was no longer the dominant power. This power shift was reflected in the revision of Article XXII, which omitted the extra jurisdiction the US gave itself.[102] Further, this US concession in criminal jurisdiction reflected a fundamental shift in its attitude toward the ISS project and deep commitment toward cooperation in outer space.

Unfortunately, Article XXII of the 1998 IGA contains no guidelines for assessing whether a person's conduct endangers the safety of the crew.[103] Procedurally, Article XXII does refer to the ISS "Code of Crew Conduct" (COCC) in Article XI.[104] Every national of a party to the 1998 IGA is required to review and sign the CCOC before going to the ISS.[105] The COCC includes prohibitions on the taking of materials on the space station for private gain by selling in the space souvenir market and the harassment of crew members. It also provides for the protection of intellectual property.[106] However, the disciplinary measures for the individual are determined by the nation State of the crew member.[107] The creation of the COCC underscores the importance of creating a unified set of rules for governing criminal conduct between space travelers.

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[100] Agreement Among the Government of the United States of America, Governments of Member States of the European Space Agency, the Government of Japan, and the Government of Canada on Cooperation in the Detailed Design, Development, Operation, and Utilization of the Permanently Manned Civil Space Station, Sept. 29, 1988, Temp. State Dep't No. 92-65, 1992 WL 466295 [hereinafter 1988 IGA]; Taylor Stanton Hardenstein, *In Space, No One Can Hear You Contest Jurisdiction: Establishing Criminal Jurisdiction On the Outer Space Colonies of Tomorrow*, 81 J. AIR L. & COM. 251, 279.

[101] Hardenstein, *supra* note 100, at 279-280.

[102] Ratner, *supra* note 32, at 337-38.

[103] 1998 IGA, *supra* note 90, art. 22(2).

[104] *Id.* at art. 22(5).

[105] LYALL & LARSON, *supra* note 60, at 129.

[106] *Id.* at 130.

[107] *Id.*

The ISS framework provides a method of apportioning criminal jurisdiction among Partner States and an application of substantive criminal law to enforcing crew discipline. While some suggest that the method for establishing jurisdiction in outer space is through Article XXII,[108] it is not without its drawbacks. For example, Article XXII, section 2 does not discuss jurisdiction over a space tourist who is not a national of an ISS participant State. An attempt to claim jurisdiction by a non-Partner State in this situation would be contrary to the 1998 IGA, which only grants criminal jurisdiction to the Partner States. This may need to be expanded if applied outside of the ISS.

While the 1998 IGA attempts to solve problems of criminal jurisdictions in Article XXII, the agreement fails to offer any meaningful guidance for Partner States disputing jurisdiction. Section 2 explicitly gives Partner States affected by an incident involving a non-national the ability to request jurisdiction over the individual.[109] The Partner States will, effectively, "consult [each other] . . . concerning their respective prosecutorial interest" and they have a 90-day timeframe to decide on jurisdiction.[110] This is problematic because it is unlikely that either Partner State will cede criminal jurisdiction, especially when they both have rightful claims of jurisdiction. For good reason, a State may choose to claim criminal jurisdiction as a demonstration of political power. If a third-party was involved, this international law power struggle might be more easily solved.

IV. ANALOGOUS SITUATIONS FOR CRIMINAL JURISDICTION

If international treaties adopted after the OST provide little clarification on the issue of criminal jurisdiction, then the drafters should look to other analogous scenarios. There are other sources of criminal jurisdiction that could apply to space law. International criminal jurisdiction can be based on traditional forms of jurisdiction, analogous situations, or specific agreements. Drawing on

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[108] Hardenstein, *supra* note 100, at 282.

[109] *Id.* at 279.

[110] 1998 IGA, *supra* note 90, art. 22(2).

these perspectives, this article will analyze a variety of ways to determine how criminal jurisdiction could be applied to Space Race 2.0.

A. Traditional Forms of Jurisdiction at Customary Law

The OST specifically indicates that international law applies to space activities. Certain long-standing doctrines of international law might be able to provide a better framework for understanding the problem of jurisdiction in space. There are four basic principles of criminal jurisdictions that apply to international law: territorial, nationality (and passivity), protective and universality.[111] These theories represent the possible basis for a State to claim jurisdiction over criminal actions abroad.[112]

i. Territorial Principle

The territorial principle is the most common basis of jurisdiction in the US. The principle is grounded in the argument that sovereign countries exercise jurisdiction within their territory, or acts having a "substantial effect within its territory."[113] This principle of jurisdiction was traditionally and originated from the US, but it includes many drawbacks.[114] In a case from 1906, a French citizen was accused of murdering an American citizen in China.[115] Referring to the case, the then Secretary of State stated "the United States government does not exercise jurisdiction over crimes committed beyond the territorial limits of this country . . . Our [consular officials] have no authority to try a French citizen charged with a crime in that country even though the victim should happen to be an American.[116]

The case demonstrates the limits of territoriality and jurisdiction over a State's own citizens. Despite the fact that a US citizen is the victim of a crime, the citizen, or her estate, has no avenue of

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[111] Christopher L. Blakesley, *United States Jurisdiction Over Extraterritorial Crime*, 73 J. CRIM. L. & CRIMINOLOGY 1109, 1110–11 (1982).

[112] *Id.* at 1114.

[113] McCord, *supra* note 77, at 1939.

[114] Blakesley, *supra* note 111, at 1115-16.

[115] *Id.* at 1116.

[116] *Id.* (quoting M.S. Department of State, file no. 226/16 (Sept. 17, 1906) (internal citation omitted)).

justice through her country's prosecutors against the perpetrator. Instead, the form of jurisdiction relies on the country whose territory the perpetrator committed the crime in, to prosecute the individual, which may never occur if certain laws do not exist in that jurisdiction. Although the territorial principle appears to be straight forward, it has many exceptions which would limit a State's jurisdictional reach from criminal actions abroad.[117] In space, if a nation were a party to the Registration Convention of 1972 or more broadly under the authority of Article VI of the OST, the principle of territoriality could easily apply through the registration of spacecraft or objects in a State's registry. Like the Registration Convention of 1972, the vessel or module would then be a section, albeit small, of national territory where jurisdiction might apply.

ii. Nationality Principle

The nationality principle applies to the individual. Under this basis, a sovereign nation has jurisdiction over the acts committed by its citizens, regardless of the individual's location. The approach derives from the old Roman notion that "one's law travels with him." Historically, it was an important concept because the honor and the respect of a country was believed to be jeopardized when a citizen committed a crime abroad.[118]

Related to the nationality principle is the passive personality principle. This type of jurisdiction is also based on the national, but instead countries retain jurisdiction when the victims (and not perpetrators) are of the forum State.[119] In other words, passive jurisdiction permits a forum State to establish jurisdiction over aliens who commit crimes on foreign soil against victims who are nationals of the forum State.[120] However, this principle has been criticized

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[117] *Id.* at 1117.

[118] Ratner, *supra* note 32, at 329.

[119] Blakesley, *supra* note 111, at 1111.

[120] Regula Echle, *The Passive Personality Principle and the General Principle of Ne Bis In Idem*, 9 UTRECHT L. REV. 56, 60–61 (2013); Eric Talbot Jensen, *Exercising Passive Personality Jurisdiction over Combatants: A Theory in Need of a Political Solution*, 42 THE INT'L LAW. 1107, 1112–14 (2008).

for being an aggressive form of jurisdiction and because "the perpetrator cannot anticipate which law would be applicable since he often does not know the victim's nationality."[121]

If the nationality (or passive personality) principle were applied in space, then astronauts or space tourists would be subject to the criminal jurisdiction of their sovereign country, regardless of their location.[122] Even beyond this, a nation may consider extending this basis of jurisdiction specifically to corporations, vessels, aircraft and spacecraft.[123] While not specifically addressed in detail in this article, these entities could be treated as legal persons and become subject to a sovereign nation's jurisdiction in the same way that an individual would.[124] This idea is similar to the concept of flagship jurisdiction discussed below. Because nationality jurisdiction has many benefits when applied abroad, a future where countries assert jurisdiction based on the nationality of the spacecraft seems extremely plausible.

iii. Protective Principle

The protective principle grants jurisdiction over specific acts, regardless of by whom or where they were committed, that might affect a country's security or its interests.[125] Some commentators contend that this basis of jurisdiction is overbroad because States have to claim jurisdiction based on extremely attenuated threats.[126] The protective principle poses significant dangers to State relations, so most national penal codes throughout the world recognize its limitations.[125] This principle would be easily abused in space, given how much damage a falling multi-ton space station might

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[121] Echle, *supra* note 120, at 60.

[122] Ratner, *supra* note 32, at 328.

[123] *Id*.

[124] *Id.*

[125] *Id*. at 329-30.

[126] *Id*. at 330.

[125] Blakesley, *supra* note 111, at 1138.

cause to a country. Not to mention, there have already been instances where countries have intentionally decommissioned or blown up satellites, creating considerable debris.[126]

iv. Universality Principle

> On the clearest of nights when the winds of the Etherium were calm and peaceful, the great merchant ships with their cargoes of Arcturian solar crystals felt safe and secure. Little did they suspect that they were pursued by Pirates! And the most feared of all these pirates was the notorious Captain Nathaniel Flint!
>
> –Narrator, Treasure Planet (2002)[127]

The last principle, universality, allows a State to prescribe punishment for offenses "recognized by the community of nations as of universal concern."[128] The sovereign nation exercising jurisdiction does not need a direct connection to the crime being committed, which makes it unique from the other principles of traditional, international jurisdiction. Many of these crimes are so heinous that virtually all nations have created domestic laws against them, and they are a violation of international law: piracy, hijacking, genocide, slave trading, apartheid and war crimes.[129] The basic principle behind this form of jurisdiction is that the criminal actions are so sufficiently serious that all nations have an equal interest in preventing them.[130] Many of the serious crimes that universality jurisdiction applies to are repackaged in the theory of *jus cogens* from which there can be no State exemption.[131] Probably the most exciting application of universal jurisdiction to criminal law in space would be

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[126] Loren Grush, *India Shows It Can Destroy Satellites in Space, Worrying Experts About Space Debris*, THE VERGE (Mar. 27, 2019, 11:50 AM), https://www.theverge.com/2019/3/27/18283730/india-anti-satellite-demonstration-asat-test-microsat-r-space-debris.

[127] *Treasure Planet*, WALT DISNEY PICTURES (2002).

[128] McCord, *supra* note 77, at 1939.

[129] Ratner, *supra* note 32, at 330.

[130] *Id*.

[131] Cherif Bassiouni, *International Crimes: Jus Cogens and Obligatio Erga Omnes*, 59 L. & CONTEMP. PROBS. 63, 66 (1996).

to the concept of space piracy.[132] This is unlikely to include the seizure of another nation's space craft by the crew of another, due to the vacuum of space making such feats essentially impossible.[133] Instead, the most common forms of piracy would be a cyber-based or wireless attack on spacecraft or satellites.[134] This would be a common criminal concern covered under universal jurisdiction on a spacecraft.

B. The Law of International Waters

The law of international waters provides an interesting analogy to space travelers. Citizens on the sea are often traveling for extended periods of time. They are in a confined setting, and they are in tough environments. Thus, looking at how crimes and criminal jurisdiction plays out on a ship could enlighten our idea of how to handle crime in space. Consider cruise ships, which are essentially floating cities carrying thousands of passengers and crew.[135] Although the crime rate on cruise ships is relatively low, both passengers and crewmembers commit crimes against other passengers and crewmembers to varying degrees.[136] These crimes include, sexual assault, disappearances (presumably, kidnapping) and theft.[137] The jurisdiction over these crimes at sea are outlined in international law in the United National Convention on the Law of the Sea (UNCLOS). While the United States is not a party to UNCLOS, the organization provides substantial value to the international community and "embodies the main source of international law outlining jurisdiction over the seas."[138]

Jurisdiction on the high seas and in maritime law embraces a predominantly territorial approach to international law, based on the registration of the ship.[139] This concept is embraced, in part, by

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[132] *See* Viets, *supra* note 51, at 159 (suggesting that the word "space piracy" be added to the space law lexicon so that it can be implemented in future space treaties); *Treasure Planet*, WALT DISNEY PICTURES (2002).

[133] Viets, *supra* note 51, at 205.

[134] *Id.*

[135] Asia N. Wright, *High Seas Ship Crimes*, 7 LOY. MAR. L. J. 1, 4 (2009).

[136] *Id.* at 4-5.

[137] *Id.*

[138] *Id.* at 15, 15–16 n.70.

[139] Hardenstein, *supra* note 100, at 275.

space law through the system of registering space objects.[140] Further, the concept of "flagship jurisdiction" – that ships are the sovereign territories of the nation whose flag they fly – also demonstrates a method of handling crimes immediately. For example, a sea captain's authority to exercise restraints on her crew is a common practice.[141] During extended periods of time, a sea captain is crucial for order on a ship to address conflict, assign responsibilities and identify the chain of command.

The idea of using flagship jurisdiction to handle criminal law in space was tested in the Draft Convention on Manned Space Flight.[142] The agreement used key elements from the OST and the Rescue Agreement to give jurisdiction to the nation of a space ship's State of registry and create a chain of command for handling crimes in space. The agreement was drafted by a group of experts in space law from Germany, Russia and the United States and published to draw attention and comment from the legal community. While the agreement has not been adopted, it provides useful guidelines on international cooperation and liability on long-term flights.[143] Article IV gives responsibility for the spacecraft and the persons onboard to the commander. Further, it holds that the commander on the spacecraft is accountable to the overall Mission Director on Earth.[144] This method provides a way to manage space travelers for long duration flights as well as guidance for defusing harmful conflicts. Additionally, the crew and passengers may feel safer knowing the commander is responsible for the protection of both the crew and the rights of the perpetrator, if ever a crime were committed.[145]

The law of international waters, as it applies to criminal jurisdiction in space, has some drawbacks. Spaceships are more expensive to build than ships at sea. Much like the ISS, multiple States may own parts of the full spacecraft. Under a "flagship jurisdiction" States may have trouble agreeing who should register the spacecraft. Nina Tannenwald argues that the analogy between outer space and the high seas is fading because of the nature of space and

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[140] Viets, *supra* note 51, at 202.

[141] Wright, *supra* note 135, at 34.

[142] Karl-Heinz Bockstiegel, Vladlen Vereshchetin & Stepehen Gorove, *Draft for a Convention on Manned Space Flight*, 40 GER. J. AIR & SPACE L. 3 (1991).

[143] RUWANTISSA ABEYRATNE, SPACE SECURITY LAW 45 (2011).

[144] Newman, *supra* note 11.

[145] *Id*.

its uses are significantly different than the high seas.[146] However, Tannenwald focuses primarily on using the high seas analogy to support the militarization of space.[147] This article does not focus on weaponizing space in self-defense but rather on criminal jurisdictions. Thus, the analogy of how a crew might operate on a spacecraft or space colony is still valuable for the purposes of criminal law, and Tennenwald's hesitations are less warranted.

C. The Law of Antarctica

The law of Antarctica provides some insight into how criminal law in outer space should be managed. Not only are the rigid climate and bountiful resources in Antarctica strikingly similar to the space environment, but the continent is also similar in terms of jurisdiction. One federal court in the tort case *Beattie v. United States* likened outer space to "Antarctica as a sovereignless geographical area."[148] The Antarctica Treaty System (ATS), derived from the initial Antarctica Treaty of 1959, still governs how partners operate in Antarctica.[149] The language of the preamble of the Antarctica Treaty parallels the language in the preamble of the OST, stating that "Antarctica shall continue forever to be used exclusively for peaceful purposes . . . [and] with the interests of science and the progress of all [hu]mankind . . . ."[150] Furthermore, the Treaty explicitly indicates that it does not create any "rights of sovereignty in Antarctica."[151] And while it explicitly prohibits the "establishment of military bases and fortifications" it implicitly permits the construction of scientific and research facilities.[152]

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[146] Nina Tannenwald, *Law Versus Power on the High Frontier: The Case for a Rule-Based Regime for Outer Space*, 29 YALE J. INT'L L. 363, 388 (2004).

[147] *Id*. at 388-90.

[148] R. Thomas Rankin, *Space Tourism: Fanny Packs, Ugly T-Shirts, and the Law in Outer Space*, 36 SUFFOLK U. L. REV. 695, 699 (citing Beattie v. United States, 756 F.2d 91, 100 (D.C. Cir. 1984) (comparing Antarctica to space) ("Like decisions . . . holding that Antarctica is not a 'foreign country'; for various purposes, the treatment of outer space is persuasive by analogy.")).

[149] *See* Antarctic Treaty, Dec. 1, 1959, 12 U.S.T. 794, 402 U.N.T.S. 71 [hereinafter Antarctic Treaty].

[150] *Id.,* preamble; Todd F. Chatham, *Criminal Jurisdiction in Antarctica: A Proposal for Dealing with Jurisdictional Uncertainty and Lack of Effective Enforcement*, 24 EMORY INT'L L. REV. 331, 337 (2010).

[151] Antarctic Treaty, *supra* note 149, art. IV.

[152] *Id.,* art. I.

To accomplish these international principles, the parties recognized that there would be conflicting jurisdictional claims that would need to be resolved.[153] Article VIII of the Antarctica Treaty addresses the question of jurisdiction, however, some scholars like Todd Chatham, contend that it was left "very incomplete."[154] In particular, Article VIII establishes that observers under the treaty, scientists and their staff are subject only to national jurisdiction.[155]

Alternatively, jurisdictional disputes over conflicts involving Antarctic tourists, military personnel or other nonprivileged foreign nationals, is left to the signatories to find their own solution.[156] They are only required to "*consult* together with a view to reaching a mutually acceptable solution."[157] Chatham avers that the system of jurisdiction based solely on nationality is unpredictable, and leaving the Partner States to come to a "mutually acceptable solution" is naïve. It is unlikely, theorizes Chatham, that one country will cede its "rightful" claim to jurisdiction to a claim of jurisdiction that may be more legitimate because it could be seen as yielding a claim of sovereignty.[158] Chatham attempts to solve this problem by recommending a regime solely tasked with resolving these jurisdictional disputes between partners in the ATS.[159]

The law of Antarctica is one of many stepping stones that could help improve jurisdictional disputes in outer space. Unfortunately, the ATS does not address concerns of territorial jurisdiction that have been applied on the ISS, such as components of the station or the station's origin as the basis for territorial jurisdiction. Chatham also points out that "the problem with basing criminal jurisdiction in Antarctica on the universal theory of territoriality is that the territory in question has been in dispute for over 100 years . . . ."[160] This means that there is a level of uncertainty as to the underlying decision to who has criminal jurisdiction - territoriality, while en-

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153 Chatham, *supra,* note 150, at 331.
154 Antarctic Treaty, *supra* note 149, art. VIII. Chatham, *supra* note 150, at 340.
155 Antarctic Treaty, *supra* note 149, art VIII.
156 *Id*.
157 *Id*. (emphasis added).
158 Chatham, *supra* note 150, at 353.
159 *Id.*
160 *Id*. at 343.

couraging nations to disregard conflicting claims of criminal jurisdiction.[161] Nonetheless, the AST shares similar principles to the OST and a "consulting" clause for determining jurisdiction. This is also similar to the 1998 IGA provision, which says that when there are two rightful claims to jurisdiction under national or territorial jurisdiction, the Partner States must "consult with such [Partner] State concerning their respective prosecutorial interests."[162]

V. A TWO-PART PROPOSAL TO CRIMINAL JURISDICTION IN OUTER SPACE

There are many concerns that should encourage the international community to agree on a new criminal law regime in outer space. As mentioned in Part II, there is a level of inevitability that humans crammed in close quarters for long periods of time, will experience behavioral issues that affect the crew, no matter how well trained they are. A system of social order and a method for administering justice on long term, interplanetary missions are essential to protecting the safety of the crew and mission objectives. Further, a clearer set of rules and principles for extending domestic jurisdiction out into space will correct the power imbalances among Partner and non-Partner States claiming prosecutorial interest over a criminal act.

Ideally, the international community would adopt a universal criminal code in space. This code would be a workable solution to the jurisdiction problem by creating exclusive criminal jurisdiction for crimes outlined in the code. Additionally, this approach would address other problems related to space crime, such as *mens rea*, trial by peers, and standards for a "reasonable astronaut." While a universal criminal code is an ideal end, the current political climate and lack of an international tribunal system to interpret the code, make the solution unworkable. Spacefaring nations – such as Russia, China and the United States – will likely view such a code as ceding their dominant power, as evidenced by past treaties. Alternatively, nonspacefaring nations might see the code as another barrier to entry for spacefaring activities.

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[161] *Id.*

[162] 1998 IGA, *supra* note 90, art. 22(2).

In order to meet the impending demands of Space Race 2.0, there needs to be a regime that can resolve criminal jurisdictional disputes among all countries. First, the international community should extend the 1998 IGA's combination of nationality and territorial jurisdiction as the basis for jurisdiction on all spacecraft, planetary colonies and research stations. Second, the community should adopt a multinational, space advisory board that is devoted to resolving criminal jurisdictional disputes among all States.

A. Adopt the ISS 1998 IGA Principles of Jurisdiction

Currently, the 1998 IGA is the closest available application of criminal law jurisdiction in space. The longstanding use and application of the agreement, in addition to its overwhelming support by major spacefaring nations, clearly demonstrates its weight. Furthermore, the changes between the 1988 IGA to the 1998 IGA, particularly the even distribution of jurisdictional powers to all countries, demonstrate that spacefaring nations are willing make concessions in order to cooperate in the use of outer space.[163] Given the overall acceptance of the 1998 IGA, any future application of criminal jurisdiction outside the ISS should be based on the principles of nationality and territoriality jurisdiction found in Article XXII of the 1998 IGA.

The transfer of Article XXII's system of jurisdiction as a model to future space travelers or colonization efforts makes sense. Movement in space is fluid. On the ISS, astronauts frequently move in and out of modules owned by other Partner States. Citizens of both Partner and non-Partner States will visit or travel on spacecraft they do not own. Jurisdiction based on the territorial principle alone would likely never be agreed to because it is arguably in direct violation of the OST, which prohibits a country from appropriating any celestial bodies as sovereign territory.[164] In the context of colonizing Mars or another celestial body, no State would have jurisdiction over an individual that commits a crime outside a spacecraft or habitat. Nationality is the logical extension to the treatment of jurisdiction and resolves the deficiencies of territorial jurisdiction.

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[163] *Compare* 1998 IGA, *supra* note 90, art. 22(2) *with* 1988 IGA, *supra* note 100, art. 22(2).

[164] Outer Space Treaty, *supra* note 64, art. II.

The 1998 IGA would be the baseline for a State's jurisdiction over criminal acts in space, but this, alone, would not make a clear framework for all space travelers.[165] First, the 1998 IGA does not discuss jurisdiction of a space tourist whose country is not a Partner to the agreement. Second, and possibly more problematic, is the same problem that occurs on international waters and in Antarctica: no nation would be willing to cede jurisdictional authority. Under traditional basis of jurisdiction, multiple States will likely claim jurisdiction for criminal acts and dispute their title. For this reason in particular, an international body should be created to resolve these disputes.

B. Create a Multinational Space Advisory Board

Currently, the way we resolve criminal jurisdiction is space is extremely problematic. This problem will worsen as Space Race 2.0 continues to expand with the support of both the private and public sector. Under traditional forms of jurisdiction, several nations might have "rightful" claims of jurisdiction over an individual's criminal act, but no method of customary international law exists to resolve the conflict. While Article XXII, Section 2 of the 1998 IGA advises countries disputing jurisdictional claims to consult with each other, there are power dynamics that make ceding jurisdictional authority unlikely. In order to deal with these jurisdictional conflicts in a way that is meaningful, flexible and efficient, the international space community should adopt a multinational, space advisory board that is devoted to the task of resolving criminal jurisdictional disputes in space.

The creation of a multinational, space advisory board would be an effective mechanism for resolving serious standoffs among States. Currently, Article XXII Section 1 of the 1998 IGA provides that Partner States have jurisdiction over persons who are their nationals.[166] And Article XXII Section 2, provides that the affected Partner State, may "consult with such [perpetrator] State concerning their respective prosecutorial interests."[167] Article XXII presupposes that first, all countries on the ISS are Partner States,[168]

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[165] Hardenstein, *supra* note 100, at 281.
[166] 1998 IGA, *supra* note 90, art. 22(1).
[167] *Id.* at art.22(2).
[168] *See id.* at art. 33.

which is problematic; and second, when Partner States "consult" to resolve a jurisdictional dispute, they will reach an agreeable solution.[169] What is much more realistic is that the country whose national commits a crime, will always make a (rightful) claim to jurisdiction. Alternatively, the country whose national is injured or whose property is damaged will always make a (rightful) claim to jurisdiction.

This new legal regime would apply to both Partner States and willing non-Partner States. Additionally, the legal regime would help eliminate the power dynamic among many States by allowing countries with more or less of a claim to jurisdictions to gracefully cede power by parties submitting before a council's decision. Resolving jurisdictional disputes among multiple nations would no longer require a dissatisfied State to publicly concede jurisdiction via the territorial or nationality principle.

To illustrate, State A, a non-Party State, may claim criminal jurisdiction over its national who commits a crime. State B, a Partner state, may claim prosecutorial interests because the crime occurred in State B's module; and Partner State C may claim criminal jurisdiction because its national was the victim. State A may truly believe that State B has a stronger claim to criminal jurisdiction, because State A is a non-Partner State. State A, however, would never concede criminal jurisdiction over its national. If State A conceded criminal jurisdiction during the "consulting" phase, then State A's assertion of criminal jurisdiction over any of its nationals would be weakened in all future attempts to claim jurisdiction, simply because it was a non-Partner State.

Alternatively, a multinational, space advisory board made up of voting representatives from each country could resolve this dispute peacefully. If State A was a voting representative on the board, then State A could vote against either State B or State C's claim of criminal jurisdiction. If the space advisory board determines that State B or State C has criminal jurisdiction, then State A is on the record publicly objecting to relinquishing criminal jurisdiction. This decision allows countries with less political clout to assert their right to jurisdiction yet cede gracefully to the board's decision in future criminal jurisdiction claims. Rather than one country with

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[169] *Id*. at art. 22(2)(b).

more resources bullying another country for jurisdiction, countries can resolve their disputes through a more formal process.

The board may also take into consideration other factors in deciding which country should have criminal jurisdiction. One concern would be that a country with fewer individual rights prosecutes a foreign perpetrator. For example, Russia might treat a South African citizen who commits a criminal act against a Russian astronaut in a Russian module more harshly than another State. The advisory board may want to consider several factors to address this issue, such as differences in individual human rights; the country of the victim; private citizen versus government employee; and due process rights. These factors are by no means exhaustive but could be useful in granting criminal jurisdiction. The downside might be that some countries may repeatedly vote according to interests that are fundamental to their society – such as democracy or socialism. As such, during the inception of the space advisory board, the board might develop broad, internal principles or guidelines that voting members can follow and prioritize certain factors. This could help prevent a country from stonewalling on a vote or reasserting jurisdiction on a single factor (i.e., individual rights) in every instance.

Once a multinational, space advisory board is created via a treaty or agreement, and represented by spacefaring and non-spacefaring States, the board may take on new responsibilities. Currently Article XXII of the 1998 IGA suggests that crew activities on the space station should follow the CCOC pursuant to Article XI, but the advisory board could make recommendations or changes to the CCOC, if it is adopted outside of the ISS. These changes could include provisions related to the chain of command discussed in the Draft Convention on Manned Space Flight. Passengers and crew on long-term flights would feel much safer knowing there is a system for defusing harmful conflicts. Additionally, it would make sense for the advisory board to make these recommendations because the chain of command would properly relay information to the board when it must determine jurisdiction disputes. In effect, the board may serve multiple functions as resolving criminal law jurisdiction and creating a system of law enforcement on the spacecraft and in colonies.

Most importantly, the new regime leaves intact the present ISS 1998 IGA system. The 1998 IGA has been an effective way for countries to operate on the international space station. Considering how difficult it can be for countries to come to international agreement, it would seem foolish to toss out an agreement that has been used for the last thirty years. Article XXII's system of jurisdiction should be extended to beyond the ISS, to the moon, Mars and interplanetary space ships. The changes in the 1988 to 1998 IGA demonstrate a growing willingness by Partner States to cooperate and compromise their own domestic superiority in favor of a more unified system.

The proposal of a multinational, space advisory board is a modest improvement to the ISS 1998 IGA and strong solution to criminal law in space. As men and women, private and nonprivate individuals and citizens from all nations begin to work, visit and live in space, we come closer to the achieving the guiding principles of the OST. That as humanity takes its next steps into the furthest reaches of space and establishes colonies off Earth, we'll also come closer together in cooperation. And maybe, one day in the distant future, when Captain Ohmer, is sailing amongst the stars on Starship Legacy, he'll be asked, "Excuse me, captain. What laws does your ship operate under?" To which, he would reply, "Well, isn't it obvious: Earth's."

ANJA NAKARADA PECUJLIC AND MATTEO TUGNOLI, *PROMOTING PRODUCTIVE COOPERATION BETWEEN SPACE LAWYERS AND ENGINEERS*

Review by Daniel A. Porras[*]

As noted at the outset of *Promoting Productive Cooperation Between Space Lawyers and Engineers*, edited by Anja Nakarada Pecujlic and Matteo Tugnoli (IGIGlobal, 2019) there are two big sets of challenges for space activities: technical and legal ones. While getting the math and physics right for launching a satellite can be difficult, getting the licenses and permits for a launch can also seem like rocket science. Much of the complexity comes from engineers and lawyers having to learn how to speak to each other so that technology and laws can develop together harmoniously. As more and more space activities emerge, the need for a book that simplifies technical and legal aspects of space and translates them for both audiences is evident. As nuanced as any multi-lingual dictionary, *Promoting Productive Cooperation Between Space Lawyers and Engineers* fills this niche and provides a solid basis for technical and legal experts to get their minds around the complexities of both disciplines. Moreover, the book provides references for further materials where engineers and lawyers alike can obtain more information. As such, *Promoting Productive Cooperation* is a must for any institution or company that is actively engaged in space activities.

One particularly good aspect of this book is the range of topics it covers. There are many activities in space that are already well-documented, such as telecommunications and Earth-imaging. This

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book, however, focuses on those activities which are only now becoming a reality. From sub-orbital flights to on-orbit servicing, there are crucial questions unanswered in public debates. Engineers need to know about laws and regulations, so they understand the legal limitations to their desired activities. Lawyers need to understand the technical capabilities of cutting-edge technology so that they draft appropriate legislation and secure the right permits. *Promoting Productive Cooperation* is especially useful as it contains separate chapters on each topic, almost like a translation of a single topic into "engineering-speak" and "legalese." Given the usefulness of this edition, the reader is likely to welcome the publication of additional volumes dedicated to telecommunications and Earth-imaging, in addition to the new activities and technologies that are emerging.

Another excellent aspect of this book is its clarity. Most likely due to the prodigious efforts of the editors, the book is clear and to the point. While many of the topics are highly complex (indeed, it really *is* rocket science), the individual chapters are broken up into logical sections that are easy to digest. This is especially important for non-experts. The clarity of the book is even more commendable in light of the fact that the experts come from many countries and with distinct writing styles.

Two chapters stand out in particular. The first concerns legal aspects of sub-orbital spaceflight, written by Dr Yuri Takaya. This chapter breaks down the distinctions between aircraft and spacecraft, as well as the legal quandaries over definitions for terms like "space object" and "space tourist." More importantly, it highlights the important distinction between state responsibility versus international liability, two distinct concepts that are often confused even by seasoned space lawyers. The second chapter that was extremely useful involves the technical aspects of mega-constellations, written by Dr Arthur Lacombe. This is a highly complex endeavor that requires an understanding of orbital mechanics, satellite engineering and telecommunications. This chapter was broken up in a way that was comprehensible and clarified certain misconceptions about what these constellations will achieve.

While this book is an overall success, there are two aspects that can be improved upon for future editions or volumes. First, the opening chapter on the Space Generation Advisory Council (SGAC)

is a bit out of place. While much of this book was put together through the support of SGAC, it might have been more appropriate to have this chapter as an intro or preface. As it is, the chapter is somewhat of a throwaway that most practitioners will likely overlook. Second, the book's contributors are nearly all of European origin. Consequently, much of the legal analysis focuses on European regulations and European perspectives of international law. While Europeans comprise some of the most prolific space actors today, a future edition of this publication could provide added value by presenting legal interpretations and perspectives from other countries (such as China, Russia and India, as well as developing countries).

Finally, it is evident that *Promoting Productive Cooperation* is a labor of love. Each of its chapters is meticulously documented and the topics well-explored. That the book manages to explain so many complex concepts and ideas in simple terms demonstrates that each of the contributors spends a great deal of time thinking about these issues and, perhaps more importantly, explaining them to non-experts. By finding practitioners and experts who love what they do, the editors have transmitted a passion for space and for learning about space. This book will encourage lawyers and engineers alike to learn more about each-others' disciplines and to become better informed about emerging technologies and regulations. It is the hope of this practitioner that such passion will result in more informed debates on space law and policies.

Overall, I highly recommend and endorse this book. It contains a lot of accessible information that is particularly useful for reference and research. It is structured logically and uses clear language. A reader can pick up this book and in moments have it open to the chapter he or she needs. If the book doesn't have the answer to a given question, it likely has a reference to a work where the reader can find the answer. This book is informative and useful. It is this author's hope that the editors will continue their work, producing future volumes as well as updated editions of *Promoting Productive Cooperation*.

NEIL DEGRASSE TYSON AND AVIS LANG *ACCESSORY TO WAR: THE UNSPOKEN ALLIANCE BETWEEN ASTROPHYSICS AND THE MILITARY*

Review by Jeremy J. Grunert[*]

On 19 February 2019, President Donald Trump signed Space Policy Directive 4 (SPD-4), directing the establishment of the United States Space Force as an independent military branch. Describing the creation of the Space Force as a "national security priority," President Trump further stated that the United States must be prepared "to deter aggression and defend the nation, our allies, and American interests against hostile actions in the form of space and taking place in space."[1] The Space Force announcement engendered varying responses, from outright mockery, to support, to nervous handwringing about space militarization. Two people who likely were neither laughing at, nor surprised by, the President's announcement were astrophysicist (and, more recently, pop culture celebrity) Neil deGrasse Tyson and Hayden Planetarium research associate Avis Lang, whose jointly-authored book, *Accessory to War: The Unspoken Alliance Between Astrophysics and the Military* (W.W. Norton & Company, 2018) was recently published in its paperback edition. For deGrasse Tyson and Lang, the formation of an American Space Force tracks with the underlying thesis of their

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[1] *Remarks by President Trump at Signing Ceremony for Space Policy Directive-4*, THE WHITE HOUSE (Feb. 19, 2019), available at https://www.whitehouse.gov/briefings-statements/remarks-president-trump-signing-ceremony-space-policy-directive-4/.

book as a natural, if lamentable, reflection of humankind's tendency to use technological advances for military preeminence and national glory.

In *Accessory to War*, deGrasse Tyson and Lang explore the symbiotic relationship between science and militarism—a relationship as mutually beneficial as it is strained by often-conflicting goals and values. DeGrasse Tyson illustrates this dichotomy in his introductory chapter, "A Time to Kill," detailing a personal anecdote in which he sat watching news coverage of the Operation Iraqi Freedom battle of Baghdad at the 2003 National Space Symposium, an annual gathering of scientists, military and government officials, defense contractors and others sponsored by the Space Foundation.[2] As the reporter described various weapons systems used in the battle and their manufacturers, deGrasse Tyson uneasily realized that employees of the named companies, many of which were prominent participants at the Symposium, were applauding whenever their particular weapons system was announced. DeGrasse Tyson cites this as the moment he recognized the existence of a dark relationship between science—the high-minded pursuit of knowledge and discovery he believed to be the key purpose of organizations like the Science Foundation—and militarism—the results-driven, warheads-on-foreheads practicality of applying scientific knowledge in the form of an offensive or defensive weapons system.[3] DeGrasse Tyson's realization provides him and Lang with one of their book's primary theses: without States' quests for military dominance or security, without the "military-industrial complex" and, indeed, without warfare itself, "there would be no astronomy, no astrophysics, no astronauts, no exploration of the solar system, and barely any comprehension of the cosmos."[4] Conflict and competition fuel scientific discovery, which, in turn, fuel additional

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[2] Founded in 1983, the Space Foundation, based in Colorado Springs, Colorado, is a prominent non-profit organization that describes itself as "the world's premier organization to inspire, educate, connect, and advocate on behalf of the global space community." *About Us*, SPACE FOUND., https://www.spacefoundation.org/who-we-are/ (last visited Sept. 27, 2019). The Space Foundation publishes reports, white papers, budget analyses and other documents related to outer space topics, and also sponsors a variety of events, including the annual Space Symposium.

[3] NEIL DEGRASSE TYSON & AVIS LANG, ACCESSORY TO WAR: THE UNSPOKEN ALLIANCE BETWEEN ASTROPHYSICS AND THE MILITARY 19-20 (2018).

[4] *Id.* at 20.

conflict and competition, in a cycle that has repeated itself since the dawn of civilization.

This thesis provides the impetus for the epic scale of Part I of deGrasse Tyson's and Lang's work, which begins at the beginning: over 6000 years ago, when ancient humans first began calculating measures of time on the basis of solar and lunar cycles. Part I, titled "Situational Awareness" (a classic military term for a person's knowledge of their surroundings), is a fascinating historical examination of the development of astronomy, navigation, physics and optics, as well as these sciences' contributions to geopolitics and warfare. Chapter 2, "Star Power," focuses on astrology and early astronomy, exploring humanity's primeval urge to find meaning in the astral portents of the stars and planets. From the omens of ancient Greece and imperial Rome, to Christopher Columbus's use of a solar eclipse to intimidate natives of the West Indies, to the Nazis' obsession with astrology, deGrasse Tyson and Lang detail the effects cosmic superstition has had on a range of civilizations. Chapter 3, "Sea Power," moves on to the sciences of navigation and cartography, detailing humankind's technological advancement from basic dead reckoning, to celestial navigation, to the invention of the magnetic compass and, finally, to the development of ever more complex geographic coordinate systems. The ultimate result? The United States Department of Defense's constellation of Global Positioning System (GPS) satellites. The final chapter of Part I, Chapter 4, "Arming the Eye," takes up optics and the development of telescopes, lenses, photography and spectroscopy—sciences that, per deGrasse Tyson and Lang's theme, contributed not only to military readiness (primarily in the fields of signaling and reconnaissance), but to the very birth of the science of astrophysics.

Having completed their historical overview of the sciences that contributed to the development of astrophysics, as well as their martial applications, Part II of *Accessory to War*, "The Ultimate High Ground," begins with deGrasse Tyson and Lang on the cusp of the Space Age. Chapter 5, "Unseen, Undetected, Unspoken," and Chapter 6, "Detection Stories," detail the discovery of the electromagnetic spectrum, comparing the astrophysicist's quest to study invisible spectrums and the warfighter's crusade for superior forms of camouflage (for their own troops or military hardware) and de-

tection (for the enemy's). Scientific advances in harnessing the electromagnetic spectrum resulted in the developments of radar detection, stealth technology, radio telescopes and ever more powerful, accurate photographic methods. As spectroscopic technologies developed, humankind's ability to use wavelengths to communicate via radio signals and track objects beyond Earth's atmosphere made the development of orbital satellites possible.

For the outer space devotee, the most significant chapters in *Accessory to War* are Chapter 7, "Making War, Seeking Peace," and Chapter 8, "Space Power." Here, at last, deGrasse Tyson and Lang have reached the apogee (so to speak) of their work: the Space Age and pressing modern questions of space militarization. "Making War, Seeking Peace" begins with a discussion of space weaponry, including cyber-weapons, space debris, lasers, kinetic-kill anti-satellite weapons (ASATs) and the missile defense technology of the Strategic Defense Initiative. The chapter continues with a sweeping chronicle of the Space Race between the United States and Soviet Union, which ultimately resulted in the United States' successful Moon-landing in 1969, as well as the development of nuclear weaponry by the two Super Powers. DeGrasse Tyson and Lang conclude "Making War, Seeking Peace," with a section on outer space diplomacy, the five primary outer space-related international treaties and, most specifically, the 1967 Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, Including the Moon and Other Celestial Bodies (more commonly known as the "Outer Space Treaty"). "Space Power," on the other hand, examines the application of outer space capabilities as a means of national power, including an extensive review of the United States' application of space technology during Operation Desert Storm. It also explores the outer space ambitions of Russia and China, the United States' two "near-peer" competitors on the international stage.

In their concluding chapter, "A Time to Heal," deGrasse Tyson and Lang reiterate the dangers of outer space threats (debris, militarization), while arguing that more terrestrial concerns (most specifically, climate change) make humankind's cooperation in space more necessary than ever. In what may smack more of idealism than scientific rationalism, they speculate that "off-planet survival"

may be sufficient to "override" humanity's geopolitical differences.[5] Ultimately, deGrasse Tyson and Lang imagine a future in which outer space, and their own field of astrophysics, "offer[] a way to redirect our species' urges to kill into collaborative urges to explore, to uncover alien civilizations, to link Earth with the rest of the cosmos . . . and protect our home planet . . . ."[6] It is, perhaps, a dream that fittingly expiates the guilt that deGrasse Tyson and Lang feel about the so-called "collaboration" between astrophysics and militarism.

A subject matter expert in the fields of space law or space security may find *Accessory to War's* treatment of outer space issues somewhat derivative. Readers of James Clay Moltz, Joan Johnson-Freese, John Klein and Everett C. Dolman will likely find little new in "Making War, Seeking Peace" and "Space Power." (Indeed, works from all four authors are cited throughout deGrasse Tyson's and Lang's discussions of space policy). Like Johnson-Freese, for instance, deGrasse Tyson and Lang turn a baleful eye on the United States' proclamations of space supremacy and pursuit of advanced military space capabilities, convinced that America's pursuit of space dominance will sow the seeds for an arms race in the cosmos.[7] "Militarization," they note, "is often exponential. Intensified, it breeds weaponization."[8] Similarly, Moltz's four schools of thought on the topic of space security are easily distinguishable throughout *Accessory to War*.[9] Particularly given deGrasse Tyson's and Lang's

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[5] *Id.* at 389.

[6] *Id.* at 404.

[7] Joan Johnson-Freese, currently Professor of National Security Affairs at the U.S. Naval War College in Newport, Rhode Island, has explored similar themes in HEAVENLY AMBITIONS: AMERICA'S QUEST TO DOMINATE SPACE (2009), and SPACE WARFARE IN THE 21ST CENTURY: ARMING THE HEAVENS (2017).

[8] DEGRASSE TYSON & LANG, *supra* note 3, at 302.

[9] Moltz describes four philosophical perspectives on the issue of space security: (1) "space nationalism," in which space is viewed simply as another environment for realism-based national competition between States; (2) "global institutionalism," in which humanity is able to harness international cooperation and organizations to collectively explore and exploit the vast, hostile cosmos; (3) "technological determinism," which theorizes that the course of technological development and scientific progress will naturally result in either (a) such positive benefits that States would begin working together in order to best harness the promise of these endeavors (optimistic view), or (b) an outer space arms race driven by the militarization of this technological development (pessimistic view); and finally, (4) "social interactionism," which stresses States' abilities to compromise and cooperate in order to set "rules of the road" for outer space, without the utopian bent of "global institutionalism." *See* JAMES CLAY MOLTZ, THE POLITICS OF

repeated characterization of outer space as the "ultimate high ground," a familiar reader will readily be able to place much of the book within Moltz's "space nationalism" and "technological determinism" (pessimistic) schools of thought, with the book's conclusion serving as a plaintive call for "global institutionalism" and scientific, rather than military, predominance in outer space.

That said, the intended audience for *Accessory to War* is not the expert practitioner but, rather, the curious non-expert. For the target audience, the book succeeds admirably. DeGrasse Tyson and Lang are expansive in their scope, providing their readers with digestible, though dense, chapters that both inform and entertain. For those unfamiliar with astrophysics, the symbiotic relationship between civilian and military science or outer space policy, *Accessory to War* provides a one-volume examination of these topics in some depth, without (perhaps surprisingly) being a mind-numbing slog. Best of all, deGrasse Tyson and Lang have amassed a lengthy bibliography that, for the especially curious reader, provides many high-quality jumping-off points for further reading.

Although there may be small points of criticism regarding the content of *Accessory to War*—for instance, some space lawyers may disagree with deGrasse Tyson and Lang's argument that the current international space law regime is "insufficient"—the only major critique of this reviewer lies in the book's subtitle. Considering the history of human space exploration, and, even farther back in time, the development of other technologies, it seems silly to describe the relationship between the military and science as an "unspoken" alliance. Indeed, deGrasse Tyson and Lang's research, and even their personal experiences (such as deGrasse Tyson's uncomfortable moment at the Space Symposium), seem to bely this characterization. If anything, the relationship between science and militarism, particularly in the nuclear age, has been open and widely-understood. The "Unspoken Alliance Between Astrophysics and the Military" is a catchy subtitle, but one that is inapropos.

With *Accessory to War*, Neil deGrasse Tyson and Avis Lang have crafted a wide-ranging work for the general public that provides an excellent background to major issues of space security, weaponization and technology facing the modern world. As we move

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SPACE SECURITY: STRATEGIC RESTRAINT AND THE PURSUIT OF NATIONAL INTERESTS 23-40 (3d ed. 2019).

into a future in which States maintain national "space forces" as branches of their militaries, in which the United States and its international competitors continue to develop increasingly complex space-based offensive and defensive systems and in which commercial entities continue to make advances toward lowering the costs of orbital launch, the central thesis of *Accessory to War*—that scientific advancement proceeds hand-in-hand with militarism—may continue to be born out. It remains to be seen whether deGrasse Tyson and Lang's hope for a more cooperative future in which this link can be decoupled is possible. If it cannot, the fault will lie, to butcher Shakespeare, not in the stars, but in ourselves.

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