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Rachel Mitchell

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NOTE

Into the Final Frontier: The Expanse of Space Commercialization

Rachel Mitchell*

*“Space, the final frontier. These are the voyages of the starship Enterprise. Its continuing mission: to explore strange new worlds; to seek out new life and new civilizations; to boldly go where no man has gone before.”*¹

I. INTRODUCTION

Space has captivated humankind since before telescopes were invented.² Danish astronomer Tycho Brahe founded an observatory and meticulously tracked the movement of planets without telescopic aid in the late 1500s;³ his calculations proved accurate to one arc minute.⁴ Fascination with the cosmos has also driven modern pop culture to create classics such as *Star Trek* and *Star Wars* and the more recent *Interstellar* and *The Martian*. Once imaginary, space voyages are now nearing reality. Innovative companies such as Space Exploration Technologies Corp. (“SpaceX”) seek to put man on Mars and beyond.⁵ Launches into space have been ongoing since the first satellite launch in 1957;⁶

*B.A., University of Missouri, 2012; J.D. Candidate, University of Missouri School of Law, 2019; Senior Lead Articles Editor, *Missouri Law Review*, 2018–2019. I would like to thank Professor Christina Wells for providing insightful feedback and suggestions during the writing process. I would also like to thank the entire *Missouri Law Review* staff for their support and guidance.

1. *Star Trek: The Next Generation: Encounter at Farpoint* (Paramount Television, Sept. 26, 1987).

2. Hans Lippershey was the first person to apply for a telescope patent in 1608, although it is disputed when it was first invented and by whom. Lauren Cox, *Who Invented the Telescope?*, SPACE.COM (Dec. 20, 2017, 10:30 PM), <https://www.space.com/21950-who-invented-the-telescope.html>.

3. Nola Taylor Redd, *Tycho Brahe Biography*, SPACE.COM (Sept. 12, 2017, 11:04 PM), <https://www.space.com/19623-tycho-brahe-biography.html>.

4. *Id.* An arc minute is an angular measurement used in astronomy to describe the position of objects in space. Specifically, an arc minute is 1/60 of a degree, while a degree itself is 1/360 of a circle. *Angular Measurements*, CALTECH, http://coolcosmos.ipac.caltech.edu/cosmic_classroom/cosmic_reference/angular.html (last visited June 5, 2018).

5. Stephen Clark, *SpaceX Announces Plan to Send Mission to Mars in 2018*, SPACEFLIGHT NOW (Apr. 27, 2016), <https://spaceflightnow.com/2016/04/27/spacex-announces-plan-to-send-mission-to-mars-in-2018/>.

6. Erik Conway, *Early History > First Satellites*, NASA, <https://www.jpl.nasa.gov/jplhistory/early/firstsatellites.php> (last visited June 5, 2018).

however, only recently have space activities shifted from being primarily conducted by national governments to being dominated by the private sector.⁷ Small victories in space commercialization have been achieved in some part through telecommunications and GPS satellites. But, as humankind approaches the technological tipping point to enable space mining and space tourism, commercial activities will rapidly expand.

This Note explores the emerging commercialization of space and the legal questions that arise as companies seek to further exploit the space economy. Whether or not new laws passed in the United States and in Luxembourg that purport to give ownership rights to companies that harvest space materials comply with the Outer Space Treaty⁸ is disputed. Furthermore, the international space regime may not be equipped to govern a new age in space. This Note advocates that space mining should be legalized but finds that space law in its current form is inadequate to effectively regulate space mining and other emerging space activities such as tourism.

II. LEGAL BACKGROUND

Outer space activities are largely governed through the United Nations' international treaties, which are developed through the Committee on the Peaceful Uses of Outer Space ("COPUOS").⁹ In the United States, most treaties must be adopted into law through legislation.¹⁰ Domestic law, both in the

7. The XPRIZE has been instrumental in helping to move the thrust of space activities from the public to the private sector. In 2004, the Ansari XPRIZE awarded \$10 million to the first privately-funded spacecraft to reach 100 kilometers twice within two weeks. See *Ansari Xprize*, XPRIZE, <https://ansari.xprize.org/> (last visited June 5, 2018). The XPRIZE continues to encourage and award innovators. The Google Lunar XPRIZE offered \$30 million to the first privately-funded team to successfully place a spacecraft on the moon, which then traveled for at least 500 meters and transmitted high definition video and photographs back to Earth. See *Google Lunar Xprize*, XPRIZE, <https://lunar.xprize.org/> (last visited June 5, 2018). Although the Google Lunar XPRIZE ended on January 23, 2018, without a grand-prize winner, its organizers have hailed the competition as a success for showing that exploration is no longer strictly the government's purview. Kenneth Chang, *The Google Lunar X Prize's Race to the Moon Is over. Nobody Won*, N.Y. TIMES (Jan. 23, 2018), <https://www.nytimes.com/2018/01/23/science/google-lunar-x-prize-moon.html>.

8. See *infra* Part II.A.1 (describing the Outer Space Treaty).

9. *Space Law Treaties and Principles*, UNITED NATIONS, <http://www.unoosa.org/oosa/en/ourwork/spacelaw/treaties.html> (last visited June 5, 2018).

10. *Whitney v. Robertson*, 124 U.S. 190, 194 (1888) ("When the stipulations are not self-executing, they can only be enforced pursuant to legislation to carry them into effect, and such legislation is as much subject to modification and repeal by congress as legislation upon any other subject. If the treaty contains stipulations which are self-executing, that is, require no legislation to make them operative, to that extent they have the force and effect of a legislative enactment."). See generally Carlos Manuel

United States and in other nations, may also fill the gaps by further regulating space activities. Therefore, this Part is divided into two subparts: international treaties and U.S. domestic law.

A. International Treaties

There are five space law treaties currently in effect: (1) 1967's 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"); (2) 1968's Agreement on the Rescue of Astronauts, the Return of Astronauts, and the Return of Objects Launched into Outer Space ("Rescue Agreement"); (3) 1972's Convention on International Liability for Damage Caused by Space Objects ("Liability Convention"); (4) 1976's Convention on Registration of Objects Launched into Outer Space ("Registration Convention"); and (5) 1984's Agreement Governing the Activities of States on the Moon and Other Celestial Bodies ("Moon Agreement").¹¹ Additionally, there are five U. N. declarations and legal principles that build off these treaties.¹² The Outer Space Treaty is the most important instrument because it serves as the basis for the others and has provided a guideline for the development of regional and national space law. As of January 1, 2017, 105 nations have ratified the Outer Space Treaty, including all nations with major space-faring capabilities.¹³ Finally, it is important to note the Antarctic Treaty, on which the

Vazquez, *The Four Doctrines of Self-Executing Treaties*, 89 AM. J. INT'L L. 695 (1995), for a discussion of the United States' approach to treaties.

11. *Space Law Treaties and Principles*, *supra* note 9.

12. See Declaration of Legal Principles Governing the Activities of States in the Exploration and Uses of Outer Space, G.A. Res. 1962 (XVIII) (Dec. 13, 1963) [hereinafter Declaration of Legal Principles]; Principles Governing the Use by States of Artificial Earth Satellites for International Direct Television Broadcasting, G.A. Res. 37/92 (Dec. 10, 1982) [hereinafter Broadcasting Principles]; The Principles Relating to Remote Sensing of Earth from Space, G.A. Res. 41/65 (Dec. 14, 1986) [hereinafter Remote Sensing Principles]; Principles Relevant to the Use of Nuclear Power Sources in Outer Space, G.A. Res. 47/68 (Dec. 14, 1992) [hereinafter Nuclear Power Sources]; Declaration on International Cooperation in the Exploration and Use of Outer Space for the Benefit and in the Interest of All States, Taking into Particular Account the Needs of Developing Countries, G.A. Res. 51/122 (Dec. 13, 1996) [hereinafter Benefits Declaration].

13. Status of International Agreements Relating to the Activities in Outer Space as at 1 January 2017, Comm. on the Peaceful Uses of Outer Space, U.N. Doc. A/Ac.105/C.2/2017/CRP.7, at 12 (Mar. 23, 2017) [hereinafter Status of International Agreements]. Major space-faring nations are generally considered to be those with full launch capability – currently: the United States, Russia, China, India, Japan, and, although not an individual nation, the European Union. Of these, only the first three have human spaceflight capabilities, although the United States ended its manned space program in 2011. See Marina Koren, *China's Growing Ambitions in Space*, ATLANTIC (Jan. 23, 2017), <https://www.theatlantic.com/science/archive/2017/01/china-space/497846/>; Robert Z. Pearlman, *NASA's Space Shuttle Program Officially Ends*

Outer Space Treaty was largely based, because it has been used as one way of interpreting the language of the Outer Space Treaty.¹⁴

1. Outer Space Treaty

The Outer Space Treaty emerged during the Cold War.¹⁵ During the Cold War, nuclear weapons were at the forefront of international concern, which, in the 1950s, caused the Soviet Union to demand that the United States remove nuclear warheads from its forward-operating bases as a precondition to any agreement on the use of space.¹⁶ The United States declined.¹⁷ As such, it is no surprise that when an agreement was reached, the Outer Space Treaty reflected the concerns of the era. The crux of the treaty promoted “cooperation”¹⁸ and prevention of the militarization – especially, the nuclear proliferation – of space against the backdrop of the “Space Race.”¹⁹ The treaty was adopted by the Soviet Union, the United States, and the United Kingdom in January 1967, following the United Nations’ Declaration of Legal Principles Governing the Activities of States in the Exploration and Use of Outer Space in 1963.²⁰

After Final Celebration, SPACE.COM (Sept. 1, 2011, 12:34 PM), <https://www.space.com/12804-nasa-space-shuttle-program-officially-ends.html>.

Since ending the shuttle program, the United States has relied on Russian launches to get its astronauts to space. Elizabeth Howell, *NASA Books More Astronaut Flights from SpaceX, Boeing*, SPACE.COM (Jan. 4, 2017, 3:46 PM), <https://www.space.com/35223-nasa-orders-astronaut-flights-spacex-boeing.html>. To eliminate this dependence, however, NASA began awarding launch contracts to SpaceX and Boeing in 2015. Press Release, NASA, *NASA Orders Second SpaceX Crew Mission to International Space Station* (July 29, 2016), <https://www.nasa.gov/press-release/nasa-orders-second-spacex-crew-mission-to-international-space-station>; see also Howell, *supra*.

14. Christopher M. Petras, “*Space Force Alpha*” *Military Use of the International Space Station and the Concept of “Peaceful Purposes”*, 53 A.F. L. REV. 135, 168 (2002).

15. Roald Sagdeev, Susan Eisenhower & John Logsdon, *United States-Soviet Space Cooperation During the Cold War*, NASA, https://www.nasa.gov/50th/50th_magazine/coldWarCoOp.html (last visited June 5, 2018).

16. *Id.* Forward-operating bases were military installations close to the Soviet Union’s borders, which is why the Soviet Union was uncomfortable with nuclear weapons at U.S. bases in places like Turkey. *Id.*

17. *Id.*

18. See generally 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].

19. *Id.*; see also Sagdeev, Eisenhower & Logsdon, *supra* note 15.

20. Outer Space Treaty, *supra* note 18; see also Nancy Flowers, *A Human Rights Glossary*, U. MINN. HUM. RTS. RESOURCE CTR., http://hrlibrary.umn.edu/edumat/hreduseries/hereandnow/Part-5/6_glossary.htm (last visited June 5, 2018) (defining “Declaration” as a “[d]ocument stating agreed upon standards but which is not legally binding”).

Article I of the Outer Space Treaty provides that exploration and scientific investigation of outer space, the Moon, and other celestial bodies “shall be carried out for the benefit and in the interests of all countries” and “be the province of all mankind.”²¹ Article II prevents any nation from claiming the Moon or any other space object as sovereign territory.²² Article III emphasizes that state parties (nations who are parties to the treaty) should indulge in the exploration of space with an interest in “maintaining international peace and security and promoting international co-operation and understanding.”²³ Article IV drives home the nuclear fears of the time with its ban on “nuclear weapons,” “weapons of mass destruction,” “military bases, installations and fortifications,” and the “testing of any type of weapons” on any celestial body.²⁴ It also declares that “the moon and other celestial bodies shall be used by all . . . exclusively for peaceful purposes.”²⁵ Article V bestows ambassadorial-like status upon all astronauts, declaring them the “envoys of mankind” and stipulating that all state parties are required to render assistance to any astronaut in distress whether they are located in space, on the territory, or on the high seas of Earth.²⁶

While the treaty was not focused on private space travel, it did foresee the need, at least in part, to address the future possibility with a specific reference to “non-governmental entities” in Article VI, which mandates that activities of both government and civilian personnel in space be authorized and supervised by their respective governments.²⁷ Article VII provides that any state parties involved in a launch are liable for damages caused by its launch to another party’s property or personnel.²⁸ Ownership of artificial space objects is addressed in Article VIII, which permits state parties to retain control over their vehicles, crews, and objects while those objects are in space.²⁹ The Article is silent about the ownership of materials removed from space objects (such as minerals mined from asteroids).³⁰

Article IX further contemplates space exploration as a joint venture between nations; it strongly advocates for cooperation and mutual assistance and requires all exploration be done in a manner that preserves space and protects the Earth from extraterrestrial contamination “so as to avoid . . . adverse

21. Outer Space Treaty, *supra* note 18, art. I.

22. *Id.* art. II.

23. *Id.* art. III; *see also id.* art. IX (further instructing co-operative exploration with an eye toward protecting celestial bodies from harmful human activities, and the Earth from extraterrestrial contamination).

24. *Id.* art. IV.

25. *Id.*

26. *Id.* art. V.

27. *Id.* art. VI.

28. *Id.* art. VII.

29. *Id.* art. VIII.

30. *See id.*

changes in the environment of the Earth.”³¹ Article X is a provision that allows state parties to request permission to observe the launches of other parties and allows parties to form agreements thereto.³² Article XI states that every State Party shall, to the greatest extent possible, notify the United Nations and the public about the “nature, conduct, locations and results” of space activities.³³ Next, Article XII states that every State Party is entitled to inspect all space stations, equipment, and vehicles located on the Moon or other celestial bodies so long as the State Party gives reasonable notice and does not interfere with the safety or operations.³⁴

After the Outer Space Treaty, additional agreements expanded the basic principles of international space law.

2. Other Treaties and Agreements

The Outer Space Treaty is a broad overview of the developing ideas behind space law. The treaties that followed continued to expand its principles. The Rescue Agreement is largely an elaboration of Articles V and VIII of the Outer Space Treaty; the agreement mandates that state parties shall take all steps to rescue and assist astronauts in distress.³⁵ The Liability Convention proscribes fault-based and strict-liability rules to damage caused by a State Party’s space objects to both the Earth’s surface, property located thereon, and space objects owned by another nation.³⁶ The Registration Convention gave the United Nations the ability to create a publicly-available register in order to assist with identification of space objects.³⁷ Finally, the most controversial of the treaties is the Moon Agreement, which not only reaffirms the Outer Space

31. *Id.* art. IX. NASA’s sub agency, Office of Planetary Protection, seeks to protect Earth “from possible life forms that may be returned from other solar system bodies.” *Overview*, OFF. PLANETARY PROTECTION, <https://planetaryprotection.nasa.gov/overview> (last visited June 5, 2018). Planetary protection is also one of the goals of the international body Committee on Space Research (“COSPAR”). *COSPAR Strategy Statement*, COMMITTEE ON SPACE RES., <https://cosparhq.cnes.fr/content/cospar-strategy-statement> (last visited June 5, 2018).

32. Outer Space Treaty, *supra* note 18, art. X.

33. *Id.* art. XI.

34. *Id.* art. XII.

35. 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 [hereinafter Rescue Agreement]; *see also* Outer Space Treaty, *supra* note 18, arts. V, VIII.

36. Convention on 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]; *see also* Outer Space Treaty, *supra* note 18, arts. VI, VII.

37. Convention on Registration of Objects Launched into Outer Space, Jan. 14, 1975, 28 U.S.T. 695, 1023 U.N.T.S. 15 [hereinafter Registration Convention].

Treaty in many ways but also attempts to address the long-term use of the Moon in more detail.³⁸

3. Moon Agreement

The Moon Agreement, despite its name, applies to not only the Moon but also to “other celestial bodies.”³⁹ Like the Outer Space Treaty, the Moon Agreement mandates that use of the moon is for “peaceful purposes” only.⁴⁰ It further bans the use of force, hostile acts, or the placement of nuclear weapons in orbit around the Moon or other celestial bodies.⁴¹ Article 4 states that exploration of the moon is to be carried out for the benefit of all nations and should also promote higher standards of living and conditions of economic and social progress.⁴² Article 5 requires parties to communicate and pass along information about moon activities as well as inform one another if multiple nations plan to use the same location.⁴³

The Moon Agreement also explicitly grants states the right to collect samples of celestial minerals and other substances for any scientific purpose.⁴⁴ Article 7 binds parties to protect the environment of the Moon and other celestial bodies.⁴⁵ Article 9 promotes the use of the Moon for space bases and explicitly allows states to establish stations so long as they immediately report the location and purpose of the base to the United Nations.⁴⁶ Space stations must also be installed in a way that does not impede nations’ right to explore.⁴⁷ In Article 11, the agreement labels the Moon’s natural resources as a “common heritage of mankind.”⁴⁸ It also calls for the establishment of an international regime to govern exploitation of the Moon’s resources.⁴⁹

The apparent reaffirmation of the Outer Space Treaty in the earlier provisions was to allay Soviet concerns over outer space militarization.⁵⁰ Yet, these articles were not and are not contentious.⁵¹ Instead, the Argentinian-drafted

38. See *infra* Part II.A.3; see also Agreement Governing the Activities of States on the Moon and Other Celestial Bodies, Dec. 5, 1979, 1362 U.N.T.S. 3 [hereinafter Moon Agreement].

39. Moon Agreement, *supra* note 38, art. I, ¶ 1.

40. *Id.* art. III, ¶ 1.

41. *Id.* art. III, ¶¶ 2–3.

42. *Id.* art. IV, ¶ 1.

43. *Id.* art. V.

44. *Id.* art. VI. No official definition of “scientific purpose” is given in the treaty.

45. *Id.* art. VII, ¶ 1.

46. *Id.* art. IX, ¶ 1.

47. *Id.* art. IX, ¶ 2.

48. *Id.* art. XI, ¶ 1.

49. *Id.* ¶ 5. The Moon Agreement consists of twenty-one Articles, but those not mentioned here do not have significant relevance to the subject of this Note.

50. Timothy G. Nelson, *The Moon Agreement and Private Enterprise: Lessons from Investment Law*, 17 ILSA J. INT’L & COMP. L. 393, 395–96 (2011).

51. *Id.*

“common heritage of mankind”⁵² language stirred controversy because of the political climate at the time; Western nations saw Article 11, and other economic provisions, as an attempt to spread socialism into space.⁵³ Supporters of the Moon Agreement argue that the “equitable sharing” contemplated in Article 11’s call for a regulatory scheme is not an attempt at wealth redistribution.⁵⁴ The language of the Moon Agreement, however, is vague and does not specify what impact “equitable sharing” would have on private profits,⁵⁵ therefore opponents may fear an unfavorable interpretation.

Because of this, the Moon Agreement has been largely rejected – only seventeen countries have ratified the Moon Agreement, none of which are major space-faring nations.⁵⁶ However, the United Nations Convention on the Law of the Sea describes the sea and its resources as the “common heritage of mankind,”⁵⁷ but, unlike the Moon Agreement, 168 nations (excluding the United States) have ratified it,⁵⁸ suggesting that the broad idea itself is not at issue.

4. Antarctic Treaty

The Antarctic Treaty was originally signed by twelve countries whose scientists worked on Antarctica in the late 1950s.⁵⁹ The treaty entered into force in 1961.⁶⁰ Since then, fifty-three nations have become parties to the treaty.⁶¹ This treaty has been seen as a blueprint for the Outer Space Treaty,⁶² and thus the following provisions are the most important in that context.

Article I states that use of Antarctica for military purposes is prohibited, and Antarctica shall be used only for peaceful purposes.⁶³ However, it also makes clear that peaceful military purposes, particularly scientific research, are permitted.⁶⁴ Article III is similar to the Outer Space Treaty in that it encourages

52. *Id.*

53. *Id.* at 401.

54. *Id.* at 400.

55. *Id.* at 401.

56. Status of International Agreements, *supra* note 13, at 12.

57. United Nations Convention on the Law of the Sea, art. 136, Dec. 10, 1982, 1833 U.N.T.S. 397 [hereinafter Law of the Sea].

58. *Chronological Lists of Ratifications of, Accessions and Successions to the Convention and the Related Agreements*, UNITED NATIONS, [http://www.un.org/depts/los/reference_files/chronological_lists_of_ratifications.htm#The United Nations Convention on the Law of the Sea](http://www.un.org/depts/los/reference_files/chronological_lists_of_ratifications.htm#The%20United%20Nations%20Convention%20on%20the%20Law%20of%20the%20Sea) (last updated Apr. 3, 2018).

59. *The Antarctic Treaty*, SECRETARIAT ANTARCTIC TREATY, <http://www.ats.aq/e/ats.htm> (last visited June 5, 2018).

60. *Id.*

61. *Id.*

62. Petras, *supra* note 14, at 168.

63. Antarctic Treaty, art. I, ¶ 1, Dec. 1, 1959, 12 U.S.T. 794, 402 U.N.T.S. 71.

64. *Id.* art. I, ¶ 2.

cooperation and exchanges of information between the parties.⁶⁵ Article V bans nuclear testing or waste disposal.⁶⁶ Article VII gives parties the right to access all of the continent freely, including the right to inspect all stations and equipment.⁶⁷

Unique to the Antarctic Treaty is the Article IV provision that states ascension to the treaty does not negate or disclaim any territorial sovereignty in Antarctica.⁶⁸ This is the opposite of the Outer Space Treaty, which specifically bans appropriation.⁶⁹ This is likely because by the time the treaty was signed, most of the signatories already had some kind of claim on the continent.⁷⁰ Despite not taking on the appropriation issue, the Antarctic Treaty is seen as one of the most successful international treaties because the international cooperation it fostered has led to significant scientific and environmental discoveries, such as the depletion of the atmospheric ozone layer.⁷¹

B. Domestic Law

The United States is one of the most advanced space-faring nations and has developed a robust body of national law for the space arena over the last seventy years. The first space-related law the United States passed created the National Aeronautics and Space Administration (“NASA”) in 1958.⁷² Congress addressed commercialization for the first time in the 1984 National Space Launch Act.⁷³ The Space Launch Act mandates licensure for private U.S. entities that want to launch vehicles into space.⁷⁴ Besides the Space Launch Act, most laws related to space addressed the growing business of near-earth satellites.⁷⁵ Until 2015, most recent changes in domestic space law only amended, replaced, or transferred the older body of law.

65. *Id.* art. III.

66. *Id.* art. V.

67. *Id.* art. VII, ¶ 3.

68. *Id.* art. IV.

69. Outer Space Treaty, *supra* note 18, art. II.

70. *The Antarctic Treaty*, *supra* note 59.

71. *The Antarctic Treaty Explained*, BRIT. ANTARCTIC SURV., <https://www.bas.ac.uk/about/antarctica/the-antarctic-treaty/the-antarctic-treaty-explained/> (last visited June 5, 2018).

72. National Aeronautics and Space Act of 1958, Pub. L. 85-568, 72 Stat. 426 (1958) (current version at 51 U.S.C. § 20111 (2012)).

73. 51 U.S.C.A § 50903 (West 2018).

74. *See* 51 U.S.C.A § 50904(a) (West 2018); The Office of Commercial Space Transportation, part of the Federal Aviation Administration (“FAA”), is responsible for managing launch licenses. *See Office of Commercial Space Transportation*, FED. AVIATION ADMIN., https://www.faa.gov/about/office_org/headquarters_offices/ast/ (last updated June 5, 2018).

75. *See, e.g.*, Communications Satellite Act of 1962, Pub. L. No. 87-624, 76 Stat. 419 (1962) (codified as amended at 47 U.S.C. ch.7); 51 U.S.C.A ch. 501 (West 2018) (originally codified at 42 U.S.C. § 14701 (1998)).

In November 2015, President Barack Obama signed the Spurring Private Aerospace Competitiveness and Entrepreneurship Act (“SPACE Act”) into law.⁷⁶ The SPACE Act revitalizes current national space law and targets private commercialization; it is “an Act to facilitate a pro-growth environment for the developing commercial space industry by encouraging private sector investment and creating more stable and predictable regulatory conditions, and for other purposes.”⁷⁷ The SPACE Act adds “reusable launch vehicles” to its licensing rules.⁷⁸ It also addresses indemnification requirements by specifically adding an additional category of persons to existing law, “space flight participants”⁷⁹ – presumably in anticipation of tourists. While the SPACE Act specifically disclaims extraterrestrial sovereignty over space bodies,⁸⁰ it also explicitly grants property rights over extracted materials to any U.S. citizen who harvests them.⁸¹

Two of the four bills that ultimately made up the SPACE Act were passed with broad bipartisan support, but the other two received intense criticism from some members of Congress.⁸² Particularly troublesome was a provision that prohibits the Federal Aviation Administration (“FAA”) from enacting any safety regulations for private travelers on commercial spacecraft until 2023⁸³ because opponents saw it as far too benevolent toward the private space industry.⁸⁴ Similarly, the provision granting property rights to space minerals was also opposed, though on grounds that it might violate the Outer Space Treaty.⁸⁵ Amendments to curtail or eliminate either controversial provision failed.

III. RECENT DEVELOPMENTS

On March 24, 2006, SpaceX,⁸⁶ a private company founded by billionaire Elon Musk in 2002, launched its first demonstration flight, Falcon 1, from a

76. U.S. Commercial Space Launch Competitiveness Act, Pub. L. No. 114-90, 129 Stat. 704 (2015) (codified as amended in scattered sections of 51 U.S.C.) [hereinafter SPACE Act].

77. *Id.*

78. *Id.* § 104 .

79. *Id.* § 103.

80. *Id.* § 403.

81. *Id.* § 402.

82. Jeff Foust, *Congress Launches Commercial Space Legislation*, SPACE REV. (May 26, 2015), <http://www.thespacereview.com/article/2759/1>.

83. *Id.*

84. *Id.*

85. *Id.*

86. *Launch Manifest*, SPACEX, <http://www.spacex.com/missions> (last visited June 5, 2018). SpaceX’s ultimate goal is to “enabl[e] people to live on other planets.” SPACEX, <http://www.spacex.com/about> (last visited June 5, 2018). In order to achieve this, SpaceX has focused primarily on the development of rockets and spacecraft. *Id.* In addition to its lofty goal of colonization, SpaceX is also notable because, in 2012, it became the first private company to resupply the International Space Station. *Id.*

U.S. missile test site at Kwajalein Atoll on the Marshall Islands.⁸⁷ Falcon 1 achieved liftoff, but the rocket failed to make it to space.⁸⁸ SpaceX attempted to launch Falcon 1 again in March 2006 and again in August 2008, but it similarly failed to reach orbit.⁸⁹ It was not until its fourth attempt on September 28, 2008, that Falcon 1 became the first private space rocket to orbit the Earth.⁹⁰ In April 2016, only ten years after its inaugural flight, SpaceX announced that it would send a capsule to Mars by 2018.⁹¹ And in February 2017, SpaceX released the news that it would fly two private space tourists around the Moon in 2018.⁹² SpaceX has quickly become a leader in private space initiatives, largely thanks to its innovative reusable rockets, which are the key to making space travel and exploration affordable⁹³ and are the basis for the company's aggressive Mars landing plans.⁹⁴ On February 6, 2018, SpaceX successfully launched its rocket, Falcon Heavy, which is the largest rocket ever built at a staggering twenty-three stories tall.⁹⁵ In addition to the successful payload launch, the bottom half of the rocket landed safely back on Earth so that it can be reused.⁹⁶ The Falcon Heavy's payload, destined to orbit Mars, is a Telsa

87. See *Launch Manifest*, *supra* note 86.

88. Tariq Malik, *SpaceX's Inaugural Falcon 1 Rocket Lost Just After Launch*, SPACE.COM (Mar. 24, 2006, 6:15 PM), <https://www.space.com/2196-spacex-inaugural-falcon-1-rocket-lost-launch.html>.

89. Tariq Malik, *SpaceX Successfully Launches Falcon 1 Rocket into Orbit*, SPACE.COM (Sept. 28, 2008, 8:49 PM), <https://www.space.com/5905-spacex-successfully-launches-falcon-1-rocket-orbit.html>.

90. Press Release, SpaceX, *SpaceX Successfully Launches Falcon 1 to Orbit* (Sept. 28, 2008), <http://www.spacex.com/press/2012/12/19/spacex-successfully-launches-falcon-1-orbit>; see also Malik, *supra* note 89.

91. Clark, *supra* note 5.

92. *SpaceX to Send Privately Crewed Dragon Spacecraft Beyond the Moon Next Year*, SPACE.COM (Feb. 27, 2017), <http://www.spacex.com/news/2017/02/27/spacex-send-privately-crewed-dragon-spacecraft-beyond-moon-next-year>.

93. Although the financial savings of SpaceX's reusable booster are not yet fully known, it is expected that a reused rocket launch would be at least thirty percent cheaper than the \$62 million-dollar price tag of a new rocket launch. San Diego Union-Tribune Editorial Board, *SpaceX Reusable Rockets Launch Elon Musk into History*, SAN DIEGO UNION-TRIBUNE (Mar. 31, 2017, 3:09 PM), <http://www.sandiegouniontribune.com/opinion/editorials/sd-spacex-musk-reusable-rocket-20170331-story.html>; Alan Boyle, *Launch a Rocket Every Day? SpaceX's Elon Musk Kicks It up a Notch for Reusability*, GEEKWIRE (Mar. 30, 2017, 7:44 PM), <https://www.geekwire.com/2017/spacex-falcon-elon-musk-reusability/>. If SpaceX also manages to make other parts of the rocket, not just the booster, reusable, the launch price could eventually be less than one percent of the current cost. *Id.*

94. Mike Wall, *SpaceX Rocket Could be 100-Percent Reusable by 2018*, SPACE.COM (Apr. 10, 2017, 1:44 PM), <https://www.space.com/36412-spacex-completely-reusable-rocket-elon-musk.html>.

95. Tariq Malik, *Success! SpaceX Launches Falcon Heavy Rocket on Historic Maiden Voyage*, SPACE.COM (Feb. 6, 2018, 4:14 PM), <https://www.space.com/39607-spacex-falcon-heavy-first-test-flight-launch.html>.

96. *Id.*

car.⁹⁷ The Falcon Heavy is an instrumental asset in the company's Mars landing plan because SpaceX intends to send it to Mars twice in 2022 to deposit cargo and supplies for a future manned mission.⁹⁸ The first manned mission to Mars, planned for 2024, will be aboard the Big Fucking Rocket ("BFR"), the larger, future successor to the Falcon Heavy.⁹⁹ BFR, however, will not just be a long range rocket, it will also change aviation as we know it by reducing flight times between major cities.¹⁰⁰ The reusable BFR will be able to travel to any location on Earth in an hour or less.¹⁰¹ In addition to private commercial ambitions, SpaceX has also partnered with NASA to resupply the International Space Station.¹⁰² NASA is not the only U.S. agency to work with SpaceX either; in 2016, the U.S. Air Force awarded a contract to SpaceX for the development of a rocket propulsion system.¹⁰³

SpaceX is not the only spacefarer with new missions on the horizon. In January 2017, NASA announced plans to visit the asteroid 16 Psyche.¹⁰⁴ 16 Psyche is located in the asteroid belt between Mars and Jupiter and is unique among asteroids because it is made up almost entirely of metals similar to Earth's core.¹⁰⁵ Although NASA's mission is one of discovery, commentators

97. *Id.*

98. Mike Wall, *Elon Musk Wants Giant SpaceX Spaceship to Fly People to Mars by 2024*, SPACE.COM (Sept. 29, 2017, 1:35 AM), <https://www.space.com/38313-elon-musk-spacex-fly-people-to-mars-2024.html>.

99. *Making Life Multiplanetary*, SPACEX, <http://www.spacex.com/mars> (last visited June 5, 2018).

100. *Id.* For example, it currently takes 10.5 hours to fly from Los Angeles to London by air, but a trip through low orbit aboard the BFR would be only thirty-two minutes. *Id.*

101. *Id.*

102. *Commercial Resupply Services Overview*, NASA, https://www.nasa.gov/mission_pages/station/structure/launch/overview.html (last visited June 5, 2018).

103. Jeff Foust, *Air Force Adds More than \$40 Million to SpaceX Engine Contract*, SPACENEWS (Oct. 21, 2017), <http://spacenews.com/air-force-adds-more-than-40-million-to-spacex-engine-contract/>. Like NASA, the Air Force is also aggressively pursuing options to end its dependence on Russia for space launches. To that end, Congress passed the National Defense Authorization Act for Fiscal Year 2018, which, among many provisions, gives the Air Force more flexibility for funding rockets. See National Defense Authorization Act for Fiscal Year 2018, Pub. L. No. 115–91, § 1605, 131 Stat. 1283, 1724–25 (2017).

104. *NASA Selects Two Missions to Explore the Early Solar System*, NASA (Jan. 4, 2017), <https://www.jpl.nasa.gov/news/news.php?feature=6713>.

105. *Id.* It is thought that 16 Psyche might have once been a planet and that its outer layers have been stripped away, leaving just the metallic core. *16 Psyche*, NASA, <https://solarsystem.nasa.gov/small-bodies/asteroids/16-psyche/in-depth/> (last visited June 5, 2018).

have been quick to point out that the iron alone on the 16 Psyche has an estimated value of \$10,000 quadrillion.¹⁰⁶ In comparison, the Central Intelligence Agency (“CIA”) estimated that world GDP in 2016 was approximately \$122.6 trillion dollars (spending power).¹⁰⁷ Companies looking to launch private space mining missions are unlikely to initially target 16 Psyche because it is located far from Earth and the technicalities of reaching it would be costly in terms of both time and money,¹⁰⁸ but the asteroid’s value speaks volumes as to why there is a push toward this new mining venture.

Although all asteroids are not as valuable as 16 Psyche, “regular” asteroids – those not composed solely of Earth-core-like minerals – are valuable as well. Planetary Resources, a U.S. company hoping to become one of the first to mine an asteroid, estimates a single asteroid the size of a football field could contain up to \$50 billion in platinum, compared to the \$2.6 billion Caltech estimates for the cost of prospecting.¹⁰⁹ Planetary Resources has announced its plan to target near-Earth asteroids and has detailed the way in which it will choose destinations.¹¹⁰ The company is on its way to achieving this goal: on January 12, 2018, it launched its Arkyd-6 satellite to test some of its prospecting technologies.¹¹¹ In 2020, the company will begin its Space Resource Exploration Mission, which will consist of multiple small spacecrafts traveling to near-Earth asteroids to collect samples.¹¹²

The United States and its “citizens” (private space companies) are not alone in taking advantage of the boundless resources of space. In June 2016, Luxembourg announced it would create a \$227 million fund to assist private

106. Monique Scotti, *NASA Plans Mission to a Metal-Rich Asteroid Worth Quadrillions*, GLOBAL NEWS (Jan. 16, 2017, 12:39 PM), <https://global-news.ca/news/3175097/nasa-plans-mission-to-a-metal-rich-asteroid-worth-quadrillions/>.

107. *The World Factbook*, CENT. INTELLIGENCE AGENCY, <https://www.cia.gov/library/publications/the-world-factbook/geos/xx.html> (click on the tab “Economy - overview” to find source of this data) (last visited June 5, 2018).

108. The asteroid belt, where 16 Psyche is located, is 1.2–2.2 astronomical units (approximately 111,546,968–204,502,776 miles) from Earth. See Matt Williams, *How Long Does It Take to Get to the Asteroid Belt?*, UNIVERSE TODAY (Aug. 10, 2016), <https://www.universetoday.com/130231/long-take-get-asteroid-belt/>.

109. Jim Edwards, *Goldman Sachs: Space-Mining for Platinum is ‘More Realistic than Perceived’*, BUS. INSIDER (Apr. 6, 2017, 6:46 AM), <http://www.businessinsider.com/goldman-sachs-space-mining-asteroid-platinum-2017-4>.

110. *How We Choose Our Near-Earth Asteroid Targets*, PLANETARY RESOURCES (Aug. 28, 2015), <https://www.planetaryresources.com/2015/08/how-we-choose-our-asteroid-targets/> (detailing the selection process and even naming 1999 JU3 as a specific target).

111. Matt Williams, *Asteroid Mining Is Getting Closer to Reality. Planetary Resources Arkyd-6 Satellite Just Launched*, UNIVERSE TODAY (Jan. 17, 2018), <https://www.universetoday.com/138266/asteroid-mining-getting-closer-reality-planetary-resources-arkyd-6-satellite-just-launched/>.

112. *Id.*

companies in the development and realization of space mining ventures.¹¹³ Planetary Resources is a beneficiary of Luxembourg's ambitious space investment and believes that asteroids will unlock the solar system's economy. Another U.S. company, Deep Space Industries, has signed a memorandum of understanding with Luxembourg for a joint venture in developing and testing an asteroid prospecting spacecraft known as "Prospector-X."¹¹⁴

To further encourage mining expeditions, Luxembourg became the second nation in the world after the United States, and the first in Europe, to pass a law that created property rights for any materials gained from Moon or asteroid mining, which became effective August 2017.¹¹⁵ Luxembourg's status as one of two countries rushing to commercialization is somewhat perplexing because Luxembourg is not, itself, a space-faring nation – it does not even have a space agency.¹¹⁶ In June 2017, it announced plans to create a space agency but specified that the agency's sole focus would be the commercial use of space resources.¹¹⁷

Despite the country's lack of a space agency, asteroid mining was not the first commercialized private space venture that Luxembourg pounced on. In 1985, Luxembourg gave satellite television broadcasting rights to the private company Société Européenne des Satellites ("SES") in a time when all other space satellites were owned and used exclusively by national governments through international agreements.¹¹⁸ When satellite TV became profitable, Luxembourg reaped significant financial rewards as the home of a leading telecommunications giant.¹¹⁹ If Planetary Resources and Deep Space Industries are successful, the potential rewards for the tiny nation could be even greater.

113. David Z. Morris, *Luxembourg to Invest \$227 Million in Asteroid Mining*, FORTUNE (June 5, 2016), <http://fortune.com/2016/06/05/luxembourg-asteroid-mining/>.

114. Emily Calandrelli, *Deep Space Industries Partners with Luxembourg to Test Asteroid Mining Technologies*, TECHCRUNCH (May 5, 2016), <https://techcrunch.com/2016/05/05/deep-space-industries-partners-with-luxembourg-to-test-asteroid-mining-technologies/>.

115. See Andrew Silver, *Luxembourg Passes First EU Space Mining Law*, REGISTER (July 14, 2017, 1:12 PM), https://www.theregister.co.uk/2017/07/14/luxembourg_passes_space_mining_law/.

116. Atossa Araxia Abrahamian, *How a Tax Haven Is Leading the Race to Privatise Space*, GUARDIAN (Sept. 15, 2017, 12:59 AM), <https://www.theguardian.com/news/2017/sep/15/luxembourg-tax-haven-privatise-space>.

117. Jeff Foust, *New Law and Space Agency to Support Luxembourg's Space Resources Ambitions*, SPACENEWS (June 6, 2017), <http://spacenews.com/new-law-and-space-agency-to-support-luxembourgs-space-resources-ambitions/>.

118. Abrahamian, *supra* note 116.

119. *Id.*

IV. DISCUSSION

This Part discusses how the recent developments in commercialization relate to preexisting laws and international treaties. First, the discussion centers on how the United States' space mining authorization interacts with the United States' obligations under the Outer Space Treaty. Second, this Part looks at the potential liability of the U.S. government for acts in space by private space companies or private space travelers. Finally, the relevance of current law is compared to present and future needs for modernization in the legal system.

A. Mining for Space Resources

Mining in space could become an important resource for Earth once the technology to do so effectively is developed. In light of this, the legal question of whether private ownership of space minerals is compliant with international space treaties must be determined. The Outer Space Treaty is no stranger to controversy. Its declaration that the "use of outer space [be] for peaceful purposes"¹²⁰ had previously been the subject of international dispute when the Soviet Union and the United States disagreed about the interpretation.¹²¹ The United States decided to define "peaceful purposes" in the same way it was used in the Antarctic Treaty, which states both that "Antarctica shall be used for peaceful purposes only" and "[t]he present Treaty shall not prevent the use of military personnel or equipment for scientific research or for any other peaceful purpose."¹²² Thus, the United States justified that "peaceful purposes" did not mean "nonmilitary." On the other hand, the Soviet Union consistently argued that reconnaissance missions, through the use of spy satellites, are military operations and are thus not peaceful and therefore are illegal under the treaty.¹²³

Likewise, what is meant by Article II of the Outer Space Treaty is now in contention.¹²⁴ Legal scholars do not agree whether space mining is lawful under the treaty. Some argue that the SPACE Act is a violation of the Outer Space Treaty because Article II prevents commercialized harvesting of space resources,¹²⁵ while others contend that the prohibition on appropriation is

120. Outer Space Treaty, *supra* note 18.

121. Kyle Evanoff, *The Outer Space Treaty's Midlife Funk*, COUNCIL ON FOREIGN REL. (Oct. 10, 2017), <https://www.cfr.org/blog/outer-space-treatys-midlife-funk>.

122. Antarctic Treaty, *supra* note 63, art. I.

123. Ivan A. Vlasic, *The Developing Law of Outer Space*, 14 CHITTY'S L.J. 241, 246 (1966).

124. Outer Space Treaty, *supra* note 18, art. II (stating that "Outer space, including the Moon and other celestial bodies, is not subject to national appropriation by claim of sovereignty, by means of use or occupation, or by any other means").

125. See *U.S. Space-Mining Law Seen Leading to Possible Treaty Violations*, CBC (Nov. 26, 2015, 7:12 PM), <http://www.cbc.ca/news/technology/space-mining-us-treaty-1.3339104> (Professor Ram Jakhu of McGill University's institute of air and

merely a bar to states exercising sovereignty.¹²⁶ The idea of non-appropriation of space was, however, adopted unanimously by the United Nations General Assembly in 1961 and reaffirmed in the Moon Agreement.¹²⁷ Although non-appropriation is usually attacked by those who are in favor of mining rights, it may be possible to reconcile the two if the concept of traditional Anglo property rights is abandoned.¹²⁸

When it comes to space activities, one proposal is to view harvesting as an “enterprise” right rather than a “property” right.¹²⁹ Enterprise rights describe the entitlements of private entities to operate in an unowned space and to collect and use the resources gained.¹³⁰ While the Outer Space Treaty’s principle of non-appropriation would bar exclusive occupation of a location, an argument in favor of enterprise rights is that it actually makes commercialization of space fair by preventing monopolies of desirable areas and resources.¹³¹ Similar arrangements have been made for other commercial ventures that use natural resources, such as offshore oil platforms.¹³² Artificial space objects, such as satellites, are already engaged in this kind of use. States may register orbital positions in the geostationary orbit to launch and operate satellites¹³³ – thus states are currently exercising enterprise rights through their use of particular spots in space.

Nevertheless, some argue that private ownership is the best direction and suggest that Article II of the Outer Space Treaty be interpreted very narrowly. One approach argues that the Outer Space Treaty only bars “national” appropriation, meaning government entities.¹³⁴ Under this interpretation, private appropriation is permitted.¹³⁵ Common law would not permit states to give property rights to private entities in the absence of sovereignty, but the civil law knows no such restraints because property rights can be recognized even in the absence of sovereignty.¹³⁶ Proponents of this view recognize that real property rights could not extend beyond the actual physical entity¹³⁷ but advocate that

space law saying that “natural resources . . . should not be allowed to be appropriated by anyone”).

126. RICKY J. LEE, *LAW AND REGULATIONS OF COMMERCIAL MINING OF MINERALS IN OUTER SPACE* 7, 169 (2012).

127. Leslie I. Tennen, *Enterprise Rights and the Legal Regime for Exploitation of Outer Space Resources*, 47 U. PAC. L. REV. 281, 284 (2016).

128. *Id.* at 285.

129. *Id.*

130. *Id.*

131. *Id.* at 286.

132. *Id.* at 285.

133. Petras, *supra* note 14, at 151.

134. WAYNE N. WHITE, JR., *REAL PROPERTY RIGHTS IN OUTER SPACE* 2 (1997), http://www.space-settlement-institute.org/Articles/research_library/WayneWhite98-2.pdf.

135. *Id.*

136. *Id.* at 6.

137. *Id.* at 6–7.

first-occupation be afforded exclusive rights insofar as the physical “envelope” – the physical location of the entity and a reasonable, safe distance around it – exists for as long as the entity is actively used.¹³⁸ But because Article VI requires that governments authorize and supervise any private citizens in space,¹³⁹ it is arguable that any activity performed in space, whether by the government or by a private actor, is considered “national” for purposes of the treaty.¹⁴⁰

Recognizing private rights for first-occupied space could be problematic. Retroactive claims from the Russians, whose claims would hold significant historic justification given that the Soviet Union was the first to launch a vehicle into space, could arise.¹⁴¹ Private and government entities alike would be encouraged to make claim to anything they can tenuously connect to themselves.¹⁴² Even if a state merely recognized the real property claims of private citizens, enforcement of exclusivity would contravene the treaty’s explicit right of parties to visit any manmade installations or equipment in space.¹⁴³ Untangling and enforcing overlapping claims might also lead to military action when inevitable disputes arise between citizens of diverse nations.¹⁴⁴

Exploration would also suffer. If areas of space were, essentially, “private property,” the owner could then prevent all others from utilizing the area, regardless of whether the desired activity was commercial, explorative, or scientific, and instead auction off the rights to whoever could pay the most.¹⁴⁵ Therefore the right of exploration¹⁴⁶ would be severely limited, and the cost of doing business in space would increase.

Although no consensus truly exists regarding whether ownership of privately mined space resources is a contravention of the Outer Space Treaty, the trend appears to favor an interpretation that allows for exploitation and profit in some form. If either property rights or “enterprise rights” are accepted, the question of regulation remains, a concept explored in Part IV.C.

B. Government Liability for Private Space Travelers

There is little question that governments are liable for any damages in space caused by private entities that are citizens of the State Party. The Outer Space Treaty both mandates that private entities be authorized and supervised by the State Party¹⁴⁷ and that the state parties are liable for damages caused by

138. *Id.* at 7–8.

139. Outer Space Treaty, *supra* note 18, art. VI.

140. Tennen, *supra* note 127, at 287.

141. *Id.* at 289.

142. *Id.* at 288–89.

143. Outer Space Treaty, *supra* note 18, art. XII.

144. Tennen, *supra* note 127, at 289.

145. *Id.*

146. Outer Space Treaty, *supra* note 18, art. I.

147. *Id.* art. VI.

any authorized personnel.¹⁴⁸ The Liability Convention goes further by meticulously proscribing fault-based regimes for in-space accidents.¹⁴⁹ But the treaties do not provide the intricate workings of insurance or indemnification at the national level. Instead, parties have been left to their own devices to determine how to implement these obligations. Indeed, the treaties also provide only for state action of personal injuries; therefore, if a space traveler is injured, he or she is not capable of bringing a claim on his or her own against the responsible state.¹⁵⁰

The liability, or lack thereof, for personal injury to space tourists appears to be a matter of domestic contract law or state regulation. Unfortunately, each nation will have its own principles, and therefore uncertainty will exist. One important consideration is whether space tourism should have some provisions for unlimited liability – as does the Liability Convention for certain damages¹⁵¹ – or if some form of cap on the upper limits of liability is preferable.¹⁵²

In the United States, private companies that receive launch licenses must also take on liability insurance as a matter of national law.¹⁵³ The SPACE Act requires that the company have insurance to cover liability related to its launch activities, protecting the government and personnel of both the government and any private persons associated with the company or its customers, including subcontractors and space flight participants.¹⁵⁴ Rather than unlimited liability, United States law imposes upper limits – the maximum of which is determined by the Secretary of Transportation.¹⁵⁵ For third parties, the limit is set at \$500 million, and for government losses the limit is \$100 million.¹⁵⁶ For claims that exceed the insurance limits, the U.S. government will pay the difference, up to \$1.5 billion.¹⁵⁷ Other nations have also sought to limit their own liability through national law.¹⁵⁸ For example, the Netherlands requires that a licensee have the maximum amount of liability insurance reasonably available for the licensee's space activities, and in Sweden, the law mandates that the government be reimbursed for any payments of damages it is required to make.¹⁵⁹

148. *Id.* art. VII.

149. Liability Convention, *supra* note 36, art. VI–VII.

150. *See id.*; Outer Space Treaty, *supra* note 18, art. VI.

151. *See* Liability Convention, *supra* note 36, art. II.

152. Steven Freeland, *Up, Up, and . . . Back: The Emergence of Space Tourism and Its Impact on the International Law of Outer Space*, 6 CHI. J. INT'L L. 1, 17–18 (2005).

153. 51 U.S.C.A § 50914(a)(1) (West 2018).

154. *Id.* § 50914(a)(4).

155. *Id.* § 50914(a)(2).

156. *Id.* § 50914(a)(1), (3).

157. *Id.* § 50915(a).

158. *See* Paul Stephen Dempsey, *National Laws Governing Commercial Space Activities: Legislation, Regulation, & Enforcement*, 36 NW. J. INT'L L. & BUS. 1, 31–32 (2016) (discussing legal liability regimes in many countries, including South Korea, Austria, China, and the United Kingdom).

159. *Id.* at 32.

The use of liability waivers is also uncertain. There is no contract uniformity even across the individual states of the United States to provide for liability waivers in the context of space tourism. Florida and New Mexico both have an informed consent waiver for spaceflight.¹⁶⁰ But other important states involved in space ventures, like California, do not. Given that space tourism and other “peaceful purposes” are likely to be carried out with a cross-section of earthly nationalities on board, developing an international scheme that provides certainty and uniformity is important. Moreover, without such a regime, private companies have no incentive to provide favorable terms to tourists, so a potential regime should consider both the need to incentivize space innovators and to protect consumer rights.

C. Modernization of Legal Regimes

The Outer Space Treaty was created in 1967 when only two nations, the United States and the Soviet Union, had the capability of launching anything into space.¹⁶¹ In 2017, the Outer Space treaty turned fifty years old. The Moon Agreement is the youngest of the international space treaties, written in 1979. No major treaty on space has been developed in nearly four decades. Therefore, there is a question whether the existing international law is capable of guiding today’s space exploration.

The Outer Space Treaty makes no mention of the regulation for exploitation of space resources.¹⁶² Instead, it is the Moon Agreement that obligates state parties to attempt to create an international regulatory scheme for exploitation as soon as “such exploitation is about to become feasible.”¹⁶³ Although few states have ratified the Moon Agreement,¹⁶⁴ the duty to create a regulatory scheme is no less paramount. The Moon Agreement further lists the purposes of such a regime, which include: safe development of resources,¹⁶⁵ logical management of resources,¹⁶⁶ expansion of opportunities to use the resources,¹⁶⁷ and “equitable sharing” by all parties of the benefits of the resources, with special consideration to be given to those states that have directly or indirectly contributed to the cultivation of the resources.¹⁶⁸ That the Moon Agreement does not ban the use of Moon resources is notable because it acknowledges that

160. See FLA. STAT. ANN. § 331.501 (West 2018); N.M. STAT. ANN. § 41-14-3 (West 2018).

161. Jason Krause, *The Outer Space Treaty Turns 50. Can it Survive a New Space Race?*, ABA J. (Apr. 2017), http://www.abajournal.com/magazine/article/outer_space_treaty.

162. See Outer Space Treaty, *supra* note 18.

163. Moon Agreement, *supra* note 38, art. XI, ¶ 5.

164. See Status of International Agreements, *supra* note 13.

165. Moon Agreement, *supra* note 38, art. XI, ¶ 7(a).

166. *Id.* ¶ 7(b).

167. *Id.* ¶ 7(c).

168. *Id.* ¶ 7(d).

the resources are instead the “common heritage of mankind,”¹⁶⁹ which need only be guided by a regulatory scheme.

Whether or not parties have ratified the Moon Agreement, an international regulatory scheme, is important to resolve contentions likely to emerge in the future as private companies become more ambitious in their plans for space activity.¹⁷⁰ The lack of a comprehensive regulatory scheme for commercial activities could create a new “Wild West” in outer space.¹⁷¹ Furthermore, a legal regime would also provide answers to other areas of possible concern: namely, protecting the environment, creating space traffic rules, and achieving humanitarian goals¹⁷² – for example, by creating an economic assistance fund to help poor countries whose livelihoods depend on exporting minerals that are now being imported en masse from space.¹⁷³ The current state of space law is simply not equipped to handle expansion on a large scale, and therefore nations need to look at updating existing law.

This Note discusses two suggestions for modernizing space law. First, this Note offers a more traditional approach by recommending that the Outer Space Treaty be amended or that current international models, such as the Law of the Sea and the Antarctic Treaty, be adapted to form a new regime for outer space. Second, a new, less orthodox approach is considered: a proposal that crowdsourcing should originate a fresh perspective on an international legal regime for space.

1. Amendment or Current International Agreements as a Blueprint

Creating a new treaty is a slow and arduous process, likely to move too slowly to meet imminent needs, and thus amendment of the Outer Space Treaty may be a more attractive option. Pushback from the private space industry, however, could keep any amendments to the Outer Space Treaty from being seriously pursued. For example, the space subcommittee of the U.S. Senate Commerce Committee held hearings in both April and May 2017 to solicit

169. *Id.* ¶ 1.

170. For example, Elon Musk has announced plans to both build a base on the Moon and to colonize Mars. Michael Slezak & Olivia Solon, *Elon Musk: SpaceX Can Colonize Mars and Build Moon Base*, GUARDIAN (Sept. 29, 2017, 4:30 PM), <https://www.theguardian.com/technology/2017/sep/29/elon-musk-spacex-can-colonize-mars-and-build-base-on-oon>.

171. See Benjamin D. Hatch, Comment, *Dividing the Pie in the Sky: The Need for a New Lunar Resources Regime*, 24 EMORY INT’L L. REV. 229, 266–67 (2010).

172. Tennen, *supra* note 127, at 291. Protection of the environment is mandated in the Outer Space Treaty. See Outer Space Treaty, *supra* note 18, art. IX.

173. This idea is adapted from a similar provision in the Law of the Sea Treaty that would help the poor who are affected by extraction of deep seabed minerals. See Law of the Sea, *supra* note 57, art. 150.

opinions from industry leaders.¹⁷⁴ Two panels of business leaders and attorneys argued against amendment of the Outer Space Treaty, concluding that the United States should simply create its own regulations to avoid “unfriendl[y]” changes that might negatively impact “American capitalism.”¹⁷⁵ This view seems to echo old Cold War concerns that socialism will permeate outer space if left to international consensus.

While it is true that any amendment of the Outer Space Treaty would require extensive negotiation, international treaties have been successful in other areas of law. Nations can and should legislate on a domestic, or even regional, basis until consensus is reached on the international scale. Domestic laws should fill regulatory gaps until an agreement is reached but should not be relied upon as the sole means to regulate commercial space activities.

Creating an international regime may not be as difficult as assumed; there is no need to completely “reinvent the wheel.” Existing international regimes in other areas of law could be helpful for designing and implementing updated space law. As Mark Watney, a fictional NASA astronaut in the novel *The Martian*, concluded, space is effectively international waters,¹⁷⁶ a theory based largely on the concepts embodied in the Law of the Sea.¹⁷⁷ The International Seabed Authority, an organization created by the Law of the Sea, has established a deep-sea mining code.¹⁷⁸ Space mining could be analogous to seabed mining, and therefore some of these provisions could be adapted. The United States has long been one of the only nations in the world not to have ratified the Law of the Sea.¹⁷⁹ But a 1994 implementation agreement for the Law of the Sea attempted to secure U.S. support by making the regime more market-friendly by reducing licensure fees and rescinding a prior provision that mandated mining technology transfers to the Enterprise (the official international body that conducts sea research and mining) upon demand.¹⁸⁰ These changes in the 1994 Law of the Sea Agreement mean that if the seabed regulations were

174. Jeff Foust, *Is It Time to Update the Outer Space Treaty?*, SPACE REV. (Jun. 5, 2017), <http://www.thespacereview.com/article/3256/1>.

175. *Id.*

176. ANDY WEIR, *THE MARTIAN* 195 (2011).

177. Law of the Sea, *supra* note 57.

178. *The Mining Code*, INT’L SEABED AUTHORITY, <https://www.isa.org.jm/mining-code> (last visited Apr. 15, 2018). Because the United States is not a party of the Law of the Sea, the United States has established its own scheme for seabed mining through the Deep Seabed Hard Minerals Act. See 30 U.S.C. §§ 1441–1444 (2012).

179. See *Chronological Lists of Ratifications of, Accessions and Successions to the Convention and the Related Agreements*, *supra* note 58. However, it has accepted that it has no extraterritorial sovereignty over the areas or resources in the deep seabed. 30 U.S.C. § 1402 (2012). The United States is a party to the High Seas Convention. Convention on the High Seas, Apr. 29, 1958, 13 U.S.T. 2312, 450 U.N.T.S. 82.

180. Agreement Relating to the Implementation of Part XI of the United Nations Convention on the Law of the Sea of 10 December 1982, annex § 5.2, July 28, 1994, 1836 U.N.T.S. 42 [hereinafter Law of the Sea 1994 Agreement] (stating that annex III, art. V of the Law of the Sea does not apply).

adopted for space, concerns about the friendliness toward “American capitalism” should be, at least in part, assuaged.

The Law of the Sea has several other attractive provisions that could meet the needs of exploration and exploitation of space. For instance, Article 137(1) bans acquisition of the deep seabed, beyond national boundaries, by anyone, be they sovereign nations or individual persons.¹⁸¹ This is important because it resolves the property or enterprise question discussed, *supra*, in Part IV.A in favor of the latter. Most nations, but particularly the United States, would want to adapt Article 302 because it explicitly exempts states from having to disclose information harmful to national security.¹⁸² Thus the location of spy satellites would remain a secret, insofar as they are not seen by a passing spaceship. Mining regulations meant to preserve the marine environment could be a useful template: the regulations could help establish a similar responsibility for entities who mine asteroids and those who operate in space generally.¹⁸³ Regulations also mandate that prospectors provide an annual report on their activities but, crucially, for entrepreneurs, guarantees confidentiality of all data and information except that which is relevant to environmental protection.¹⁸⁴

Another resource that could be used to formulate space regulations is the Antarctic Treaty. Although a subsequent international protocol banned Antarctic mining for fifty years,¹⁸⁵ which would likely not promote investment or private enterprise if adapted to space, the Antarctic Treaty itself has proven successful for fostering peaceful and joint scientific research and exploration.¹⁸⁶ These goals are also important for outer space activities, whether conducted publicly or privately. Another important aspect of an international regime for space would be a dispute resolution mechanism that has jurisdiction to hear claims not only between governments but also those involving private entities as parties. Again, the Law of the Sea provides a model.¹⁸⁷ Its dispute mechanism is a hybrid; it both allows states to work out their differences with each other on their own terms¹⁸⁸ and, when the parties cannot reach agreement, to submit to arbitration.¹⁸⁹

Updating existing space law treaties or using existing treaties in other areas as a blueprint for new regulations is a daunting but not an impossible task.

181. Law of the Sea, *supra* note 57, art. 137(1).

182. *Id.* art. 302.

183. *Cf.* DECISION OF THE COUNCIL OF THE INTERNATIONAL SEABED AUTHORITY RELATING TO AMENDMENTS TO THE REGULATIONS ON PROSPECTING AND EXPLORATION FOR POLYMETALLIC NODULES IN THE AREA AND RELATED MATTERS 6–7 (July 22, 2013), https://www.isa.org.jm/sites/default/files/files/documents/isba-19c-17_0.pdf (regulation 5).

184. *Id.* at 7 (regulations 6–7).

185. Protocol on Environmental Protection to the Antarctic Treaty art. 7, Oct. 4, 1991, 30 I.L.M. 1461, 1464 (1991).

186. *The Antarctic Treaty Explained*, *supra* note 71.

187. Law of the Sea, *supra* note 57, arts. 279–99.

188. *Id.* art. 280.

189. *Id.* arts. 286–87.

What remains to be seen is whether the political will needed to undertake it will materialize.

2. Crowdsourcing Space Law

There may be no need to “reinvent the wheel,” but in the alternative, what if reinventing the wheel is precisely what a new regulatory scheme requires? Space is out of this world, and therefore, perhaps, so is the solution. Rather than looking at the past to regulate the future, imagination may be prudent. After all, the United Nations still reflects a Cold War structure, which many believe needs reform to address the problems of today.¹⁹⁰ A new space-oriented body, free of the confines of the United Nations, could offer flexibility and new ideas that the machinery of an old, Cold War relic cannot. As Uber has proven, innovation can revolutionize an industry.¹⁹¹ And Uber’s crowdsourcing model may be just the injection of fresh suggestions the space realm needs. A global congregation could transform the public and private space industry in the same way that Uber transformed the transportation sector.¹⁹² Space exploration and exploitation are largely multinational endeavors¹⁹³ and, as such, deserve global input.

Crowdsourcing may seem like an improbable and fanciful way to revamp space law, but a closer look reveals that crowdsourcing¹⁹⁴ and crowdfunding¹⁹⁵

190. See, e.g., THOMAS G. WEISS, *WHAT’S WRONG WITH THE UNITED NATIONS AND HOW TO FIX IT* 1–5 (3d ed. 2017).

191. See generally Miriam A. Cherry, *Are Uber and Transportation Network Companies the Future of Transportation (Law) and Employment (Law)?*, 4 TEX. A&M L. REV. 173 (2017) (describing how Uber and Lyft have dramatically changed transportation).

192. Cf. *id.*

193. Recall that Luxembourg, a sovereign nation, has invested in Planetary Resources, a U.S. Company. Morris, *supra* note 113. The International Space Station is a massive multinational endeavor – five space agencies contributed to the \$100-billion engineering project, and since 2000 astronauts of different nationalities have continuously inhabited it. Remy Melina, *International Space Station: By the Numbers*, SPACE.COM (Aug. 3, 2017, 10:54 PM), <https://www.space.com/8876-international-space-station-numbers.html>; see also Elizabeth Howell, *International Space Station: Facts, History & Tracking*, SPACE.COM (Feb. 7, 2018, 8:25 PM), <https://www.space.com/16748-international-space-station.html>. SpaceX’s founder, Elon Musk, was born in South Africa, migrated to Canada, and eventually became a naturalized U.S. citizen. *Elon Musk Biography*, BIOGRAPHY, <https://www.biography.com/people/elon-musk-20837159> (last visited June 5, 2018).

194. Defined as “the practice of obtaining needed services, ideas, or content by soliciting contributions from a large group of people and especially from the online community rather than from traditional employees or suppliers.” *Crowdsourcing*, MERRIAM-WEBSTER, <https://www.merriam-webster.com/dictionary/crowdsourcing> (last updated May 28, 2018).

195. Defined as “the practice of obtaining needed funding (as for a new business) by soliciting contributions from a large number of people especially from the online

have transformed everything, from information and open knowledge – such as Wikipedia¹⁹⁶ and Ushahidi¹⁹⁷ – to finding solutions to food waste.¹⁹⁸ Furthermore, crowdsourcing is already prevalent in the space community and the appropriately dubbed “citizen scientists” have contributed countless hours to enhance our understanding of outer space by shifting through astrological data and images in the search of new discoveries.¹⁹⁹ Already, in 2018, “citizen scientists” have discovered a five-planet system.²⁰⁰ In short, there is no shortage of global interest in space and that could be harnessed to address the future of law and humanity beyond Earth.

The first question then seems to be, can you crowdsource *the law*? A gut reaction might be no, but a second glance reveals that it has already been done, at least in a limited capacity, and in numerous ways. An innocuous example of this is the *Restatements*.²⁰¹ Both experts and non-experts are engaged to source blackletter law from case law into a single, summarized tome.²⁰² While *Restatements* are not binding, they have wielded incredible influence and have been cited and adopted by both the judiciary and federal and state legislatures.²⁰³ Similarly, in 2002, the U.S. government launched *Regulations.gov*

community.” *Crowdfunding*, MERRIAM-WEBSTER, <https://www.merriam-webster.com/dictionary/crowdfunding> (last updated May 25, 2018).

196. Wikipedia is an online encyclopedia. *See Wikipedia*, WIKIPEDIA, <https://www.wikipedia.org/> (last visited June 5, 2018).

197. Ushahidi is a crowdsourcing platform that was originally created to map out outbreaks of violence in Kenya and has since been used to aggregate data, especially geo mapping, about other communities in need. *See About Ushahidi*, USHAHIDI, <https://www.usahidi.com/about> (last visited June 5, 2018).

198. Matthew Ridenour, *Reducing Food Waste Through Open Innovation*, OPENIDEO (May 2, 2017), <https://stories.openideo.com/reducing-food-waste-through-community-led-innovation-5dc1effdf929> (describing how an OpenIDEO crowd challenge fostered innovative proposals to repurpose otherwise wasted food and lead directly to the donation of \$50,000 to Full Cycle Bioplastics, a company seeking to convert food waste into biodegradable plastic); *see generally A Better Approach to Plastics*, FULL CYCLE BIOPLASTICS, <http://fullcyclebioplastics.com/> (last visited June 5, 2018).

199. *See, e.g.*, Eric Mack, *Search for Elusive Planet 9 Gets a Crowdsourcing Boost*, CNET (Mar. 31, 2017, 12:51 PM), <https://www.cnet.com/news/planet-9-james-webb-space-telescope-crowdsourcing-nasa/>; Adam Hadhazy, *Crowdsourcing the Universe: How Citizen Scientists Are Driving Discovery*, SPACE.COM (Jan. 14, 2016, 8:01 PM), <https://www.space.com/31626-crowdsourced-astronomy-finding-faint-galaxies-in-deep-space.html>.

200. *Multi-planet System Found Through Crowdsourcing*, NASA (Jan. 11, 2018), <https://www.nasa.gov/feature/jpl/multi-planet-system-found-through-crowdsourcing>.

201. *See generally Restatements of the Law*, ALI, <https://www.ali.org/publications/#publication-type-restatements> (last visited June 5, 2018).

202. *How the Institute Works*, ALI, <https://www.ali.org/about-ali/how-institute-works/> (last visited June 5, 2018).

203. *See, e.g.*, Symeon C. Symeonides, *The Judicial Acceptance of the Second Conflicts Restatement: A Mixed Blessing*, 56 MD. L. REV. 1248, 1256 (1997) (showing that

with the goal of “enabl[ing] the public ease of access to participate in a high quality, efficient, and open rulemaking process.”²⁰⁴ The site allows any member of the public to view, track, and submit comments on proposed rules and regulations.²⁰⁵ Its slogan is “Your Voice in Federal Decision-Making.”²⁰⁶ More potently, crowdsourcing has been used successfully to provide remedies for e-commerce disputes. For example, e-Bay India deployed a “Community Court” to crowdsource resolutions for its high volume of disputes between sellers and buyers to other e-Bay users.²⁰⁷ And in the justice system itself, crowdsourcing has been used to collect and identify evidence: in Baltimore, evidence investigated and vetted by people on the Internet was presented in the post-conviction hearing of Adnan Syed and resulted in a judgment for a new trial.²⁰⁸ In this vein, police across the globe have attempted to solve crimes through crowdsourcing by asking the public for cellphone photos and videos in a variety of cases – for example, in the 2017 mass shooting in Las Vegas and the 2011 Vancouver riots.²⁰⁹ Axon, the producer of the Taser, has launched a new online platform, “Citizen,” to allow the public to upload videos and photographs of suspected crimes for police review.²¹⁰ These examples of crowdsourcing the law are only a few of the many that currently exist. More are likely to come.

Given that innovative uses for crowdsourcing show no signs of slowing down, this Note proposes that crowdsourcing be utilized as an advisory body to make suggestions for the rules and laws governing an international space regime. Because of the intricacies of current space law, particularly the pursuit of mining and tourism as discussed *supra*,²¹¹ a more formalized team of experts is necessary to vet the suggestions and formulate a model code that does not violate the Outer Space Treaty or its progeny. The team should be composed of multinational individuals from various backgrounds, including, but in no way limited to, legal professionals, government representatives, scientists, private business persons, and the lay public. Such a configuration would mine

the vast majority of states have adopted the Restatement (Second) of Torts and the Restatement (Second) of Contracts).

204. *The eRulemaking Initiative*, REGULATIONS.GOV, <https://www.regulations.gov/aboutProgram> (last visited June 5, 2018).

205. *Id.*

206. *Id.*

207. Colin Rule & Chittu Nagarajan, *Leveraging the Wisdom of Crowds: The eBay Community Court and the Future of Online Dispute Resolution*, ACRESOLUTION, Winter 2010, at 5.

208. See Tony Jeff, *Crowdsourcing Justice*, 35 MISS. C. L. REV. 365 (2017).

209. Alex Pasternack, *To Crowdfund Crime-Fighting, a Cop Camera Giant Eyes Your Videos*, FAST COMPANY (Oct. 20, 2017), <https://www.fastcompany.com/40480948/axon-citizen-police-video-todd-basche>.

210. *Id.*; see also *Axon Citizen*, AXON, <https://www.axon.com/products/citizen> (last visited June 5, 2018) (whose slogan is, “Evidence from the community. In three clicks”).

211. See *supra* Part IV.A & B.

the collective intellect and innovation of the world at large while allowing experts to apply those ideas in a practical and lawful fashion that considers competing interests. While a model space code developed in this fashion would, ideally, be readily adopted by the nations of the world, at the very least it could provide a concrete starting point to jump start the conversation before space travel and commercialization proliferate. Furthermore, allowing the global public at large to contribute would positively embrace the idea that space truly is “the province of all mankind.”²¹²

V. CONCLUSION

Commercialization of space, until recently, had been slow to get its start. Now, with the significant reduction in the expenses of space launches, private companies are seizing opportunities to carve out a niche in this fast-growing area. Utilization of space resources is important not only for commercial profits but also for exploration and discovery. Using space resources is key to creating space entities at low costs and making tourism and colonization affordable. Imagine if, instead of paying upwards of \$9100 to send one sixteen-ounce bottle of water to space,²¹³ water on the Moon or asteroids could be utilized – this would significantly reduce costs of exploration and commercialization.

Current space law is ill-equipped to handle the new challenges likely to be posed by private commercial companies operating in space. In response, some national governments have already taken steps to fill in the gaps on their own. The most prime example is the United States’ SPACE Act. Unless the international community moves quickly to form a regulatory scheme of its own, protests to national decisions about issues as important as who owns the right to harvested space materials will, by default, go unheeded as nations seek to protect the interests of themselves and their citizens through their own interpretation of international treaties. Even if such actions become the norm, other questions about space law still need to be addressed through an international regulatory scheme. Without conformity, uncertainty and differing standards of acceptability will remain in areas such as personal injury liability, commercial licensure, and the legal treatment of harvested minerals across nations.

Updated international law is not only urgently needed to regulate commercialization but also necessary to ensure the right of all nations to peaceful exploration and discovery in outer space.

212. See Outer Space Treaty, *supra* note 18, art. I.

213. Sarah Kramer & Dave Mosher, *Here’s How Much Money It Actually Costs to Launch Stuff into Space*, BUS. INSIDER (Jul. 20, 2016, 10:08 AM), <http://www.businessinsider.com/spacex-rocket-cargo-price-by-weight-2016-6/#bottle-of-water-9100-to-43180-1>.