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For the Betterment of All mankind Claiming the Benefits of Outer Space Through Intellectual Property Rights

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FOR THE BETTERMENT OF ALL MANKIND: CLAIMING THE BENEFITS OF OUTER SPACE THROUGH INTELLECTUAL PROPERTY RIGHTS

by MAEVE DINEEN*

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INTRODUCTION

When humans first began to reach for the stars in the 1950s,¹ the world powers entered treaties that articulated the goals of space exploration. Those countries vowed that space exploration would benefit every country and recognized the interests and participation of the developing world.² But space exploration has changed in the past sixty years. When the space race first began, only a few national programs were capable of exploring beyond Earth's atmosphere. The space race was more focused on national prestige and less on economic returns. Now, however, private businesses seem to be the next step in space exploration, and developing countries are looking to space programs as a mode of economic development.³ The patent system plays an important role in how the next era of space exploration will progress. Private entities look to commercial benefits from this exploration and research, and the patent system offers valuable protection for investments made by private businesses.⁴ With this new driver in space exploration, an issue that arises is how to resolve the conflict between international space principles, which declare outer space the province of all mankind, and the patent system, which gives exclusionary rights to the inventor who makes a new discovery.

Already, there is debate over who can claim property rights to minerals mined from the moon and other celestial bodies.⁵ Despite the assertion that the Outer Space Treaty designated outer space as a "common area," the United States has passed legislation that allows private companies to gain property interests in outer-space minerals.⁶ This seems to undermine the

¹ See Jacob M. Harper, *Technology, Politics, and the New Space Rule: The Legality and Desirability of Bush's National Space Policy under the Public and Customary International Laws of Space*, 8 CHI. J. OF INT'L L. 681, 682 (2008).

² TOSAPORN LEEPUENGTHAM, *THE PROTECTION OF INTELLECTUAL PROPERTY RIGHTS IN OUTER SPACE ACTIVITIES*, 16-29 (Edward Elgar Pub. Limited, 2017).

³ See Lori Garver, *SpaceX Could Save NASA and the Future of Space Exploration*, THE HILL (Feb. 8, 2018, 6:00 PM), <https://thehill.com/opinion/technology/372994-spacex-could-save-nasa-and-the-future-of-space-exploration>. See also Akshat Rathi, *Poor Countries Want Space Programs More Than Rich Ones Do*, ARS TECHNICA (Nov. 11, 2013, 8:47 AM), <https://arstechnica.com/science/2013/11/poor-countries-want-space-programs-more-than-rich-ones-do/>.

⁴ See Richard D. Nelson & Roberto Mazzoleni, *Economic Theories About the Costs and Benefits of Patents*, in *INTELLECTUAL PROPERTY RIGHTS AND THE DISSEMINATION OF RESEARCH TOOLS IN MOLECULAR BIOLOGY: SUMMARY OF A WORKSHOP HELD AT THE NATIONAL ACADEMY OF SCIENCES*, 17-27 (National Research Council, 1996).

⁵ LEEPUENGTHAM, *supra* note 2, at 21.

⁶ See U.S. Commercial Space Launch Competitiveness Act, PUB. L. NO. 114-90, 129 STAT. 704 (2015) (codified as amended at 51 U.S.C. § 10101).

concept of outer space as the province of all mankind and negatively impacts countries that lack the resources or ability to mine celestial bodies. As developing countries create space programs and partner with other nations, this conflict may be less concerning because economically challenged countries may have the opportunity to collect minerals from the moon. But, perhaps an even more important question is whether a country can and should give an inventor exclusionary rights to an invention derived from outer-space resources. Imagine a laboratory on a private space station where the scientists are engaged in revolutionary research. The scientists on board are running a series of experiments on natural resources collected from outer space. Using these space materials and the microgravity environment, these scientists can conduct experiments that would be impossible on Earth. And because of this research, the privately employed scientists discover the cure for cancer. Should these inventors receive a patent that will prevent other scientists, organizations, and nations from conducting the same experiment and reaping the benefits that the outer-space materials and environment provide?

This Article addresses how exclusionary patent rights for inventions derived from the research and natural resources of outer space conflict with the status of space as a “common area.” Part I describes the international treaties governing the exploration of outer space and the principles governing this exploration. Part II discusses patent law and the international intellectual property treaties that govern patent law. Part III describes the role of private companies in space exploration and the benefits of space exploration to developing countries. Part IV provides a possible solution for promoting private exploration while also honoring the principles governing outer space exploration.

I. SPACE AND THE PROVINCE OF ALL MANKIND

The purpose and theories behind a national and international patent system do not always align with the goals and ideals of international space law. While the patent system emphasizes individual property rights, international agreements concerning the exploration of outer space emphasize that space is for the betterment of all mankind and that no one person, or one nation, owns the resources of space.

A. HISTORY OF SPACE LAW

The Soviet Union's launch of Sputnik in 1957 started the exploration and exploitation of outer space.⁷ As space programs developed and outer space activities increased, the global community recognized the need for international treaties to regulate these activities.⁸ The Outer Space Treaty of 1967 was the first international treaty that established regulations in the space law realm.⁹ This treaty outlined several principles of space law designed to guide the conduct of countries exploring and utilizing the resources found in outer space.¹⁰ Importantly, Article I of the Outer Space Treaty states that “[t]he exploration and use of outer space . . . shall be carried out for the benefit and in interests of all countries, irrespective of their degree of economic or scientific development and shall be the province of all mankind.”¹¹ Under international law, once a state ratifies a treaty or international agreement, the treaty imposes an obligation on the state to “carry out the agreement in good faith.”¹²

Following the Outer Space Treaty, other international agreements were ratified to further explain the provisions and principles found in the 1967 agreement.¹³ For example, the Registration Convention of 1975 reaffirmed previous international agreements that gave individual states responsibility over national activities where objects were launched from that State's

⁷ LEEPUENGTHAM, *supra* note 2, at 1.

⁸ See U.N. OFF. FOR OUTER SPACE AFF., *Space Law Treaties and Principles*, <https://www.unoosa.org/oosa/en/ourwork/spacelaw/treaties.html> (last visited Oct. 1, 2020).

⁹ LEEPUENGTHAM, *supra* note 2, at 12.

¹⁰ See G.A. Res. 2222 (XXI), at 13 (Dec. 19, 1966); See also *Space Law Treaties and Principles*, U.N. OFF. FOR OUTER SPACE AFF., <https://www.unoosa.org/oosa/en/ourwork/spacelaw/treaties.html> (last visited Oct. 1, 2020).

¹¹ G.A. Res. 2222 (XXI), *supra* note 10, at art. 1.

¹² Martin A. Rogoff, *The International Legal Obligations of Signatories to an Unratified Treaty*, 32 ME. L. REV. 263, 268-69 (1980).

¹³ LEEPUENGTHAM, *supra* note 2, at 12. See Agreement Governing the Activities of States on the Moon and Other Celestial Bodies, Dec. 5, 1979, 1363 U.N.T.S. 3 (entered into force July 11, 1984), See also G.A. Res. 2345 (XXII), at 5 (Dec. 19, 1967).

territory into outer space.¹⁴ The UN has passed a series of resolutions emphasizing the importance of international cooperation on “an equitable and mutually acceptable basis” and that a particular focus should be given to the benefits experienced by developing countries from international cooperation conducted with “more advanced space capabilities.”¹⁵ An important focus of this discussion is to what extent these international agreements ensure that space programs explore and utilize outer space for the benefit of all mankind.

B. THE UNITED STATES AND ITS TREATY OBLIGATIONS UNDER SPACE TREATIES

Article II of the Outer Space Treaty states that “[o]uter 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.”¹⁶ The United States signed the Outer Space Treaty in January 1967 and ratified the treaty in October 1967.¹⁷ Under international law principles, once the United States ratified the Outer Space Treaty, the U.S. became obligated to “carry out the agreement in good faith.”¹⁸ Notably, the Outer Space Treaty does not discuss private entities or the resources found on the moon or other celestial bodies. The absence of a reference to private entities might mean that this treaty does not control the conduct of private actors and that the United States would only violate the treaty if the country itself made a sovereignty claim. If true, then there is neither a law preventing private companies from claiming space resources nor an obligation for private companies to share the resources collected from outer space.

Adopted in 1979, the UN Treaty known as the “Moon Agreement” states that the “moon and its natural resources are the common heritage of mankind.”¹⁹ The agreement specifies that no governmental or non-

¹⁴ G.A. Res. 3235 (XXIX), U.N. OFF. FOR OUTER SPACE AFF., <https://www.unoosa.org/oosa/en/ourwork/spacelaw/treaties/introregistration-convention.html>

¹⁵ G.A. Res. 51/122, U.N. OFF. FOR OUTER SPACE AFF., <https://www.unoosa.org/oosa/en/ourwork/spacelaw/principles/space-benefits-declaration.html>.

¹⁶ G.A. Res. 2222 (XXI), *supra* note 10.

¹⁷ *Id.*

¹⁸ Rogoff, *supra* note 12 at 269 (“Once a treaty is ratified and does enter into force, the principle *pacta sunt servanda* imposes the obligation on the parties to carry out the agreement in good faith.”); See *Vienna Convention on the Law of Treaties Signed at Vienna 23 May 1969*, Department Of Legal Services (Jan 27, 1980), <https://www.oas.org/legal/english/docs/Vienna%20Convention%20Treaties.htm>.

¹⁹ LEEPUENGTHAM, *supra* note 13.

governmental organization can claim the surface, subsurface, or other natural resources of the moon as property.²⁰ This agreement reflects Article II of the Outer Space Treaty, which states that “[o]uter space, including the moon and other celestial bodies, is not subject to national appropriation by claim of sovereignty.”²¹ Therefore, the Moon Agreement “closes a loophole” present in the Outer Space Treaty by “banning ownership of any extraterrestrial property by any organization or private person.”²² If followed, the Moon Agreement could impose obligations on private companies within the United States and, under other international agreements, may make the United States government liable for these private entities’ noncompliance with the Moon Agreement provisions. However, unlike the Outer Space Treaty, the United States did not sign or ratify the Moon Agreement.²³ With only eleven signatories and a total of eighteen ratifying parties, this treaty is considered a failure of international law as the ratifying parties “are minor players in space exploration.”²⁴

In addition, Article I of the Outer Space Treaty states that “exploration and use of outer space . . . shall be carried out for the benefit and in the interests of all countries . . . and shall be the province of all mankind.”²⁵ There is not a consensus about the requirements and limits of this provision.²⁶ One view is that, unlike the Moon Agreement’s “Common Heritage Principle” which requires “the exploiter to share any benefit with all states,” the Outer Space Treaty’s “Province Principle” only grants “the freedom of access to natural resources in outer space and its celestial bodies on an equal basis.”²⁷ Another view is that these provisions are “equivalent and interchangeable terms,”²⁸ so the Outer Space Treaty also requires the sharing of benefits with other states. However, because the Moon Agreement uses both of these terms in different provisions, it is unlikely that the Common Heritage Principle and the Province Principle were meant to be used interchangeably.²⁹

Even if the Outer Space Treaty’s Province Principle cannot import definitions from the Moon Agreement, Article II of the Outer Space Treaty

²⁰ *Id.*

²¹ G.A. Res. 2222 (XXI), *supra* note 10.

²² Michael Listner, *The Moon Treaty: failed international law or waiting in the shadows?*, THE SPACE REVIEW (Oct. 24, 2011), <https://www.thespacereview.com/article/1954/1>.

²³ Listner *supra* note 22.

²⁴ *Id.*; See Elizabeth Howell, *Who Owns the Moon? Space Law & Outer Space Treaties*, SPACE.COM (Oct. 27, 2017), <https://www.space.com/33440-space-law.html>.

²⁵ G.A. Res. 2222 (XXI), *supra* note 10.

²⁶ LEEPUENGTHAM, *supra* note 2, at 21.

²⁷ *Id.*

²⁸ *Id.* at 26.

²⁹ *Id.*

“establish[es] that space is *res communis*, a ‘common area.’”³⁰ Therefore, states are prevented from appropriating the area and “all states have the right to use the area.”³¹ Because all states have a right to use outer space, “[s]tates are ‘bound to refrain from any acts which might adversely affect the use of the [common area].’”³² While this treaty establishes space as an area that is available for use by all nations, individuals can still protect “personal rights in tangible property.”³³ So how does this affect intangible property rights? There is an important distinction “between use *of* objects *in* exploiting an area that is *res communis* and uses *of* an area that is *res communis*.”³⁴ Looking back to the cure-for-cancer hypothetical, a patent on the method for using outer-space materials in the micro-gravity environment would prevent others from using an area that is *res communis*.³⁵

The interpretation of the Province Principle can be taken one step further. By looking to Articles I(I) and I(II) of the Outer Space Treaty in combination, the Province Principle “proclaims outer space as a *res communis*, where all states can freely and equally access its resources regardless of their technological capability and contribution to the exploitation.”³⁶ This suggests that countries that ratified this treaty have an obligation to share all information, and all technology to access this information, with countries that do not have the capability to explore and utilize outer space. However, others argue that the Province Principle is “not intended to be *legally* binding, but rather imposes only a *moral* obligation upon states.”³⁷ This proposition is supported by the lack of description or elaboration on how space exploration is to benefit all countries or how to share these benefits.³⁸

³⁰ Tim Smith, *A Phantom Menace – Patents and the Communal Status of Space*, 24 VICTORIA U. WELLINGTON L. REV. 545, 550 (2003).

³¹ *Id.* at 554.

³² Smith, *supra* note 30, at 554.

³³ *Id.* at 555.

³⁴ Smith, *supra* note 30, at 555.

³⁵ *Id.* at 556, (It appears strongly arguable that certain patents involve the grant of a personal property right in the *use* of space. Consider a patent for “a method for producing magnetostrictive material, a particular type of “smart material”. Intrinsic to the process over which the patent is granted is cooling the material in a micro-gravity environment. As such, the process patented makes use *of* the [sic] space environment itself. The patent right therefore excludes others from, inter alia, making use *of* space in that particular manner.)

³⁶ LEEPUENGTHAM, *supra* note 2, at 22, (The author looks to the requirements of Article I(I) and I(II) together to conclude the referenced statement.)

³⁷ *Id.*

³⁸ *Id.* at 22–23.

Despite these international agreements, the United States passed the Commercial Space Launch Competitiveness Act (“Space Act”) in 2015.³⁹ This act permits U.S. citizens to mine and own resources from asteroids.⁴⁰ Although the Space Act reiterates that the United States does not “assert sovereignty . . . or jurisdiction over, or the ownership of, any celestial body,”⁴¹ scholars are divided on whether the Space Act is in conflict with international agreements prohibiting states from claiming sovereignty over natural resources and other materials that are found in outer space.⁴² One view of the Space Act is that it is a domestic law that creates “a property right in minerals found in outer space, which constitutes an impermissible act of sovereignty.”⁴³ If the Space Act does create a property interest in the minerals taken from outer space bodies, an important question is whether the United States violated its obligations under international law. Notably, the Space Act requires that individuals involved in asteroid mining conduct this activity “in accordance with applicable law, including the international obligations of the United States.”⁴⁴ If property interests in outer-space resources interfere with the outer space’s designation as a *res communis*, then the United States is in violation of its obligations under the Outer Space Treaty by passing the Space Act.

³⁹ U.S. Commercial Space Launch Competitiveness Act, *supra* note 6; *See also* James Rathz, *Law Provides New Regulatory Framework for Space Commerce*, THE REGULATORY REVIEW (Dec. 31, 2015), <https://www.theregreview.org/2015/12/31/rathz-space-commerce-regulation/>, (“The law is designed to foster growth in the nascent commercial space industry in areas such as mining and tourism, as well as streamline space regulations.”).

⁴⁰ U.S. Commercial Space Launch Competitiveness Act, *supra* note 6, at § 51303 (“A United States citizen engaged in commercial recovery of an asteroid resource or a space resource under this chapter shall be entitled to any asteroid resource or space resource obtained, including to possess, own, transport, use, and sell the asteroid resource or space resource obtained in accordance with applicable law, including the international obligations of the United States.”); *See* Rathz, *supra* note 39 (“Private companies have been planning space mining operations for years. Although challenging, the potential rewards are vast. The minerals in one asteroid in our solar system may be worth about \$95 trillion, greater than the entire world’s gross domestic product last year.”).

⁴¹ U.S. Commercial Space Launch Competitiveness Act, *supra* note 6, at § 51303.

⁴² *See* Rathz, *supra* note 39 (“Frans von der Dunk, a law professor at the University of Nebraska College of Law, reportedly says that it is unsettled whether space mining is legal. By contrast, Fabio Tronchetti, a professor at the Harbin Institute of Technology’s School of Law in China, contends that the SPACE Act violates the Outer Space Treaty’s provisions prohibiting countries from appropriating any part of outer space – a prohibition which, he argues, extends to private entities.”).

⁴³ *Id.* (discussing Tronchetti’s view of the Space Act).

⁴⁴ U.S. Commercial Space Launch Competitiveness Act, *supra* note 6, at § 51303.

C. CONTROL OVER PRIVATE SPACE EXPLORATION

As discussed in Part II(B), the obligations of the Outer Space Treaty may not apply to the conduct of private actors in space exploration because the treaty fails to discuss private entities. However, if the provisions of the Outer Space Treaty do apply to private companies, the United States may be responsible for ensuring private entities within the U.S. border act within the provisions of international law. One way for the United States to monitor and regulate the actions of private entities, as these companies explore space, is through federal regulatory agencies.

Two federal agencies are already involved in regulating this activity.⁴⁵ For many years, the Federal Communications Commission (FCC) has regulated communication satellites owned and operated by private companies, and the Federal Aviation Administration (FAA) has regulated the launching of vehicles and other objects by private companies into space.⁴⁶ Theoretically, these agencies could ensure that private entities did not improperly assert property rights over space resources in violation of international space law. However, although these agencies have provided regulatory oversight over space-related activities, a question remains as to whether these agencies can deny private entities access to outer space.⁴⁷

Article VI of the Outer Space Treaty states that “the activities of non-governmental entities shall require authorization and continuing supervision.”⁴⁸ Some view this provision as requiring entities to receive governmental authorization or else the company may not operate in outer space.⁴⁹ Indeed, the FAA has suggested that under Article VI of the Outer Space Treaty it may deny private entities access to space if those entities do not receive proper authorization.⁵⁰ However, others argue that “the treaty

⁴⁵ Laura Montgomery, *US Regulators May Not Prevent Private Space Activity on the Basis of Article VI of the Outer Space Treaty* 5, MERCATUS CENTER WORKING PAPER, <https://www.mercatus.org/publications/technology-and-innovation/us-regulators-may-not-prevent-private-space-activity-basis>.

⁴⁶ Montgomery, *supra* note 45, at 5 (noting that another governmental agency, the National Oceanic and Atmospheric Administration of the Department of Commerce, regulates remote sensing satellites).

⁴⁷ *Id.* at 3.

⁴⁸ G.A. Res. 2222 (XXI), *supra* note 10, at art. VI.

⁴⁹ Montgomery, *supra* note 45, at 3.

⁵⁰ *Id.* at 3; *Commercial Space: Federal Regulation, Oversight, and Utilization*, CONGRESSIONAL RESEARCH SERVICES R45416, 17 (Nov. 29, 2018), <https://fas.org/sgp/crs/space/R45416.pdf> (“FAA, NOAA, and FCC regulation of commercial launch and reentry, remote sensing, and satellite communications, as described above, is generally considered to meet [the Article VI] requirement for commercial space activities under the jurisdictions of those agencies.”).

itself does not prohibit private activities” and therefore “private actors may operate in outer space even without authorization or supervision.”⁵¹ One argument that supports this view is that Article VI of the Outer Space Treaty is not self-executing. Because Congress has the power to make laws, a treaty is self-executing if the President and Senate intend “for the agreement to have domestic effect.”⁵² In contrast, a non-self-executing treaty is a treaty that was “ratified with the understanding that it is not to have domestic effect of its own force.”⁵³ Article VI states that private organizations “shall require authorization and continuing supervision by the appropriate State Party.”⁵⁴ This language describes a future effect in which “some part of a government must, in the future, require authorization and continuing supervision of private activities in outer space.”⁵⁵ This suggests that some “future legislative response” is necessary to enforce this provision.⁵⁶ Additionally, Article VI contains ambiguous terms “that the drafters have left to the different countries to define as they see fit” and therefore requires Congress to define these ambiguous terms.⁵⁷

If Article VI is not self-executing, then it “does not have the force of law within the United States without an explicit act of Congress applying it to a private space activity” and then “assigning authority over that specific activity to whatever regulatory agency Congress considers most appropriate.”⁵⁸

D. A COMPARATIVE MODEL FOUND ON EARTH

Although outer-space mining is still in the developmental stage, similar debates surrounding property interests found in non-territorial areas have already occurred on Earth. The Third United Nations Convention on the Law of the Sea (UNCLOS III) governs international conduct for the oceans

⁵¹ *Id.*

⁵² *Medellin v. Texas*, 552 U.S. 491, 519 (2008).

⁵³ *Id.* at 527.

⁵⁴ G.A. Res. 2222 (XXI), *supra* note 10, at art. VI.

⁵⁵ MONTGOMERY, *supra* note 45, at 21.

⁵⁶ *Id.*

⁵⁷ *Id.* (“The terms are ‘authorization,’ ‘continuing supervision,’ and ‘activities.’ They each necessitate policy judgments by the legislative branch, which means the task of implementation falls to the legislative branch, and legislation must be passed before the treaty applies to private actors.”).

⁵⁸ *Id.* at 3-4 (concluding that Article VI should not be a barrier to private space activity, despite its call for authorization and continuing supervision).

and seas.⁵⁹ One important focus of this treaty was determining the property rights that nations could claim for the oceans' resources.⁶⁰ Unsurprisingly, "[t]echnologically advanced, sea-faring nations" argued that the nation that extracted minerals and other resources from the ocean should own the property rights to the resources.⁶¹ "Smaller nations without the capabilities or funds to launch expeditions" argued these resources should be shared among all nations because "the high seas are international territory belonging equally to all nations."⁶²

UNCLOS III agreed with these smaller nations and established the sea as "the common heritage of mankind," and therefore states could not "claim or exercise sovereignty or sovereign rights over any part of the Area or its resources."⁶³

This concept of common heritage and benefits sharing concerned developed nations that feared private companies would not invest in ocean mining without profit incentives.⁶⁴ In response to these concerns, the UN passed the Agreement Relating to the Implementation of Part XI of the United Nations Convention on the Law of the Sea, which recognized pre-existing claims to ocean mining sites and implemented a "market oriented approach" to "managing seabed resources."⁶⁵

Ultimately, this debate over property interests in ocean resources mirrors the conflicts and concerns found in the discussion surrounding property interests in outer-space resources. Developed nations argue for property rights in outer-space resources that the nation collects, and developing nations argue for these resources to be shared with all nations. Interestingly, the UN sided with developing nations in the ocean resources debate by establishing the sea as a common heritage area. Even though the

⁵⁹ *United Nations Convention on the Law of the Sea of 10 December 1982 Overview and full text*, U.N. DIVISION FOR OCEAN AFFAIRS AND THE LAW OF THE SEA, https://www.un.org/Depts/los/convention_agreements/convention_overview_convention.htm (last accessed Mar. 15, 2020).

⁶⁰ Sarah Coffey, *Establishing a Legal Framework for Property Rights to Natural Resources in Outer Space*, 41 CASE W. RES. J. INT'L L. 119, 129 (2009).

⁶¹ *Id.*

⁶² *Id.* at 129.

⁶³ U.N. DIVISION FOR OCEAN AFFAIRS AND THE LAW OF THE SEA, *supra* note 59, at 70; Coffey, *supra* note 60, at 129 ("This divide is strikingly similar to that between space-faring nations and non-space-faring nations in the debate over lunar resources.").

⁶⁴ Coffey, *supra* note 60, at 130 ("The United States said that the common heritage principle and ISA would deter private mining companies from seeking licenses, impede the development of seabed mineral resources, deny national access, and create a monopoly by an international authority. According to estimates from one U.S. consortium, it would take ten years and \$1.5 billion to start up the seabed mining industry, time and money unlikely to be invested unless profits and a mining site are guaranteed.").

⁶⁵ G.A. Res. 48/263, at 4 (Aug. 17, 1994).

UN ultimately made concessions to developed countries like the United States by recognizing pre-existing mining sites, the UN's decision to recognize the ocean as a common area is important to consider during the space debate.

II. PATENT LAW AND DISCOVERING THE UNKNOWN

When space exploration began, a select group of national governments were the only entities with the capabilities and inclination to journey to outer space. Now, more countries have created space programs and the economic opportunities of outer space have created incentives for private entities to join the space race. And although entities like SpaceX and Blue Origin are owned by private individuals, international agreements place the responsibility and liability on national governments for the actions of private actors within the government's borders.⁶⁶ Now, the question is what do the international space agreements require private actors to share with the rest of the world?

A. HISTORY OF THE PATENT SYSTEM

Unlike the governing treaties of space law, which emphasized outer space and its resources as “the province of all mankind,” the principles of patent law describe a proprietary interest in the inventor's discovery.⁶⁷ A patent is a “government-issued grant” that gives the patent owner the “right to exclude” others from making or using the patent.⁶⁸ Even though the patent system rewards inventors with an individual property right, two predominant theories in patent law are that the patent system creates incentives for inventors to invent and that the patent system creates incentives for inventors to disclose information that ultimately benefits the public.⁶⁹ The invention-inducement theory proposes that the promise of receiving patent rights on an invention provides the inventor with motivation to invent.⁷⁰ The disclosure theory argues that patent rights encourage inventors to disclose their invention when the inventor would otherwise keep his or her discovery secret.⁷¹

⁶⁶ G.A. Res. 2222 (XXI), *supra* note 10, at art. VI.

⁶⁷ *Id.* at Art. I; *see* CRAIG A. NARD, THE LAW OF PATENTS 1 (2016).

⁶⁸ NARD, *supra* note 67 at 1.

⁶⁹ *See id.* at 3, 34; *See also id.* at 38 (“American patent law is a utilitarian-based regime designed to promote social welfare by encouraging technological innovations.”).

⁷⁰ Mazzoleni, *supra* note 4.

⁷¹ *Id.*

Patent law seeks to balance these incentive theories that encourage invention and disclosure with the benefit to the general public. One way to balance these interests is by determining the duration of the patent rights. Noticing an increase in inventive activity as a result of increases in the duration of patent rights, one theorist argued that patent duration should increase until the marginal benefits that the inventive activity gives to society equals the social welfare costs that patents impose on society.⁷² Therefore, in the context of space exploration, an important question is to what extent the duration of a patent properly encourages inventors to invent and disclose discoveries without imposing a burden on the public benefit experienced by these space technologies.

B. INCENTIVES TO INVENT AND THE CREATION OF NEW TECHNOLOGY

There is little consensus on whether the patent system truly creates an incentive to invent new technology and whether discovery would stop in the absence of a protectable property right.⁷³ From one perspective, there are “patent-induced inventions that would not have seen the light of day without the existence of a patent system for their protection.”⁷⁴ Inventions that effect “a genuine revolution in production or consumption patterns are thought to be patent induced” because these “inventions typically require large investment and entail a high risk of failure.”⁷⁵ Commercial space travel and other space-related activities could fall under this category.

There are also inventions “that would be made irrespective of the availability of patent protection.”⁷⁶ The necessity of the invention as well as other “inherent incentives” can compel discovery without the reward of patent rights.⁷⁷ Since there are patents that fall into both categories, there is no clear answer whether the patent system is the appropriate vehicle to induce discovery. Fritz Machlup argued that if a country did not have a patent system then it should not implement one, but abolishing a preexisting

⁷² William Fisher, *Theories of Intellectual Property*, <http://www.law.harvard.edu/faculty/ffisher/iptheory.html>.

⁷³ Jay P. Kesan, *Economic Rationales for the Patent System in Current Context*, 22 GEO. MASON L. REV. 897, 897-98 (2015).

⁷⁴ A. Samuel Oddi, *The International Patent System and Third World Development: Reality or Myth?*, DUKE L.J. 831, 838 (1987).

⁷⁵ *Id.*

⁷⁶ *Id.*

⁷⁷ *Id.* (“[T]here are inherent incentives provided to the inventor outside of any patent system, such as the potential for secrecy, the competitive advantage of being first on the market, and the possibility of developing source recognition of the product (product differentiation).”).

patent system would be irresponsible.⁷⁸ While countries like the United States seem unlikely to abolish a preexisting patent system, there are some countries that do not have domestic patent laws.⁷⁹ In the context of space exploration, a country without a patent system faces the important question of whether the creation of a domestic patent system would improve access to outer space or impede the advancement of its space program.

C. PATENTS ON A GLOBAL SCALE

Like space law, the patent world is governed by a series of international agreements.⁸⁰ These treaties aim to create minimum standards for patent protection,⁸¹ streamline national patent application processes,⁸² and, importantly, create enforcement procedures of patent rights against infringers.⁸³ In an effort to promote trade, the Agreement on Trade-Related Aspects of Intellectual Property Rights (“TRIPS”) created a minimum standard for protection of intellectual property rights that each member country was responsible for implementing within its border.⁸⁴ Another example is the Patent Cooperation Treaty, which streamlines the process for seeking patent protection internationally and “facilitates public access to a

⁷⁸ *An Economic Review of the Patent System*, S. RES. 236, 85TH CONG. STUDY NO 15 (1958). (“If we did not have a patent system, it would be irresponsible, on the basis of our present knowledge of its economic consequences, to recommend instituting one. But since we have had a patent system for a long time, it would be irresponsible, on the basis of our present knowledge, to recommend abolishing it.”).

⁷⁹ Louis J. Hoffman, *Countries in which the Patent Cooperation Treaty (PCT) Does NOT Apply*, HOFFMAN PATENT FIRM (Feb. 24, 2015), <https://www.valuablepatents.com/non-pct-countries/> (As of 2015, In “9 countries, it appears that an inventor cannot get a patent, because no patent laws are in force. They are Eritrea, Maldives, Marshall Islands, Micronesia, Myanmar, Palau, South Sudan, East Timor, Somalia.”); *See also id.* (There are also some countries that do not conform to the more widely recognized international patent systems. For example, Taiwan, Cape Verde, Ethiopia, and Vanuatu have “bilateral treaties or local laws that seem to permit priority applications, similar to Paris Convention regulations.”).

⁸⁰ *See* Patent Cooperation Treaty, Jun. 19, 1970, 28 U.S.T. 7645; Agreement on Trade-Related Aspects of Intellectual Property Rights, Apr. 15, 1994, 1869 U.N.T.S. 3 [hereinafter TRIPS AGREEMENT]; Patent Law Treaty, Jun. 1, 2000, WIPO.

⁸¹ *Id.*; WORLD INTELLECTUAL PROPERTY ORGANIZATION, [https://www.wipo.int/treaties/en/registration/pct/summary_pct.html#:~:text=The%20Patent%20Cooperation%20Treaty%20\(PCT\)%20makes%20it%20possible%20to%20seek,an%20%22international%22%20patent%20application.&text=The%20Treaty%20regulates%20in%20detail,which%20international%20applications%20must%20comply](https://www.wipo.int/treaties/en/registration/pct/summary_pct.html#:~:text=The%20Patent%20Cooperation%20Treaty%20(PCT)%20makes%20it%20possible%20to%20seek,an%20%22international%22%20patent%20application.&text=The%20Treaty%20regulates%20in%20detail,which%20international%20applications%20must%20comply) (last visited Oct. 6, 2020); LEEPUENGTHAM, *supra* note 2, at 33.

⁸² TRIPS AGREEMENT, *supra* note 80; LEEPUENGTHAM, *supra* note 2, at 34.

⁸³ TRIPS AGREEMENT, *supra* note 80; LEEPUENGTHAM, *supra* note 2, at 54.

⁸⁴ TRIPS AGREEMENT, *supra* note 80.

wealth of technical information relating to those inventions.”⁸⁵ Like any international agreement, the principles and procedures generally apply only to the countries that sign and ratify the treaties.⁸⁶ In essence, a non-signatory is not obligated to recognize an inventor’s patent rights within its jurisdiction.

Like other areas of law, complications arise when the scope of domestic patent law overlaps with international agreements. For example, data or experiments that began on the International Space Station (“ISS”) are taken back to Earth before the discovery is ready for patenting.⁸⁷ In this scenario, whether space law or domestic patent law governs the patent of the invention makes a significant difference in the duration of the patent rights.⁸⁸ For example, if data is transmitted from the ISS to a space agency on Earth, will space law or domestic patent law govern the data if the data itself is compiled and analyzed on the ground?⁸⁹ Ultimately, determining which legal doctrine to apply may be a question of fact for a judge to decide during a trial or for the patent examiner to determine during patent prosecution.

III. PRIVATE COMPANIES, THE DEVELOPING WORLD, AND THE FINAL FRONTIER

So, if international law stresses the sharing of benefits of outer space with mankind, why should governments allow private companies to apply for a proprietary interest in those space-related benefits? As discussed in Part II, a key principle of patent law is that a government-backed patent system creates incentives for discovery. This incentive theory is especially present when looking at the motivations and decisions of private companies.

When the space race began, the participants were limited to a select group of national governments.⁹⁰ The United States and the Soviet Union were in competition to establish its respective nation as the leader in space

⁸⁵ WORLD INTELLECTUAL PROPERTY ORGANIZATION, [https://www.wipo.int/pct/en/#:~:text=The%20Patent%20Cooperation%20Treaty%20\(PCT,information%20relating%20to%20those%20inventions](https://www.wipo.int/pct/en/#:~:text=The%20Patent%20Cooperation%20Treaty%20(PCT,information%20relating%20to%20those%20inventions) (last visited Oct. 6, 2020).

⁸⁶ See Rogoff, *supra* note 12 at 267-68.

⁸⁷ *Space Law: The Commercialization of Space and its Patents*, CISC365 at UNIVERSITY OF DELAWARE: INTELLECTUAL PROPERTY IN THE DIGITAL AGE (Apr. 16, 2015), <https://sites.udel.edu/cisc356/2015/04/16/space-law-the-commercialization-of-space-and-its-patents/> [hereinafter SPACE LAW COMM.].

⁸⁸ *Id.*

⁸⁹ SPACE LAW COMM., *supra* note 87.

⁹⁰ See Sintia Radu, *The Global Race to Space*, U.S. NEWS AND WORLD REPORT (Aug. 27, 2018), <https://www.usnews.com/news/best-countries/articles/2018-08-27/60-years-after-nasa-a-global-space-race>.

exploration.⁹¹ The Soviet Union was the first to send a man-made satellite into space, and the United States was the first to land a man on the Moon.⁹² Initially, the space race was between two world superpowers, and each was trying to establish itself as the leader of human space exploration. Now, the actors in space exploration have changed. The number of nations involved in space exploration has increased as developing countries have begun using space programs to boost economic development. In addition, the space race has expanded into the private sector. Economic incentives and national funding have led to a rise in space activity by private actors.⁹³ These private corporations are “building their own products, launching commercial satellites and even exploring small missions.”⁹⁴

A. ROLE OF THE PATENT SYSTEM IN PRIVATE EXPLORATION

The United States shifted space exploration priorities after the government halted shuttle missions to the moon.⁹⁵ American space travel significantly reduced after the retirement of the space shuttle program in 2011.⁹⁶ Unable to send astronauts into outer space without a shuttle program, for years NASA was reliant on the Russian *Soyuz* capsule program to transport United States astronauts to the ISS.⁹⁷ The retirement of the United States shuttle program “handed Russia a monopoly on human spaceflight, which . . . led to the price NASA paid per astronaut increasing from about \$40 million in 2011 to more than \$90 million” in 2020.⁹⁸ NASA’s movement away from shuttle missions, however, opened the door for private actors. Companies like SpaceX and Virgin Galactic are exploring the

⁹¹ See Radu, *supra* note 90.

⁹² *Id.*

⁹³ *Id.*

⁹⁴ *Id.*

⁹⁵ See Tariq Malik, *NASA Grieves Over Cancelled Program*, NBC NEWS (Feb. 2, 2010), http://www.nbcnews.com/id/35209628/ns/technology_and_science-space/t/nasa-grieves-over-canceled-program/#.XZzegkZKhPY (“President Obama’s 2011 budget request for NASA cut the agency’s Constellation program completely, effectively canceling a five-year, \$9 billion effort to build new Orion spacecraft and Ares rockets.”).

⁹⁶ John Miaschi, *Countries Who Spend the Most on Space Exploration*, WORLDATLAS (Apr. 25, 2017), <https://www.worldatlas.com/articles/which-countries-spend-the-most-on-space-exploration.html>.

⁹⁷ Steve J. Markovich & Andrew Chatzky, *Space Exploration and U.S. Competitiveness*, COUNCIL ON FOREIGN RELATIONS (Sept. 10, 2019), <https://www.cfr.org/backgrounders/space-exploration-and-us-competitiveness>.

⁹⁸ Michael Sheetz, *Why the first SpaceX astronaut launch marks a crucial leap for NASA’s ambitions*, CNBC (Jun. 3, 2020), <https://www.cnbc.com/2020/06/03/first-spacex-astronaut-launch-marks-crucial-leap-for-nasa-ambitions.html>.

possibility of using shuttles for space tourism.⁹⁹ And this pursuit of a space tourism industry is shaping the future of space exploration in the United States. After a successful launch in 2018, SpaceX's Falcon Heavy rocket was recognized as a potential "game changer" for future space exploration,¹⁰⁰ as the Falcon Heavy rocket could save NASA billions of dollars in shuttle launches.¹⁰¹ And save money it will. May 30, 2020, marked the "return [of] human spaceflight to the United States"¹⁰² when, "[f]or the first time in history," NASA astronauts aboard the SpaceX Crew Dragon "launched from American soil in a commercially built and operated American crew spacecraft on its way to the International Space Station."¹⁰³ A seat on the SpaceX Dragon Crew shuttle is around \$55 million per astronaut—cheaper than the \$90 million seat on a *Soyuz* capsule.¹⁰⁴

But SpaceX did not develop the shuttle on its own. A partnership with NASA called the Commercial Crew Program awarded SpaceX and Boeing billions of dollars to "develop spacecraft to replace the Space Shuttle."¹⁰⁵ Despite this significant investment cost, the Commercial Crew Program is

⁹⁹ *A New Age of Space Exploration is Beginning*, THE ECONOMIST (July 18, 2019), <https://www.economist.com/leaders/2019/07/18/a-new-age-of-space-exploration-is-beginning>.

¹⁰⁰ Jason Daley, *Watch SpaceX's Successful Launch of Their Falcon Heavy Rocket*, SMITHSONIAN MAGAZINE (Feb. 6, 2018), <https://www.smithsonianmag.com/smart-news/why-falcon-heavy-rocket-game-changer-180968052/#:~:text=After%20seven%20years%20of%20designing,the%20world%20hurtle%20into%20space&text=Update%20February%206%2C%202018%3A%20To,it%20was%20supposed%20to%20land>.

¹⁰¹ *Id.* ("SLS will cost NASA over \$1 billion per launch. The Falcon Heavy, developed at zero cost to the taxpayer, would charge NASA approximately \$100M per launch. In other words, NASA could buy 10 Falcon Heavy launches for the cost of one SLS launch — and invest the remainder in truly revolutionary and meaningful missions that advance science and exploration.").

¹⁰² *NASA Astronauts Safely Splash Down after First Commercial Crew Flight to Space Station*, NASA (Aug. 2, 2020), <https://www.nasa.gov/press-release/nasa-astronauts-safely-splash-down-after-first-commercial-crew-flight-to-space-station>.

¹⁰³ *NASA Astronauts Launch from America in Historic Test Flight of SpaceX Crew Dragon*, NASA (May 30, 2020), <https://www.nasa.gov/press-release/nasa-astronauts-launch-from-america-in-historic-test-flight-of-spacex-crew-dragon>.

¹⁰⁴ Michael Sheetz, *Why the first SpaceX astronaut launch marks a crucial leap for NASA's ambitions*, CNBC (Jun. 3, 2020), <https://www.cnbc.com/2020/06/03/first-spacex-astronaut-launch-marks-crucial-leap-for-nasa-ambitions.html> ("NASA awarded SpaceX with \$2.4 billion for six operational missions. Dividing those up, each Crew Dragon launch costs about \$400 million, with \$220 million of that cost allotted to the four astronauts NASA expects to fly per mission — or \$55 million per astronaut.").

¹⁰⁵ Michael Sheetz, *NASA estimates having SpaceX and Boeing build spacecraft for astronauts saved \$20 billion to \$30 billion*, CNBC (May 13, 2020), <https://www.cnbc.com/2020/05/13/nasa-estimates-having-spacex-and-boeing-build-spacecraft-for-astronauts-saved-up-to-30-billion.html>.

expected to save “taxpayers more than \$20 billion compared to the agency’s previously plan for flying astronauts to the ISS.”¹⁰⁶ What SpaceX Crew Dragon showed the nation was that partnerships with the private sector can allow space agencies to more “cost-effectively” achieve agency goals of “sustainable space exploration.”¹⁰⁷

Because of the significant financial investment by private companies in designing and building space technology, patents can be a valuable tool to protect the company’s investment.¹⁰⁸ Yet, despite the protection offered by the patent system, some companies may choose to protect their intellectual property through trade secrets.¹⁰⁹ In a 2011 interview, SpaceX’s Elon Musk said that SpaceX has “essentially no patents” because they are in competition with China.¹¹⁰ Musk feared that if his company published patents, the “Chinese would just use them as a recipe book.”¹¹¹ Despite these fears, SpaceX has applied for patents on space-related technologies.¹¹²

Seeking patent protection on SpaceX technologies differs from Musk’s approach with Tesla patents on electric vehicle technology. In 2014, Tesla released its patents to foster an open source platform to advance electric vehicles.¹¹³ Criticizing the patent system’s stifling effect on progress, Musk argued that “the world would all benefit from a common, rapidly-evolving

¹⁰⁶ Sheetz, *supra* note 104.

¹⁰⁷ *Id.*; Marc Boucher, *Global Government Spending on Space Exploration to Grow Modestly*, SPACEQ (Oct. 1, 2018), <https://spaceq.ca/global-government-spending-on-space-exploration-to-grow-modestly/> (“Space agencies are increasingly seeking to leverage partnerships with the private sector to achieve their goals more cost-effectively while fostering sustainable space exploration.”). Another example of private sector partnerships with NASA is found in the commercial cargo program to the ISS. In the early 2000s, NASA created a program where NASA gave private companies funding to develop cargo shuttles after these “companies met specific performance milestones.”; Casey Dreier, *Huge Case Prizes and the Abdication of Public Oversight*, THE SPACE REVIEW (Aug. 26, 2019), <http://www.thespaceview.com/article/3782/1> (Companies that did not reach the milestones did not receive further funding from NASA. Even though there was not a cash prize reward, competitors were pulled in by the possibility of “billions of dollars in future service contracts for the space station.”).

¹⁰⁸ Stefan Paterson & Robert Wulff, *The Role of Intellectual Property in Space*, SPACE TECH (July 31, 2018), <https://www.spacetechnasia.com/the-role-of-intellectual-property-in-space/>.

¹⁰⁹ See Kim Bhasin, *Elon Musk: ‘If We Published Patents, It Would Be Farcical’*, BUSINESS INSIDER (Nov. 9, 2012), <https://www.businessinsider.com/elon-musk-patents-2012-11>.

¹¹⁰ *Id.*

¹¹¹ *Id.*

¹¹² See Eric Ralph, *SpaceX Seeks Patent for Custom-Built Starlink Internet Satellite Antenna Design*, TESLARATI (Sept. 6, 2018), <https://www.teslarati.com/spacex-custom-built-starlink-satellite-antenna-patent-grant/>; WO/2018/152439 (Aug. 23, 2018), <https://patentscope.wipo.int/search/en/detail.jsf?docId=WO2018152439&tab=PCTBIBLIO>.

¹¹³ Elon Musk, *All Our Patent are Belong to You*, TESLA (Jun. 12, 2014), <https://www.tesla.com/blog/all-our-patent-are-belong-you>.

technology platform.”¹¹⁴ Despite this dim view of the patent system, SpaceX has applied for patent protection on technology such as phase shifters for satellite systems.¹¹⁵ One explanation is that the space industry varies significantly from the electric vehicle industry.¹¹⁶ While there is a much larger market for electric vehicles, the space exploration industry is much smaller and made up of only a few competitors, and therefore it would be more difficult for “SpaceX to give up a valuable market share in such a small, young market.”¹¹⁷

B. EMERGING SPACE PROGRAMS AND THE BENEFITS OF EXPLORATION

The number of countries with space programs has greatly increased since the 1950s.¹¹⁸ Space capabilities no longer rest solely with the United States or the Soviet Union. Instead, seventy-two nations have space programs, and fourteen of these nations have the capability to launch objects into outer space.¹¹⁹ The development of space programs in European countries and China is not as surprising because of economic growth and stability within these countries. More surprising is the rapid growth of India’s space program and the developments in space programs in African countries.¹²⁰

In 2018, India invested \$1.5 billion into its national space program.¹²¹ Striving to establish itself as a leader in space exploration, India is

¹¹⁴ Musk, *supra* note 113.

¹¹⁵ Ralph, *supra* note 112.

¹¹⁶ *Should Elon Musk make SpaceX patents and trade secrets available for all who would use them in good faith as he did with the Tesla patents?*, LAW TRADES, <https://www.lawtrades.com/answers/elon-musk-make-spacex-patents-trade-secrets-available-use-good-faith-tesla-patents/> (last visited Dec. 18, 2019).

¹¹⁷ *Id.*

¹¹⁸ Major Dan, *How Many Countries Have Space Programs?*, HISTORY & HEADLINES (Feb. 24, 2019), <https://www.historyandheadlines.com/how-many-countries-have-space-programs/>.

¹¹⁹ *Id.*

¹²⁰ See Niha Masih, *India’s Moon Mission Signals Country’s Growing Space Ambitions*, WASH. POST (July 12, 2019, 5:05 AM), https://www.washingtonpost.com/world/asia_pacific/moon-mission-is-a-signal-of-indias-growing-space-ambitions/2019/07/12/91ba2ad6-a1d0-11e9-a767-d7ab84aef3e9_story.html; See also Chris Giles, *Africa Leaps Forward into Space Technology*, CNN (May 16, 2018, 5:48 AM), <https://www.cnn.com/2017/08/10/africa/africa-space-race/index.html>.

¹²¹ Nicolas Rapp & Brian O’Keefe, *50 Years After the Moon Landing, Money Races Into Space*, FORTUNE (July 22, 2019, 3:30 AM), <https://fortune.com/longform/space-program-spending-by-country/>; Simon Seminari, *Global Government Space Budgets Continues*

“cultivating a reputation as a low-cost space power.”¹²² Launching satellites for national purposes as well as “on behalf of foreign governments,” India is looking to gain a larger share of the space industry.¹²³ India has also launched an unmanned mission to Mars at a fraction of the cost of the United States’ Mars mission.¹²⁴ Looking to take the next advancement in space flight, India announced in 2018 that it is aiming to send a small crew to low-Earth orbit.¹²⁵

African countries are also developing and expanding space programs. Spending \$36 million on its space program in 2018, South Africa is in the process of building infrastructure that will allow the country to host the Square Kilometre Array, the world’s biggest radio telescope.¹²⁶ Nigeria is aiming to be the first African country to send manned missions into space.¹²⁷ Having launched five satellites since 2003, Nigeria is now planning to send astronauts to space by 2030.¹²⁸ Other African countries are in the process of developing space agencies, designing satellites, and launching satellites into space.¹²⁹

These impressive advancements are not without criticism. African space programs “are frequently criticized for being a waste of money” as those nation are facing “more immediate concerns.”¹³⁰ Yet, India’s space program has shown that modest investments in a space program can result in

Multiyear Rebound, SPACE NEWS (Nov. 24, 2019), <https://spacenews.com/op-ed-global-government-space-budgets-continues-multiyear-rebound/>; MASIH, *supra* note 120 (noting an 11% increase in India’s spending on its space program to 1.8 billion).

¹²² Krishna N. Das, *India Says Manned Space Mission to Cost 1.4 Bln*, REUTERS (Aug. 28, 2018, 6:28 AM), <https://www.reuters.com/article/india-space/india-says-manned-space-mission-to-cost-14-bln-idUSL3N1VJ4B1>.

¹²³ *Id.*

¹²⁴ *Id.* (India unmanned Mars mission cost \$74 million, which is “a fraction of the \$671 million the U.S. space agency NASA spent on its MAVEN Mars mission.”).

¹²⁵ *Id.*

¹²⁶ Giles, *supra* note 120; SQUARE KILOMETRE ARRAY, <https://southafrica.skatelescope.org/welcome/> (last accessed Dec. 18, 2019).

¹²⁷ *Id.*

¹²⁸ *Id.*; *Government Spending in Space Programs Reaches \$62 Billion in 2016*, EUROCONSULT (May 30, 2017), http://euroconsult-ec.com/30_May_2017/.

¹²⁹ See Giles, *supra* note 120. (In 2017, Ethiopia announced goal to launch satellites into space within the next 5 years and in 2015 opened a multi-million observatory. In 2017, Kenya launched its first “cube satellite.” In 2017 Ghana sent its “first satellite into orbit.”).

¹³⁰ *Id.*; See also, A.R., *How Can Poor Countries Afford Space Programmes?*, THE ECONOMIST (Nov. 4, 2013), <https://www.economist.com/the-economist-explains/2013/11/04/how-can-poor-countries-afford-space-programmes> (“But as the Mangalyaan begins its journey, many might wonder how a country that cannot feed all of its people can find the money for a Mars mission.”).

economic and social gains for the country.¹³¹ By investing in space exploration, African countries can also utilize space-related technology to promote economic development and address the pressing concerns that African countries are facing. After all, investment in a space program goes beyond national prestige.¹³² Space programs can serve as economic drivers,¹³³ contribute to improvement in agriculture,¹³⁴ and improve communication systems.¹³⁵ Importantly, space exploration leads to technology innovation and “new means to address global challenges.”¹³⁶

Space exploration “generates tremendous Return-On-Investment.”¹³⁷ Early satellites that were designed to study outer space contributed crucial knowledge that led to the development of “satellite telecommunications, global positioning, and advances in weather forecasting.”¹³⁸ Technology used for space exploration led to spin off technology that is used in “everyday life, from solar panels to implantable heart monitors, from cancer therapy to light-weight materials, and from water-purification systems to improved computing systems and to global search-and-rescue system[s].”¹³⁹ Financial estimates for ROI from technology spinoffs “range from \$2 back for every \$1 spent to \$7 for every \$1 spent.”¹⁴⁰

Space technology can be particularly valuable in developing countries. For example, the research into sustainably growing plants in outer space has helped improve agricultural growing techniques on Earth in regions where

¹³¹ Rathi, *supra* note 3 (“In the last 44 years, [India] has achieved remarkable feats on a shoe-string budget.”).

¹³² Zoe Hawkins, *Space Exploration is for Everyone, Including Developing Nations*, CRITICAL HIT (Feb. 8, 2017), <https://www.criticalhit.net/technology/space-exploration-everyone-including-developing-nations/>.

¹³³ Ian A. Christensen, Jason W. Hay & Angela D. Peura, *National Development Through Space: India as a Model*, SPACE TECHNOLOGIES FOR THE BENEFIT OF HUMAN SOCIETY AND EARTH 453 (2009).

¹³⁴ Hawkins, *supra* note 132.

¹³⁵ NASA, INT’L SPACE EXPLORATION COORDINATION GROUP, *Benefits Stemming from Space Exploration*, INTERNATIONAL SPACE EXPLORATION COORDINATION GROUP 1 (Sept. 2013), <https://www.nasa.gov/sites/default/files/files/Benefits-Stemming-from-Space-Exploration-2013-TAGGED.pdf>

¹³⁶ *Id.* at 1-2.

¹³⁷ Hawkins, *supra* note 132 (quoting Kartik Kumar, an Analog Astronaut with the Austrian Space Forum).

¹³⁸ NASA, INT’L SPACE EXPLORATION COORDINATION GROUP, *supra* note 135, at 1.

¹³⁹ *Id.*

¹⁴⁰ Kjell Stakkestad, *What Space Exploration Means for the Growth of Our Economy*, PHOENIX BUSINESS JOURNAL (Jan. 7, 2016), <https://www.bizjournals.com/phoenix/blog/techflash/2016/01/what-space-exploration-means-for-the-growth-of-our.html>.

growing food was “previously considered impossible.”¹⁴¹ NASA satellites “help Kenyan farmers protect their crops from frost, Nepalese officials monitor forest fires, and policymakers in Botswana prevent land degradation.”¹⁴² This satellite imagery also measures vegetation health and rainfall measurements. This ability to “monitor for potential crop failures” helps African countries predict food availability and shortages.¹⁴³

Space exploration can also lead to economic growth as developing countries can use the space industry as “a means to bootstrap high-tech industries and lead to sustainable jobs.”¹⁴⁴ Creating a space program leads to investment in infrastructure and space assets – such as remote sensing (e.g., using a satellite to scan the Earth) – enable a country to identify and manage natural existing resources, “thereby increasing a nation’s productivity and wealth.”¹⁴⁵ Additionally, “by developing the skills and technologies necessary for a national space program,” a country can build “the capacity for a technically driven economy.”¹⁴⁶

C. WORKING TOGETHER FOR THE BETTERMENT OF ALL

NASA and other established space programs have worked to share the benefits and resources that these agencies have gathered from space exploration in many ways. As discussed in Part III(C), programs like the United Nations Development Program¹⁴⁷ and the United Nations (“UN”) space mission on the Dream Chaser¹⁴⁸ show an effort by the international community to include developing space programs in space exploration and research initiatives. Notably, developing countries can participate directly in ongoing research instead of simply receiving an organization’s finished research product.

¹⁴¹ Hawkins, *supra* note 132 (quoting Kartik Kumar, an Analog Astronaut with the Austrian Space Forum).

¹⁴² Linda Poon, *NASA’s Mission to Bring Data from Space to the Developing World*, CITY LAB (Sept. 24, 2015), <https://www.citylab.com/life/2015/09/nasas-mission-to-bring-data-from-space-to-the-developing-world/406537/>.

¹⁴³ *Id.*

¹⁴⁴ Hawkins, *supra* note 132.

¹⁴⁵ Christensen, *supra* note 133, at 456; *What is Remote Sensing?*, NATIONAL OCEAN SERVICE (Jun. 25, 2018), <https://oceanservice.noaa.gov/facts/remotesensing.html>.

¹⁴⁶ Christensen, *supra* note 133, at 456.

¹⁴⁷ Carl Q. Christol, *Space Joint Ventures: The United States and Developing Nations*, 8 AKRON L. REV. 398, 398-99, 409 (1975).

¹⁴⁸ Merrit Kennedy, *The United Nations is Launching a Space Mission*, NPR (Sept. 30, 2016), <https://www.npr.org/sections/thetwo-way/2016/09/30/495954858/the-united-nations-is-launching-a-space-mission>.

NASA's approach to patenting its inventions encourages public access to space technology. Unlike private companies that generally seek to exclude others from using the company's patented technology, NASA has a unique patent strategy that "is focused on promoting development and access, rather than . . . prevent[ing] others from relying on the technology."¹⁴⁹ NASA only patents technology that "can be brought to market within seven years and that which a patent license is deemed the best way to get the technology to market."¹⁵⁰ NASA has also dedicated numerous patents to the public domain. By 2016, NASA had released "56 formerly-patented agency technologies into the public domain."¹⁵¹ By patenting an invention before dedicating the patent to the public, "NASA precludes other inventors from obtaining that patent, thereby also preventing the patent being used to exclude others."¹⁵² Additionally, NASA offers both exclusive and non-exclusive licenses to its patented technology.¹⁵³ These efforts make space-related patented technology more available for public use within and outside of the United States. Another interesting approach is to shorten the patent duration granted to technology discovered on the ISS. Under the NASA Authorization Act of 2010, NASA can enter into cooperative agreements with private companies to conduct research aboard the ISS.¹⁵⁴ While patents invented in the United States are granted a twenty-year patent term for an invention patented in the United States, discoveries made on the ISS may have shorter protection periods if the cooperative agreement shortens the patent duration.¹⁵⁵ This short-term patent reflects the principle of sharing space-related technology and information instead of excluding others from its use. However, while this approach appears to strike a good balance, there are drawbacks and complications when dealing with short-term patent rights

¹⁴⁹ Krista L. Cox, *NASA Patent Licenses Demonstrate Space Research Not Just for Aerospace Industry*, ABOVE THE LAW (Oct. 25, 2018), <https://abovethelaw.com/2018/10/nasa-patent-licenses-demonstrate-space-research-not-just-for-aerospace-industry/>.

¹⁵⁰ *Id.*

¹⁵¹ *NASA Makes Dozens of Patents Available in Public Domain to Benefit U.S. Industry*, NASA (May 5, 2016), <https://www.nasa.gov/press-release/nasa-makes-dozens-of-patents-available-in-public-domain-to-benefit-us-industry>.

¹⁵² Cox, *supra* note 149.

¹⁵³ *Id.*

¹⁵⁴ National Aeronautics and Space Administration Authorization Act of 2010, PUB. L. NO. 111-267, §504, 124 Stat 2805, 2825-26 (2010).

¹⁵⁵ 35 U.S.C. § 154(a)(2). See Alexandra M. Davidson, *To Explore Outer Space: The Intellectual Property Frontier for Patents*, 47 HOFSTRA L. REV. 889, 902 (2019) (protection on the duration of a patent); See also Debra Werner, *U.S. Intellectual Property Rules Hinder Space Station Research*, SPACE NEWS (Nov. 27, 2013), <https://spacenews.com/38389us-intellectual-property-rules-hinder-space-station-research> ("If the discoveries occur on the space station, however, Zero Gravity Solutions would have exclusive rights to its inventions for only five years.").

that differ from the established twenty-year duration found throughout most of the world. Zero Gravity Solutions, Inc., a company researching microgravity planting, argued that “[i]t could take five years of research to get to the point where you have something you can patent.”¹⁵⁶ Understandably, companies may be discouraged from conducting research if the company does not receive any real commercial use from those property rights. Again, the balancing act of patent law looks to guard the public domain while still providing an incentive to inventors to research and invent. This incentive is important because of the benefit this technology will bring to the public domain.

A developing country is not necessarily limited to the country’s infrastructure or the capability of the individual space program. Developing countries can also participate in joint ventures with countries possessing more advanced space capabilities in order to benefit from space technology. The United Nations Development Program (UNDP) works to “facilitate international cooperation in the development of regional communication satellites” as well as assisting other countries participating in joint ventures.¹⁵⁷ For example, the UNDP worked with “eight Latin American countries” to conduct a feasibility study of a “regional educational television satellite system.”¹⁵⁸ By 1974, the UNDP contributed a total of \$4,042,440 to joint venture projects in 11 developing countries.¹⁵⁹

Another opportunity for developing countries is the United Nations’ plan to launch its own space mission that is “packed with scientific experiments from countries that can’t afford their own space program.”¹⁶⁰ The goal is to launch a shuttle (“Dream Chaser”) in 2021 for a “14-day flight in low Earth orbit” with the shuttle being outfitted with “20 to 25 laboratory stations for countries to do experiments in microgravity.”¹⁶¹ Additionally, prior to the mission, the United Nations’ Office for Outer Space Affairs is

¹⁵⁶ Anna, *Space Law: The Commercialization of Space and its Patents*, UNIVERSITY OF DELAWARE: INTELLECTUAL PROPERTY IN THE DIGITAL AGE (Apr. 16, 2015), <https://sites.udel.edu/cisc356/2015/04/16/space-law-the-commercialization-of-space-and-its-patents/> (quoting Richard Godwin of Zero Gravity Solutions); See also Werner, *supra* note 155. (“Other commercial researchers eager to explore the potential benefits of microgravity on plants, pharmaceuticals and materials express similar concerns that government rules limiting their intellectual property rights could prevent them from profiting from new discoveries.”).

¹⁵⁷ Christol *supra* note 147.

¹⁵⁸ *Id.* at 409.

¹⁵⁹ *Id.* at 410.

¹⁶⁰ Merrit Kennedy, *The United Nations is Launching a Space Mission*, NPR (Sept. 30, 2016), <https://www.npr.org/sections/thetwo-way/2016/09/30/495954858/the-united-nations-is-launching-a-space-mission>.

¹⁶¹ *Id.* at 157.

“planning to provide technical support to countries that haven’t had experience conducting microgravity experiments.”¹⁶² Because of the financial cost and technical training necessary to start a space program, joint ventures could allow developing countries to participate in space exploration without over investing the limited resources available in the country.¹⁶³

IV. TO GIVE OR NOT TO GIVE . . . A PATENT

In an ideal world, all areas that touch space exploration would be equally accessible and usable to every person in the world. All research, technology, and infrastructure could be utilized by each nation to conduct its own exploration into outer space. Because of the enormous benefits stemming from space exploration, it would seem that unrestricted access to space is for the betterment of all mankind. From this perspective, intellectual property as a form of legal appropriation seems to disfavor space exploration as a common good. Instead of unrestricted access, nations have developed a property-rights system that allows inventors of new technology to exclude others from utilizing their inventions for twenty years. And yet, the patent system provides valuable incentives for private actors investing in space exploration. Without patent protection, space research and exploration could decrease, and then no country would receive benefits from outer space.

As private entities and other nations enter space exploration, the global community needs to clarify what conduct is permissible in space and what property rights an individual or organization has to the resources – both tangible and intellectual – of outer space. The Outer Space Treaty declared that space exploration was to be conducted for “the benefit and in interests of all countries, irrespective of their degree of economic or scientific development” and that this exploration and use “shall be the province of all mankind”¹⁶⁴ Although the full legal implications of the Outer Space Treaty are unclear, this guiding principle reaffirms that the benefits of space are for all nations, not just the select group of countries who entered the race first. At a minimum, the Outer Space Treaty designates space as a *res communis*, meaning that all states have a right to use the area.¹⁶⁵ Now that developing countries are partnering with other nations and creating their own programs, developing countries have a greater ability to go to space and collect space minerals. Perhaps there is less need to resolve how tangible property should

¹⁶² Kennedy, *supra* note 160.

¹⁶³ Christol, *supra* note 147, at 411 (“Just as the average individual cannot afford a \$33,500 Rolls Royce automobile, it would be a mistake for an LDC to commit its limited resources to an extensive space program.”).

¹⁶⁴ G.A. Res. 2222 (XXI), *supra* note 10, at art. 1.

¹⁶⁵ See *supra* Part I(A).

be used for the betterment of all mankind. But, if the global community allows private entities to claim intangible properties rights on the use of space (e.g., a method using microgravity to perform a chemical reaction), then this property right does interfere with another's use of outer space. This would violate the *res communis* principle of the Outer Space Treaty and ignore the interests of developing countries by simply rewarding the private company that researches space first.

So how can the world create incentives for space exploration while abiding by international law? First, the global community should pass a new UN space treaty ("Treaty") that clarifies property interests in outer-space resources. The Treaty should recognize outer space as "common heritage" and specify that the minerals and other resources of space belong to all nations. However, the Treaty should also provide a patent system to grant inventors property rights in inventions derived from these space resources. Inventors would submit patent applications to a newly created UN committee, disclosing their inventions and identifying the role that outer space materials have in the inventions. The UN committee would then assess the patentability of the invention.

Recognizing that space resources are the common heritage of all nations, the patent terms would operate differently than the standard twenty-year patent terms recognized by most nations.¹⁶⁶ Inventions based on outer-space resources would receive shorter terms than would be granted under domestic law. These short-patent terms (e.g., seven years) would reflect that the use of a global resource should not be given long-term exclusionary rights. However, inventors could apply for a waiver by agreeing to good-faith negotiations for the licensing of their inventions with developing countries. If the inventor agrees to this licensing, then the inventor would receive a longer-patent term (e.g., fourteen years) on the invention. Each provision of the Treaty should be self-executing to avoid the need for additional legislation to implement the Treaty.

¹⁶⁶ See *supra* Part III(C).

V. CONCLUSION

The benefits of outer-space research and exploration are significant and could provide valuable information and technology to nations that are struggling economically. But, without an international treaty to govern the granting of intangible property rights for outer-space resources, there will be little consensus on the appropriate scope of patented technology based on these resources. This Treaty would recognize outer-space resources as the common heritage of mankind while still providing incentives for space research and exploration. Even more valuable is the incentive for inventors to partner with and license their inventions in order to receive a longer patent term. This Treaty, therefore, would encourage the exploration of outer space while ensuring that this exploration truly is for the betterment of all mankind.