PROTECTING THE COSMOS: THE NEED TO DEFINE CELESTIAL BODIES IN THE OUTER SPACE TREATY

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ABSTRACT

The lack of a clear definition of the term "celestial bodies" as used in the Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, including the Moon and Other Celestial Bodies (Outer Space Treaty or OST) risks exporting legal and political conflict into the cosmos. With advancing technology and expanding extraterrestrial human activity, nations, private enterprise and even individuals could engage in a free-for-all to test the boundaries of what is permissible in outer space, risking legal or even armed conflict. Through national and international measures, clear criteria defining what is and is not a "celestial body" must be established to avoid misunderstanding and miscalculation, and to provide meaning to the term as used in the Outer Space Treaty. Attempts to address this issue have largely focused on broad, and often binary, approaches to determining what "celestial bodies" are or are not. Work to address this issue, however, has been limited and rendered somewhat obsolete given technological

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advancements, as well as national and multilateral policy and legal changes in the field. While past scholarship is helpful in framing the issue, it fails to propose a universal and holistic approach that takes emerging technological developments into account alongside these national and multilateral policy and legal developments. Instead of seeking to determine whether vast classes of objects are "celestial bodies" or not, a far more nuanced approach should be taken that actually enumerates and catalogues those objects that will be considered "celestial bodies" for the purposes of the OST. Moreover, these efforts should also clearly demarcate where the jurisdiction of the OST ends by declaring its writ to extend to the limits of the solar system and no farther. By providing a multi-tiered and finite approach to the problem, this article can instantly help frame the discussion to ensure the exploration and use of outer space for peaceful purposes as envisioned by the OST.

I. INTRODUCTION

On June 13, 2010, a streak of light split the sky over Woomera Test Range in Australia. Described as "breathtakingly beautiful,"[1] it was not an entirely natural phenomenon, but it was nevertheless jaw-droppingly spectacular and record-breaking. The light marked the entry into the atmosphere of the Japan Aerospace Exploration Agency's (JAXA) Hayabusa spacecraft, the first ever human object to land on an asteroid—a near-Earth object named Itokawa—and return to Earth with a sample of material from that object.[2] Scientists describe Itokawa as "a 'rubble pile' loosely held together by gravity."[3] While the spacecraft itself was incinerated, a heat-shielded capsule landed carrying "1,500 tiny particles" most of

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[1] Ken Kremer, *Japanese Asteroid Lander Hayabusa Plunges Home to Earth,* SPACEREF (June 13, 2010), https://spaceref.com/uncategorized/japanese-asteroid-lander-hayabusa-plunges-home-to-earth/.

[2] Dennis Normile, *Japan's Hayabusa2 Capsule Lands with Carbon-rich Asteroid Samples*, SCIENCE (Dec. 7, 2020), https://www.science.org/content/article/japan-s-hayabusa2-capsule-lands-carbon-rich-asteroid-samples (last visited Sept. 17, 2023).

[3] Paul Scott Anderson, *Asteroid Itokawa Gives Up Its Secrets,* EARTHSKY.ORG (Sept. 8, 2018) https://earthsky.org/space/dust-grains-returned-from-asteroid-itokawa-by-hayabusa-reveal-its-age-and-history/.

which were determined to be from Itokawa.[4] On average, the particles were just "one-tenth the width of a human hair."[5]

The fundamental precept of the Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, including the Moon and Other Celestial Bodies (Outer Space Treaty or OST) is that the exploration and use of outer space are "the province of all [hu]mankind"[6] and "shall be carried out for the benefit and in the interests of all countries."[7] The OST also provides that there "shall be freedom of scientific investigation in outer space, including the Moon and other celestial bodies."[8] While the Treaty provides that "there shall be free access to all areas of celestial bodies,"[9] Article II is clear 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."[10]

The United States (US) has signaled, through its national law,[11] and through the development and execution of international agreements such as the Artemis Accords,[12] that it interprets Article

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[4] Wendy Zukerman, *Spacecraft is First to Bring Asteroid Dust to Earth,* NEWSCIENTIST (Nov. 16, 2010), https://www.newscientist.com/article/dn19730-spacecraft-is-first-to-bring-asteroid-dust-to-earth/.

[5] Elizabeth Howell, *Hayabusa: Troubled Sample Return Mission,* SPACE.COM (Mar. 30, 2018), https://www.space.com/40156-hayabusa.html.

[6] The author would urge that future developments in space law should employ the inclusive term "humanity" rather than the more limiting, exclusionary, and etymologically archaic "mankind" in reference to the human race and human civilization. EDITOR'S NOTE: it has been the policy and practice of the *Journal of Space Law* to use the terms "human," "humanity" and "humankind" since 2018.

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

[8] *Id.*

[9] *Id.*

[10] *Id.* at art. II.

[11] See e.g., US Commercial Space Launch Competitiveness Act, Pub. L. No. 114-90, §§ 101-403, 129 Stat. 704, 704-22 (2015).

[12] The Artemis Accords: Principles for Cooperation in the Civil Exploration and Use of the Moon, Mars, Comets, and Asteroids, NASA, https://www.nasa.gov/specials/artemis-accords/img/Artemis-Accords-signed-13Oct2020.pdf [hereinafter Artemis Accords]. The original signatories were representatives from Australia, Canada, Italy, Japan, Luxembourg, the United Arab Emirates, the United Kingdom, and the United States; these original parties have (as of this writing) since been joined by Bahrain, Brazil, Colombia, France, The Isle of Man, Israel, South Korea, Mexico, New Zealand, Poland, Romania, Singapore, Ukraine, Rwanda, and Nigeria.

II to mean that it is permissible, particularly for private enterprises and individuals, to extract and utilize resources from space, including the Moon and other celestial bodies without running afoul of the provisions of Article II of the Outer Space Treaty or any other international law or obligation. As of December 13, 2022, 23 nations have signed the Artemis Accords, indicating their agreement with this interpretation.[13] However, this understanding merely scratches the surface of the implications and meaning of Article II.

Deconstructing the language of Article II suggests that it may have truly been intended to restrict national—versus private—appropriation. Moreover, as we consider space with far more knowledge than we had in the 1960s, when the Outer Space Treaty was negotiated, we must consider what is meant by the term "celestial body," and even the term "outer space" itself. On the one hand, the language of Article II suggests that nothing in space, including an orbital slot, or even the energy generated by our sun, may be "appropriated." Yet it would be absurd to apply that literal a meaning to Article II. Are parties to the Outer Space Treaty obligated not to "appropriate" even a miniscule speck of cosmic dust? If the resources contained in a so-called "celestial body" are extracted to the point where the celestial body disappears, does that cross a threshold into appropriation?

With all this in mind, the argument can certainly be raised that Japan must share these 1,500 particles with the rest of humanity. Of course, JAXA shared its bounty with allied nations and scientific results were made publicly available.[14] And indeed, no State Party to the OST objected to this mission to retrieve space resources, just as no nations objected when the Soviet Union, the United States, and then China returned sample material from the Moon. Certainly, it would feel absurd to argue that the collection of 1,500 particles smaller than a human hair for the purposes of scientific discovery collected from a pile of rubble held together by gravity violates the substance or purpose of the Outer Space Treaty.

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[13] White House Statement, *Strengthening the US-Africa Partnership in Space*, THEWHITEHOUSE (Dec. 13, 2022), https://www.whitehouse.gov/briefing-room/statements-releases/2022/12/13/statement-strengthening-the-u-s-africa-partnership-in-space/.

[14] *Hayabusa Project,* JAXA, https://darts.isas.jaxa.jp/planet/project/hayabusa/index.html (last visited Nov. 1, 2023).

Fast forward just one decade. In December 2020, another JAXA mission, Hayabusa 2, returned to Earth carrying 5.4 grams of soil and rock gathered from another collection of gravitationally bound fragments, this one named Ryugu.[15] Again, the collection was made in the name of science and no doubt provided a benefit to humanity by assisting in our understanding of the cosmos. The United States, also a signatory to the Outer Space Treaty, likewise launched an asteroid sample-return mission (OSIRIS-REx [Origins, Spectral Interpretation, Resource Identification, Security, Regolith Explorer]), which successfully touched down on and collected a sample from its target asteroid. OSIRIS-REx returned to Earth on September 24, 2023.[16]

By extrapolating from Moore's Law[17] of exponential technological growth and applying it to the rapid developments in space launch technology, and one can imagine, just a decade or so from now, not a return mission that retrieves a scientific sample, but a commercial operation that lands on an asteroid to mine its resources solely for commercial benefit. It could even be that the asteroid would be mined literally out of existence. Can this be permissible under the Outer Space Treaty? Each of the asteroids targeted by Japan and the United States for sample-return missions range in size from 330 meters to 1 kilometer in diameter and each have names (162173 Ryugu, 25143 Itokawa, and 101955 Bennu). Are they to be considered "celestial bodies?" Does it make sense to limit the definition of "celestial bodies" based on size (or even whether the objects are named)?

The Outer Space Treaty employs the term "celestial bodies" repeatedly throughout its text. However, the term has never been concretely defined in an academic, scientific, or legal context. While the lack of any definitional clarity has not, heretofore, caused any

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[15] Shiori Ogawa, *'Building Blocks of Life' Found in Soil Taken from Asteroid Ryugu,* ASAHI.COM (June 6, 2022), https://www.asahi.com/ajw/articles/14638613.

[16] *OSIRIS-Rex*, NAT'L AERONAUTICS AND SPACE ADMIN., https://science.nasa.gov/mission/osiris-rex/ (last visited Dec. 30, 2023).

[17] Gordon Moore predicted that the number of transistors per square inch on an integrated circuit would double approximately every two years. In 1975, chips held 10,000 transistors each. Today that number is 50 billion. *See* Tina Sieber, *What is Moore's Law and Is it Still Relevant in 2022?,* MAKEUSOF.COM (Mar. 15, 2022), https://www.makeuseof.com/tag/what-is-moores-law-and-what-does-it-have-to-do-with-you-makeuseof-explains/.

difficulties to humanity writ large, advances in technology will soon empower governments, public and private enterprises, and even private citizens to engage in extraterrestrial activities that will be impacted by how the term "celestial bodies" is defined or interpreted. [18] How we think about and define "celestial bodies" will impact the application of and limitations imposed by Article II.

Steven Gorove posed the question this way in 1969:

> Does the prohibition extend to the collection of dust particles or other special elements during flight in outer space? Does the prohibition extend to the appropriation of cosmic rays, gases or the sun's energy, or to the collecting of mineral samples or precious metals on the Moon or other celestial bodies? Should the answer depend on the type of resource involved, or on its availability in unlimited (cosmic rays, meteorites, gases) or limited (minerals, metals) quantities or perhaps on its location?[19]

Further, does the concept extend to objects that came to Earth naturally as opposed to those brought back by human intervention?[20] And finally, are any intangible cosmic phenomena, such as Lagrange points, to be included as a "celestial body?"

All of these questions remain unanswered.

This article analyzes the language of Article II of the OST, considering what is meant by the concept of appropriation and argues that: 1) Article II was not intended to reach private non-State entities; 2) the Outer Space Treaty does not prohibit the appropriation or extraction of resources from extraterrestrial objects that do not fall within the meaning of the term "celestial bodies" and 3) that the term "celestial body" itself should be limited and clearly defined. This article will also explore some prior approaches to these same questions and ways in which they require further elaboration. That said, the focus of this article is on the term "celestial body" with

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[18] David A. Epstein, *Boosting Space Diplomacy at State*, FOREIGN SERV. J. (2022), https://afsa.org/boosting-space-diplomacy-state.

[19] Stephen Gorove, *Interpreting Article II of the Outer Space Treaty,* 37 FORDHAM L. REV. 349, 350 (1969).

[20] *Id.* ("With respect to location, it could be argued that if any parts of outer space, including the Moon and other celestial bodies, were found on the earth, they would not be subject to the prohibition of national appropriation since they would become part and parcel of the earth. Under a strict interpretation it may also be argued that the prohibition extends to the resource irrespective of its location").

some consideration, too, to the extent of the application of terrestrial space law in general and, thus, the definition of "outer space" itself.

Part II of this article reviews space law in general and focuses on the language contained in Article II of the Outer Space Treaty. Part III analyzes the term "celestial bodies" from a historical standpoint and within the context of the Outer Space Treaty, also explaining why a definition is important. Part IV reviews different definitions of "celestial bodies" that have been offered and Part V provides the author's proposed solution.

II. THE SPACE TREATIES

A. Generally[21]

In October 1957, Sputnik 1 became the first human-made object to reach space.[22] Shortly thereafter, the United Nations (UN), "*[r]ecognizing* the common interest of [hu]mankind in outer space…and that it is the common aim that outer space should be used for peaceful purposes [and] [*w*]*ishing* to avoid the extension of present national rivalries in this new field,"[23] created an ad hoc committee to, among other things, report on the "nature of legal problems which may arise in the carrying out of programmes to explore outer space."[24] The Committee on the Peaceful Uses of Outer Space (COPUOS) was made a permanent body in 1959.[25] COPUOS was the backdrop for negotiation and implementation of the treaties which today govern space activities.

Five treaties related to sovereign space activities were negotiated in the COPUOS, colloquially known as the Outer Space

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[21] Parts II.A and II.B. of this article were prepared with Michelle L.D. Hanlon and initially presented at the Space Resources Roundtable at the Colorado School of Mines in Golden, Colorado on June 9, 2022.

[22] *Sputnik 1,* NAT'L AERONAUTICS AND SPACE ADMIN, https://www.nasa.gov/image-article/sputnik-1/ (last visited Sept. 17, 2023).

[23] G.A. Res. 1348 (XIII) (Dec. 13, 1958).

[24] *Id.*

[25] G.A. Res. 1472 (XIV) (Dec. 12, 1959).

Treaty,[26] Rescue Agreement,[27] the Liability Convention,[28] the Registration Convention[29] and the Moon Agreement.[30] As their names suggest, these agreements respectively offer principles and guidelines to govern sovereign space activities generally as well as more detailed guidance on how States should act in relation to the rescue of astronauts; responsibility and liability for damage caused by space objects; and the registration of objects launched or intended to be launched into orbit. The Moon Agreement, which suggests that States should consider developing a regulatory regime to govern lunar resource mining when such activity is likely to occur, has been ratified by only eighteen States.[31] None of the major spacefaring nations, including China, the United States or Russia, has done so. And indeed, in April 2020, then-US president Trump issued an Executive Order which made clear both: 1) the United States' unwillingness to enter into the Moon Agreement; and 2) the US strategy to object to "any attempt to . . . to treat the Moon Agreement as reflecting or otherwise expressing customary international law."[32]

Negotiated during the Cold War essentially by the world's two superpowers, the four widely ratified treaties reflect a remarkable—and to date successful—détente. The overriding concern was, as the name of the COPUOS suggests, peace. As they hammered out the *Magna Carta* for peace in space, the negotiators cannot be faulted for not considering an environment where, as today, private entities could perform all the space activities once reserved for State actors—and very few State actors at that. As a result, peace, collaboration, and freedom[33] are the regime's key principles, while

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[26] Outer Space Treaty, *supra* note 7.

[27] Agreement on the Rescue of Astronauts, the Return of Astronauts and the Return of Objects Launched into Outer Space, Apr. 22, 1968, 19 UST. 7570, 672 UNT.S. 119 [hereinafter Rescue Agreement].

[28] Convention on the International Liability for Damage Caused by Space Objects, Mar. 29, 1972, 24 UST. 2389, 961 UNT.S. 187 [hereinafter Liability Convention].

[29] 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].

[30] Agreement Governing the Activities of States on the Moon and Other Celestial Bodies, Dec. 18, 1979, 1362 UNT.S. 3 [hereinafter Moon Agreement].

[31] *Id.*

[32] Exec. Order No. 13914, 85 Fed. Reg. 20, 381 (Apr. 6, 2020).

[33] Article I of the Outer Space Treaty encompasses three foundational aspects of all space activities: the exploration and use of space is the "province" of all humankind; space, including the Moon and other celestial bodies "shall be free for exploration and use by all States;" and "States shall facilitate and encourage international co-operation"

other increasingly important matters, including cultural heritage preservation and private resource mining and utilization are unaddressed.

That said, the activities of private entities are not entirely overlooked. Article VI of the Outer Space Treaty makes it quite clear that States bear "international responsibility for national activities in outer space…whether such activities are carried on by governmental agencies or by non-governmental entities."[34] The Article further indicates that States must assure that all "national activities are carried out in conformity with the provisions set forth" in the Treaty.[35]

B. Article II

Article II of the Outer Space Treaty states in full: "[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."[36]

i. Sovereignty

The international community seems largely to agree that no sovereign may make a claim to extraterrestrial territory. Indeed, it is a principle so embedded in the bedrock of space exploration as to be considered by many to be not just a treaty obligation but customary international law.[37] Nevertheless, a colorable argument can be made that this particular provision does not apply to non-State entities.

First, the Article plainly indicates that space shall not be subject to *national* appropriation. Second, the primary restriction is against appropriation by claiming *sovereignty*. Arguably, then, if a non-State entity asserts proprietary rights, it is not a "national appropriation," nor is it "by claim of sovereignty." This interpretation

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in scientific investigation. Outer Space Treaty, *supra* note 7, art. I. Article IV avers that "the Moon and other celestial bodies shall be used…exclusively for peaceful purposes." *Id.* at art. IV.

[34] *Id.* at art. VI.

[35] *Id.*

[36] Outer Space Treaty, *supra* note 7, art. II.

[37] Fabio Tronchetti, *The Non-Appropriation Principle Under Attack: Using Article II of the Outer Space Treaty in Its Defence*, 50 PROC. L. OUTER SPACE 526, 530 (2007).

is supported by the United Nations Declaration of Human Rights, which, in Article 17 plainly states that "[e]veryone has the right to own property alone as well as in association with others."[38] The Declaration applies to space activities through Article III of the Outer Space Treaty which requires States to "carry on activities in…space in accordance with international law."[39] Surely, this would require States to support and defend fundamental human rights even in a space environment. As such, arguably, it would be a violation of international law not to permit ownership in space.

As Stephen Gorove put it: "an individual acting on his [or her] own behalf or on behalf of another individual or a private association or an international organization could lawfully appropriate any part of outer space, including the Moon and other celestial bodies."[40] Perhaps it was this observation that catalyzed the COPUOS to develop the Moon Agreement.

This argument notwithstanding, no State Party to the Outer Space Treaty has indicated a preference to interpret Article II in this manner. Instead, debate remains over what actually constitutes national appropriation. The "sweeping language" of Article II could have been interpreted to apply both to areas as well as resources.[41] However, reference must be made once again to the Moon Agreement which clearly states that "[n]either the surface nor the subsurface of the Moon, *nor any part thereof or natural resources in place*, shall become property of any State, international intergovernmental or non- governmental organization, national organization or non-governmental entity or of any natural person."[42] It is deeply significant that the Outer Space Treaty does not include this language, suggesting that Article II does not apply to parts of celestial bodies, or the resources contained therein. In other words, Article II definitely could be interpreted to allow for the ownership of resources extracted from space, the Moon and other celestial bodies.

It is also worth noting again that each of the United States, China, Russia, and Japan have obtained material directly from the Moon or other extraterrestrial objects without objection by any

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[38] Universal Declaration of Human Rights, G.A. Res. 217A (Dec. 8, 1948).

[39] Outer Space Treaty, *supra* note 7, art. III.

[40] Gorove, *supra* note 19, at 352.

[41] Stephen Gorove, *Implications of International Space Law for Private Enterprise,* 7 ANNALS AIR & SPACE L. 319, 323 (1982).

[42] Moon Agreement, *supra* note 30, art. 11(3) (emphasis added).

other State Party to the Outer Space Treaty. This supports the interpretation that there are clearly instances in which the national non-appropriation principle does not apply, which may be, of course, when the object in question is not, in fact or in law, considered as falling within the category of "celestial bodies."

ii. By Any Other Means

There is also a question of what the concept of "by any other means" entails. This idea appears to conflict with other provisions of the Outer Space Treaty. Pursuant to Article VIII, objects left in space remain under the ownership and control of the State that put them there.[43] In fact, pursuant to Article VII of the Outer Space Treaty and Article III of the Liability Convention, States are "internationally liable" for damage caused to an object in space belonging to another State.[44] Yet leaving the objects *in situ,* or giving them wide berth in order to avoid liability, essentially results in perpetual occupation of the surface upon which they rest or the location they occupy. This notion could even be extended to locations that exist in an even more confounding state for legal and physical consideration, such as a Lagrange points, which possess a physical nature.[45] Given that any object sent to space would, by necessity, occupy or appropriate the physical space of the object itself, applying a prohibition on the appropriation of the space an object occupies by the fact of its existence would be an "absurd" interpretation of Article II.[46] However, this approach could certainly be argued to run afoul of the non-appropriation principle encapsulated in Article II and evidences the incompatibility of "appropriation in the broadest

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[43] Outer Space Treaty, *supra* note 7, art. VIII.

[44] *Id.* at art. VII. Liability Convention, *supra* note 28, art. III. To compound matters, under both the Outer Space Treaty and Liability Convention liability is not based on ownership of the object, but on a country's status as a so-called "launching State." Per the treaty regime, any one of four States may be considered a "launching State" for liability purposes: 1) the State which launches; 2) the State which procured the launch; 3) the State from whose territory the object was launched; and 4) the State from whose facility the object was launched. *Id.* at art. I.

[45] This is not idle conjecture, but present reality. The James Webb Telescope, for example, jointly operated by NASA, the European Space Agency, and the Canadian Space Agency, currently occupies the Lagrange point designated as L2.

[46] Timothy Justin Trapp, *Taking up Space by Any Other Means: Coming to Terms with the Nonappropriation Article of the Outer Space Treaty*, 2013 U. ILL. L. REV. 1681 1691 (2013).

sense of the word" and what the actual, practical, and preferable meaning of the term might be.[47] Additionally, while at one end of the spectrum, it is clear that the use or threat of force to exclude access to any part of space would be prohibited under the Outer Space Treaty,[48] merely stating that an act by or presence of an object does not constitute appropriation, such as is the case with the International Space Station,[49] cannot be deemed sufficient to resolve the matter.[50] Moreover, others have argued that private property rights are likewise proscribed by the OST in so far as the reasoning that holds that "if States cannot appropriate the extraterrestrial realms, then *a fortiori* neither can their nationals…and State endorsement of private appropriation would be a form of national appropriation."[51] Therefore, whether by mere existence, location, national endorsement, or otherwise, "by any other means" lacks the clarity necessary to allow the term to be construed as to have any absolute governing effect to the terms of the Outer Space Treaty. Virgiliu Pop argues, in fact, that some of this lack of clarity can be resolved not by determining the scope and application of Article II of the OST to private persons in the context of property rights as such, but to the objects governed themselves.[52] This approach is an inspired starting point to resolve the ambiguity and confusion surrounding this issue, though it must be done in concert with a defined limitation and applied criteria on the extent to which any formulation is applied. Further, this postulation does not sufficiently take into account the acts and assertions of individual nations or advances in technology whether to date or into the future.

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[47] *Id.*

[48] *Id.* at 1698; *see also* Leslie I. Tennen, *Towards A New Regime for Exploitation of Outer Space Mineral Resources*, 88. NEB. L. REV. 794, 804 (2010).

[49] *See e.g.,* Agreement Among the Government of Canada, Governments of Member States of the European Space Agency, the Government of Japan, the Government of the Russian Federation, and the Government of the United States of America Concerning Cooperation on the Civil International Space Station, Jan. 29, 1998, T.I.A.S. No. 12927, Art. 2 (noting, "(2) Nothing in this Agreement shall be interpreted as … (c) constituting a basis for asserting a claim to national appropriation over outer space or over any portion of outer space.").

[50] Trapp, *supra* note 46, at 1700.

[51] VIRGILIU POP, WHO OWNS THE MOON? 12 (2009).

[52] *Id.* at 48.

C. What is Outer Space and How Far do Earth's Laws Extend?

In addition to considering what is or is not a "celestial body" we must also consider to what extent we might apply this term when finally agreed. The vastness of space is, potentially, infinite,[53] and we must contemplate the limits of, or distinctions between different areas of space as we consider defining terms such as "celestial bodies" and the broader development and application of space law in general. Should we determine where space begins,[54] and simply apply the agreed terms, quite possibly, *ad infinitum* (and *ad absurdum*), in turn coining a new legal maxim of *lex terre est sine fine in universo* (the law of the Earth is without end in the universe)? Or should we adopt the proposed construct of distinct regions of space such as "solar space" (which itself could be subject to debate as scientists and lawyers argue in favor of or against marking the edge of our Solar System as the Oort Cloud, the Termination Shock, or Heliopause),[55] "galactic space" (the entirety of our Milky Way Galaxy outside of the Solar System), and "extragalactic space" (the rest of the universe beyond the Milky Way)?[56] The question should also be asked: where does the Outer Space Treaty's jurisdiction end? This question affects the debate and our understanding of

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[53] Jonathan Gordon & Nola Tillman, *How Big is the Universe?*, SPACE.COM (Jan. 28, 2022), https://www.space.com/24073-how-big-is-the-universe.html.; *See also* DOUGLAS ADAMS, THE HITCHHIKER'S GUIDE TO THE UNIVERSE, N.Y. Harmony Books (1980).

[54] Numerous proposals have been offered to define the limits of air space, and thus the beginning of outer space. A widely accepted notion for the edge of space is the "Von Kármán Line," which defines space as beginning 100 kilometers (54 nautical miles; 62 miles; 330,000 feet) above Earth's mean sea level. *See* Rodney W. Johnson, *Problems of Law and Public Order in Space*, 52 A.B.A.J. 555, 556 (1966). Controversy exists, however, and science continues to challenge the notion of the edge of space; as such, various alternative proposals have been put forth, which often define the lower limits of outer space as being closer to the surface of the Earth. *See* Eric Betz, *The Kármán Line: Where Does Space Begin?*, ASTRONOMY (Mar. 5, 2021), https://www.astronomy.com/space-exploration/the-karman-line-where-does-space-begin/ (noting that the actual boundary between Earth and space could lie anywhere between 30 kilometers (18.5 miles) above the surface to more than a 1.6 million km (over a million miles) away).

[55] Daniel B. Reisenfeld, *A Three-dimensional Map of the Heliosphere from IBEX*, 254 ASTROPHYSICAL J., SUPP. SER. 40 (2021); *see also* Jamie Carter, *The Edge Of Our Solar System Has Been Found: 'Bat-Sense' Used To Find 'Bubble' All Around Us*, FORBES (June 18, 2021), https://www.forbes.com/sites/jamiecartereurope/2021/06/18/the-edge-of-our-solar-system-has-been-found-the-heliosphere-bubble-just-got-mapped/.

[56] John C. Hogan, *Legal Terminology for the Upper Regions of the Atmosphere and for the Space Beyond the Atmosphere*, 51 AM. J. OF INT'L L. 362 (1957); E. Weinmann & H.C. MacDougall, *The Law of Space*, 35 FOREIGN SERV. J., 22-26 (1958).

whether any physical object or phenomena falls within the meaning and prohibitions prescribed by Article II of the Outer Space Treaty.

According to Pop, considering whether a "celestial body" is a legal "thing" requires the application of common sense and the reasonable person standard, and terrestrial *corpus juris spatialis*, should be restricted to our solar system:

> Recently, astronomers have discovered quasars more than 10 billion light years away, the farthest objects ever seen in space. These may be objects in the astronomical sense; we would however submit that they are not objects in the legal sense. Neither should nebulae, black holes, stars other than our Sun, or extrasolar planets, be considered as falling under the sway of *corpus juris spatialis*. While the Outer Space Treaty does not impose on itself any territorial limits, it would be unreasonable to extend terrestrial law to the scale of the universe.[57]

This author could not agree more. Moreover, while not widely ratified, and explicitly rejected by US presidential executive order, the Moon Treaty does provide evidence that limiting the applicability of space law of terrestrial origin has not been only contemplated but attempted. Consider Pop again:

> The Moon Treaty, despite its poor record of ratification, does contain a reasonable limit, its provisions applying "…to other celestial bodies within the solar system, other than the Earth…" (Article 1.1.). It is thus submitted by us that the legal notion of "thing" does not have any validity beyond our solar system.[58]

It should be noted that there is no agreed standard defining where national or international air space stops and outer space begins.[59] As such, determining exactly when the application of the Outer Space Treaty's provision begins is difficult. As noted, however, even more difficult would be considering the outer limits of the application of the Outer Space Treaty. At the boundary between air space and outer space, wherever that is determined to be, there

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[57] POP, *supra* note 51, at 48.

[58] *Id.* at 48-49.

[59] Shadi A. Alshdaifat, *Who Owns What in Outer Space? Dilemmas Regarding the Common Heritage of Mankind*, PECS J. INT'L & EUR. L. 21 (2018).

is nothing recognizable or credibly claimed to be a "celestial body," thus this ongoing debate does not frustrate our purposes here. The first, undeniably "celestial object" one encounters as we travel farther from the Earth is the Moon, so clearly and universally agreed to be a "celestial body" that it has been singled out for specific and more rigorous, though as yet unsuccessful, legal treatment. However, once past the Moon, Lagrange Points, other planets and dwarf planets, their respective satellites or companions, and the myriad other objects encountered within the solar system require legal definition. We may also need to consider those objects that regularly traverse the solar system, or which may enter it at some point and remain for a considerable period of time measured in geologic or galactic timescales. Surely, we cannot presume that the term "celestial body" applies to every speck of dust beyond Earth's atmosphere AND that Earth's authority extends throughout the entire Universe. The author would contend that, so far as seems reasonable, the Solar System would be the maximum extent of the applicability of the jurisdiction of the Outer Space Treaty.

We are also confronted with further complications as, even the authoritative International Astronomical Union (IAU) only applies the term "celestial body" to its definition of planets and "dwarf planet[s]."[60] IAU Resolution B5 provides the following definitions:

> (1) A planet is a celestial body that (a) is in orbit around the Sun, (b) has sufficient mass for its self-gravity to overcome rigid body forces so that it assumes a hydrostatic equilibrium (nearly round) shape, and (c) has cleared the neighbourhood around its orbit.
>
> (2) A "dwarf planet" is a celestial body that (a) is in orbit around the Sun, (b) has sufficient mass for its self-gravity to overcome rigid body forces so that it assumes a hydrostatic equilibrium (nearly round) shape, (c) has not cleared the neighbourhood around its orbit, and (d) is not a satellite.
>
> (3) All other objects, except satellites, orbiting the Sun shall be referred to collectively as "Small Solar System Bodies."[61]

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[61] IAU Res. B5, (Aug. 24, 2006) 26th General Assembly IAU.

Resolution B5 goes on to enumerate the planets as Mercury, Venus, Earth, Mars, Jupiter, Saturn, Uranus and Neptune. Further, the IAU describes "Small Solar System Bodies" as "*most* of the Solar System asteroids, *most* Trans-Neptunian Objects (TNOs), comets, and other small bodies."[62] Limiting the definition of "celestial bodies" to the objects identified and named by the IAU, however, would be far too restrictive and open the whole of the rest of the solar system to a legal void and a free-for-all by both sovereign States and private actors.

Further contradictions by such an authority as the IAU exist in abundance. On a webpage maintained by the IAU describing Pluto's place within our solar system and the IAU categorization scheme, not even dwarf planets are described as "celestial bodies," but rather, blandly, as "objects"[63] The IAU states that "[a] planet is a celestial body. . ." [64] and then further states, in the context of the preceding IAU definition, that, "[p]lutoids are celestial bodies," and "[t]he two known and named plutoids are Pluto and Eris."[65] The IAU makes clear that once size and characteristics of the objects themselves, along with their orbits and relationships to other objects in the Solar System (e.g., their orbital plane), begin to change they cease to be described as a "celestial body" and are simply referred to as "object[s]."[66] What's more, the IAU describes planets and dwarf planets as being separate classes of "objects" and then explicitly goes on to call one of these categories "celestial objects." The basic and long-established legal interpretation principle of *inclusio unius est exclusio alterius* leads only to one conclusion: the IAU maintains an extremely minimalist and strictly limited definition of what is and is not a "celestial body." The IAU further, and troublingly, restricts those objects that may be considered "celestial bodies" for the purposes of interpreting the Outer Space Treaty, however, in that it does not count natural satellites of planets to be "celestial bodies" in their own rights.[67] The IAU rejects the notion

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[62] *Id*. (emphasis added).

[63] *Id*.

[64] *Id*.

[65] Pluto and the Developing Landscape of Our Solar System, INT'L ASTRONOMICAL UNION, https://www.iau.org/public/themes/pluto/ (last visited Nov. 2, 2023)

[66] *Id.* ("Currently there are five objects accepted as dwarf planets. Ceres, Pluto, Eris, Makemake and Haumea.").

[67] *Id.*

that natural satellites of the eight recognized planets can be considered Dwarf Planets themselves, which naturally precludes them from being Plutoids, Dwarf Planets, or "celestial bodies" as well.[68] The IAU specifically states that a "dwarf planet cannot be a satellite."[69] However, taking the IAU's explanation to its logical conclusion, the Moon would also not qualify as a "celestial body" within the scope of the OST under the IAU's definition and clearly this could not have been the intent of the drafters of the OST or its State parties as the Treaty consistently references the "Moon and *other* celestial bodies."[70] Therefore, we must consider the IAU listing and definitions to be helpful, but not definitive or exhaustive.[71] We should then turn to other sources to explore this question further and expand the contours of our understanding of what is practicable on this issue.

D. Examples of National and International Interpretations of Article II

i. The Artemis Accords

The Artemis Accords are a non-binding, "political commitment" intended to "increase the safety of operation, reduce uncertainty, and promote the sustainable and beneficial use of space for all humankind."[72] The Artemis Accords reinforce existing international space law and reaffirm that space activities are to be undertaken for "peaceful purposes" and "in accordance with relevant international law."[73] Specifically, the Artemis Accords emphasize astronaut assistance obligations from the Rescue Agreement[74] and registration requirements from the Registration Convention.[75] Additionally, the Artemis Accords seek transparency, interoperability,

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[68] *Id.*

[69] IAU Resolution B5, *supra* note 61.

[70] *See e.g.,* Outer Space Treaty, *supra* note 2, art. I. (emphasis added).

[71] One clear feature of the objects listed, "celestial" or otherwise, is that many of them are named, thus imputing an intangible value to them and their categories. By this we can understand that humanity feels greater affinity for the Moon or for Pluto, despite neither strictly qualifying as a "celestial object" according to the IAU, than we would for any mass comprising part of the asteroid belt or defined generally as a "meteor."

[72] Artemis Accords, *supra* note 12, § 1.

[73] *Id.* § 3.

[74] *Id.* § 6. *See also* Rescue Agreement, *supra* note 27.

[75] *Id.* § 7. *See also* Registration Convention, *supra* note 29.

sharing of scientific findings, and mitigation against causing space debris.[76] Finally, and most importantly for our purposes here, the Artemis Accords aim to promote specific interpretations of the Outer Space Treaty concerning the extraction and utilization of space resources, affirming "that the extraction of space resources does not inherently constitute national appropriation under Article II of the Outer Space Treaty."[77] Clearly, the extraction of space resources must come from somewhere; without a more clearly defined meaning, that somewhere could inadvertently be a "celestial body." Moreover, by its own terms, the Artemis Accords implicitly designates the Moon and Mars as "celestial bodies." Section 9 of the Accords declares the intent of the signatories to "preserve outer space heritage, which they consider to comprise historically significant human or robotic landing sites, artifacts, spacecraft, and other evidence of activity on celestial bodies."[78] As the Moon and Mars are currently the primary the locations on which "human or robotic landing sites" as well as any artifacts, spacecraft, and other evidence of activity" are to be found, they must, per the Artemis Accords, be "celestial bodies."

As the Artemis Accords are open to any nation to join, and the list of those electing to do so continues growing, the Artemis Accords have the potential to achieve much in the way of establishing not only a broad range of acceptable standards of responsible behavior in outer space but to help resolve the many outstanding issues left unanswered by the Outer Space Treaty as well as emerging heretofore unknowns about extraterrestrial human activities.

ii. National Laws: United States, UAE, Luxembourg and Japan

a. United States

As noted above, the United States is party to four of the five space treaties. Rather than ratify the Moon Treaty, however, the United States pursued national legislation and policy declarations to supplement and interpret the Outer Space Treaty and the other broadly ratified space-related legal instruments. Beginning with

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[76] Artemis Accords, *supra* note 6, §§ 4, 5, 8 & 12.
[77] *Id.* § 10.
[78] *Id.* § 9.

the Space Resource Exploration and Utilization Act of 2015[79] (Space Resources Act), the United States recognized the right of private citizens to own and trade in natural resources obtained from an "asteroid resource or a space resource."[80] Such legislative text appears to reflect the abovementioned notion distinguishing between restraints on national appropriation versus the permissibility of private appropriation. Moreover, the United States explicitly avoids the use of the term "celestial bodies" and identifies at least one category of "asteroid resources" that would seem to be separate and apart from the OST's terminology. US space policy pronouncements also explicitly draw from Article II of the Outer Space Treaty in asserting that "[t]he United States will pursue the extraction and utilization of space resources in compliance with applicable law, recognizing those resources as critical for sustainable exploration, scientific discovery, and commercial operations."[81] An executive order issued by then-President Trump declares that:

> Americans should have the right to engage in commercial exploration, recovery, and use of resources in outer space, consistent with applicable law. *Outer space is a legally and physically unique domain of human activity*, and the United States does not view it as a global commons. Accordingly, it shall be the policy of the United States to encourage international support for the public and private recovery and use of resources in outer space, consistent with applicable law.[82]

Finally, it is noteworthy that the United States was one of the original authors of the Artemis Accords. Taken together, it would appear there are ample grounds to argue that the United States recognizes the broad interpretation of Article II of the Outer Space Treaty for certain appropriation of celestial bodies, particularly when these activities are private in nature.

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[79] Space Resource Exploration and Utilization Act of 2015, Pub. L. No. 114-90, 129 Stat. 720, 721 (2015) (codified as amended at 51 USC. § 51302(b) (2012)).

[80] *Id.*

[81] NAT'L SPACE POL'Y OF THE UNITED STATES OF AMERICA (2020), https://trumpwhitehouse.archives.gov/wp-content/uploads/2020/12/National-Space-Policy.pdf.

[82] Exec. Order No. 13914, 85 Fed. Reg. 20381 (Apr. 6, 2020)(emphasis added).

b. UAE

The United Arab Emirates (UAE) is an active and relative newcomer to space policy and law. UAE only established its national space agency in 2014 under the authority of Decree No. 1 of 2014.[83] The UAE Space Agency swiftly established a bold program, launching *The Hope* orbiter on July 19, 2020, which entered orbit around Mars on February 9, 2021.[84] The UAE Space Agency, however, has ambitions to establish what it expects to be the first permanent human settlement on the Red Planet by 2117.[85] To achieve this success and attain its longer-term goals, the UAE partners with other national space programs, such as those in the United States,[86] Japan,[87] and India,[88] as well as the private sector. To support its rapid entry into the community of space nations, the UAE has worked swiftly to establish national space legislation and a national space policy. The space sector in the UAE is governed by Federal Law No. 46 of 2023 on the Regulation of the Space Sector.[89] The legislation addresses space activities such as (i) launch, re-entry, and removal or disposal of space objects from orbit; (ii) the operation of space objects and satellite communication activities; (iii) the provision of logistical support services in outer space; (iv) the management of space data activities; and (v) the collection or trade of meteorites that land in the territory of the UAE.[90]

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[83] *Space Regulatory Authorities*, Gov't of the U.A.E. (Oct. 30, 2023), https://u.ae/en/about-the-uae/science-and-technology/key-sectors-in-science-and-technology/space-science-and-technology/space-regulatory-authorities.

[84] Jonathan Amos, *Emirates Mars Mission: Hope Spacecraft Enters Orbit*, BBC (Feb. 9, 2021). https://www.bbc.com/news/science-environment-55998848.

[85] Leonard David, *United Arab Emirates Wants to Build a City on Mars*, SPACE.COM (2017), https://www.space.com/35817-uae-city-on-mars-2117-project.html.

[86] *See* Stephen Clark, *United Arab Emirates Successfully Sends Its First Mission Toward Mars*, SPACEFLIGHT NOW (July 19, 2020). https://spaceflightnow.com/2020/07/19/united-arab-emirates-successfully-sends-its-first-mission-toward-mars/.

[87] Kenneth Chang, *From Dubai to Mars, With Stops in Colorado and Japan*, N.Y. TIMES (Feb. 15, 2020), https://www.nytimes.com/2020/02/15/science/mars-united-arab-emirates.html.

[88] Monit Khanna, *How ISRO Contributed to Success of UAE's Hope Probe Mars Mission*, INDIA TIMES (Feb. 10, 2021), https://www.indiatimes.com/technology/news/isro-success-uae-hope-mars-mission-533956.html.

[89] Federal Law No. (46) of 2023, Concerning the Regulation of the Space Sector, https://uaelegislation.gov.ae/en/legislations/2129/download.

[90] *Id.* at arts. 4 & 18.

The more interesting aspect is the UAE's stated aim to utilize this legislation to achieve the objectives of the UAE's National Space Policy, in addition to, *inter alia*, "[s]timulate investment and encourage private and academic sector participation in the Space Sector and related activities."[91] Additionally, the UAE views its legislation as supporting the nation's commitment to implement the provisions of international conventions and treaties related to outer space.[92] The UAE is a party to the Outer Space Treaty, and it should be noted that, as a signatory to the Artemis Accords, the UAE is implicitly affirming that the Artemis Accords comply with these international conventions and treaties related to outer space. Moreover, UAE's federal law contemplates space resources exploration or extraction activities[93] for exploitation and use for scientific, commercial or other purposes.[94] Thus UAE appears not to deem all objects within the solar system or generally in outer space as "celestial bodies" under the terms of the OST.

c. Luxembourg

Luxembourg has also already undertaken steps to address several aspects of commercial space activities.[95] Luxembourg's Space Agency is a component of the country's Ministry of Economy, which published Luxembourg's National Action Plan for Space and Technology 2020 – 2024.[96] Luxembourg's space policy and legal framework reflect the nation's understanding that "[i]nternational space treaties remain untested regarding who would own the rights to minerals, gases, and water found in outer space."[97] To resolve this state of affairs, in 2017, Luxembourg adopted a legal and regulatory space law framework (2017 Luxembourg Space Law) that "ensures

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[91] *Id*. at art. 2(2).

[92] *Id*. at art. 2(4).

[93] *Id*. at art. 8. *See also* Ministry of Cabinet Affairs Resolution No (19) of 2023 Regarding Space Resources. Copies of UAE Space Regulations can be found here: https://space.gov.ae/en/policy-and-regulations.

[94] *Id.*

[95] *Space Policy and Strategy*, LUXEMBOURG SPACE AGENCY (Sept. 23, 2019), https://space-agency.public.lu/en/agency/mission-vision.html.

[96] *National Action Plan, Space Science and Technology 2020-2024,* Luxembourg Space Agency, (2020), https://space-agency.public.lu/dam-assets/publications/2020/Luxembourg-space-action-plan-ENG-final-kw.pdf

[97] *Legal Framework, Law on Space Resources*, LUXEMBOURG SPACE AGENCY (Mar. 2, 2022). https://space-agency.public.lu/en/agency/legal-framework.html.

stability and guarantees a high level of protection for investors, explorers, and miners."[98] Luxembourg is clear to note, however, that the 2017 Luxembourg Space Law "does not have an objective, purpose or effect of paving the way for any national appropriation of outer space, including the Moon and other celestial bodies themselves," but, rather, seeks to ensure "that private operators can be confident about their rights [to] resources they extract in space."[99] Here, Luxembourg employs the term "celestial bodies" without giving any meaning to the term while simultaneously recognizing the "untested" nature of the treaties from which this term is derived. Moreover, Luxembourg also distinguishes between prohibited actions by nations under Article II of the OST and explicit legal protection for similar activities carried out by "private operators." Like the UAE, Luxembourg is also a party to the Artemis Accords and has ratified the Outer Space Treaty, providing further support for the notion that not only do the Artemis Accords comply with extant international treaties but that private extraction and use of space resources is permissible under the current legal structure.

d. Japan

As noted above, Japan is another significant spacefaring nation which has undertaken impressive feats warranting the analysis of this article. Japan's space history and policy stretch back a bit further than that of Luxembourg or the UAE. In fact, just two years after becoming one of the original parties to the Outer Space Treaty, the lower house of Japan's national legislature adopted a resolution stating that "[t]he development and use of objects that can be launched into space beyond the main part of the earth's atmosphere and rockets for launching such objects…shall be limited to the purposes of peace…"[100] Over several years, Japan's space policy, space law[101] and space capabilities have evolved, culminating in the

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[98] *Loi du 20 juillet 2017 sur l'exploration et l'utilisation des ressources de l'espace*, Journal Officiel du Grand Luxembourg (July 20, 2017), https://data.legilux.public.lu/file/eli-etat-leg-loi-2017-07-20-a674-jo-fr-pdf.pdf.

[99] IAU Res. B5, *supra* note 6161.

[100] *Resolution on the Basics of Space Development and Utilization in Japan*, Plenary Session of the House of Representatives, May 9, 1969, http://www.clearing.mod.go.jp/hakusho_data/1988/w1988_9119.html.

[101] *Basic Space Law*, Japan 169th Diet, Law No. 43 (May 28, 2002). https://www.shugiin.go.jp/internet/itdb_housei.nsf/html/housei/16920080528043.htm.

consolidation of Japan's Institute of Space and Astronautical Science (ISAS), the National Aerospace Laboratory of Japan (NAL), and National Space Development Agency of Japan (NASDA) into The Japan Aerospace Exploration Agency (JAXA) in 2003. As described previously, JAXA has already engaged in activities that could be deemed extraction, or exploitation and use, of at least part of a "celestial body." However, Japan has thus far not engaged in any actions to which any parties to the Outer Space Treaty have objected. Japan is also a party to the Artemis Accords, further entrenching the notion that State Parties to the Outer Space treaty do not view the Artemis Accords or their individual space activities as violative of international treaties or law. The Artemis Accords feature quite prominently in Japan's latest national space policy,[102] and clearly, Japan believes its capture of scientific samples does not violate the Outer Space Treaty, although its asteroid missions could easily be cast as "national appropriation…by means of use…or by any other means."[103] Therefore, the only reasonable conclusion one could draw from Japan's space activities and the (non) reaction of other nations is the fact that they do not view the objects from which Japan drew samples as "celestial bodies" under the Outer Space Treaty.

III. WHAT IS OR WHAT SHOULD BE A "CELESTIAL BODY?"

As noted, we cannot employ a single term, "celestial bodies," to refer to all matter in the universe or even just the solar system. Moreover, authorities as esteemed as the IAU have differing and, at times, contradictory uses of that term. N. Jasentuliyana and Roy S.K. Lee concisely articulate the surprising generality attributed to the Moon in the OST and to "celestial bodies" generally:

> The Moon and other celestial bodies come under the scope of application of the Treaty. It was perhaps presumptuous and inappropriate to consider in one single instrument such separate elements as outer space (which is not a *res* but an infinite ocean of ether), the Moon (only natural satellite of earth) and other celestial bodies (which represent finite and microcosmic

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[102] Outline of the Basic Plan on Space Policy, Gov't of Japan, (June 30, 2020), https://www8.cao.go.jp/space/english/basicplan/2020/abstract_0825.pdf.

[103] Outer Space Treaty, *supra* note 7, art. II.

> entities). It was also surprising that the Moon and all the other celestial bodies were considered together … [104]

A. Humanity's Evolving Understanding of the Cosmos and Celestial Bodies

For eons, humans have gazed at the night sky and experienced a personal, spiritual or religious connection to certain celestial objects in our solar system. However, before the 17th century, "the known solar system consisted of six planets."[105] The 17th Century witnessed the discovery of several moons in orbit around Jupiter[106] and Saturn,[107] and in the 18th Century, humanity added Uranus[108] to its catalog of named solar system objects along with two named satellites each for Uranus[109] and Saturn.[110] During the 19th

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[104] N. JASENTULIYANA & ROY S.K. LEE, MANUAL ON SPACE LAW 253 (1979).

[105] John Uri, *240 Years Ago: Astronomer William Herschel Identifies Uranus as the Seventh Planet,* NASA (Mar. 15, 2021), https://www.nasa.gov/history/240-years-ago-astronomer-william-herschel-identifies-uranus-as-the-seventh-planet/.

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> Peering through his newly-improved 20-power homemade telescope at the planet Jupiter on Jan. 7, 1610, Italian astronomer Galileo Galilei noticed three other points of light near the planet, at first believing them to be distant stars. Observing them over several nights, he noted that they appeared to move in the wrong direction with regard to the background stars and they remained in Jupiter's proximity but changed their positions relative to one another. He later observed a fourth star near the planet with the same unusual behavior. By Jan. 15, Galileo correctly concluded that they were not stars at all but moons orbiting around Jupiter, providing strong evidence for the Copernican theory that most celestial objects did not revolve around the Earth.

John Uri, *410 Years Ago: Galileo Discover's Jupiter's Moons,* NAT'L AERONAUTICS AND SPACE ADMIN (Jan. 9, 2020), https://www.nasa.gov/history/410-years-ago-galileo-discovers-jupiters-moons/.

[107] "Titan, Saturn's largest moon…was observed by Christiaan Huygens in 1655 . . . Between 1671 and 1684, Giovanni Domenico Cassini discovered the moons of Tethys, Dione, Rhea and Iapetus – which he collectively named the 'Sider Lodoicea' (Latin for 'Louisian Stars,' after King Louis XIV of France). Matt Williams, *The Moons of Saturn*, PHYS.ORG (Sept. 14, 2015) https://phys.org/news/2015-09-moons-saturn.html.

[108] William Herschel discovered Uranus on March 13, 1781. Uri, *supra* note 105.

[109] "Herschel later discovered Uranus' two largest moons, Titania and Oberon, in 1787." *Id.*

[110] "In 1789, William Herschel discovered Mimas and Enceladus," both moons of Saturn. Williams, *supra* note 107.

Century, Ceres[111] and Neptune[112] joined this growing list of "celestial bodies" along with moons orbiting Saturn, Jupiter, Mars, Uranus and Neptune.[113]

It was not until the 20th Century that the human race came to know of Pluto and expanded its count of moons orbiting Jupiter, Saturn, Uranus, and Neptune.[114] While a portion of humanity expressed dismay at Pluto's reclassification as a "Dwarf Planet,"[115] much of the human race identifies and feels attachment to a small handful of items, which are invariably named. At the same time, however, some named objects may only be a "pile of rubble."[116] We should consider whether there are named and enumerable objects that hold a special place in the hearts and minds of humanity, regardless of their location or physical properties, that would make them not only "celestial bodies" for the purposes of the OST but part of the Common Heritage of Humanity.

To speak of a Common Heritage of Humanity in space as an element of defining "celestial bodies," we may wish to determine what exactly that Common Heritage is by also considering the relative cultural—or even emotional—value humanity applies to any and all objects of any mass within the solar system.

Undoubtedly, all would agree that Earth's Moon, the named planets, and many of the natural satellites of the solar system, as well as several other named objects, should be counted as "celestial bodies." Reasonable people could differ, however, on the exact

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[111] *Ceres Facts,* NAT'L AERONAUTICS AND SPACE ADMIN, https://science.nasa.gov/dwarf-planets/ceres/facts/ (last visited Sep. 15, 2023), Of significant relevance to this discussion, and our understanding of the fluidity of the terminology used to describe individual "celestial bodies," we must note that Ceres was originally categorized as a planet, then as an asteroid, and then as a Dwarf Planet alongside Pluto. Moreover, while the IAU currently recognizes just five Dwarf Planets, debate on this point, and of the very use of the term "Dwarf Planet," rages. *See generally, Pluto and the Developing Landscape of Our Solar System,* INT'L ASTRONOMICAL UNION, https://www.iau.org/public/themes/pluto/ (last visited Sept. 15, 2023).

[112] John Uri, *175 Years Ago: Astronomers Discover Neptune, the Eighth Planet,* NAT'L AERONAUTICS AND SPACE ADMIN. (Sept. 22, 2021), https://www.nasa.gov/history/175-years-ago-astronomers-discover-neptune-the-eighth-planet/.

[113] *See Planet and Satellite Names and Discoveries,* U.S. GEOLOGICAL SURVEY, https://planetarynames.wr.usgs.gov/Page/Planets (last visited Sept. 15, 2023).

[114] *Id.*

[115] Brian Resnick, *The Debate Over Pluto Will Never Die. Here's the Latest Argument for Why It's a Planet*, VOX (May 7, 2018).

[116] *See* Anderson, *supra* note 3.

boundaries of this list—do we include Pluto's binary companion Cheron and its moons Styx, Nix, Kerberos and Hydra? What about the other Dwarf Planets identified by the IAU or the asteroids visited by Japan and the United States? Most people considering this issue could agree that humanity as a whole would not know, care or be affected in any way if, for example, most asteroids or Kuiper Belt Objects were excluded from the list of "celestial bodies" whether named or not. Further, would human beings care if, at some far-distant future point in time, the solar system event ceased to have an asteroid belt due to mining and other human activities?

Excellent scholarship has been produced regarding the legal status of "celestial bodies,"[117] while others have explored the question of mining in space in the context of international, domestic, and national legal regimes.[118] Still, others have examined the general landscape of current space law and the perceived gaps therein.[119] However, none of the literature has or proposes a concrete definition or mechanism to define "celestial bodies."

The term "celestial" derives from the late 14th century:

> pertaining to the sky or the visible heavens; pertaining to the Christian or pagan heaven," from Old French *celestial* "celestial, heavenly, sky-blue," from Latin *caelestis* "heavenly, pertaining to the sky," from *caelum* "heaven, sky; abode of the gods; climate," which is of uncertain origin; perhaps from PIE **kaid-slo-*, perhaps from a root also found in Germanic and Baltic meaning "bright, clear" (compare Lithuanian *skaidrus* "shining, clear;" Old English *hador*, German *heiter* "clear, shining, cloudless," Old Norse *heið* "clear sky").[120]

"Body" has Old English roots from *bodig,* meaning "the whole physical structure of a human or animal; material frame, material existence of a human; main or principal part of anything . . . The

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[117] *See* Michel Smirnoff, *Legal Status of Celestial Bodies,* 28 J. AIR L. & COM. 385, 388 (1962).

[118] *See generally* Laura C. Byrd, *Soft Law in Space: A Legal Framework for Extraterrestrial Mining*, 71 EMORY L. J. 801 (2022).

[119] *See generally* Katherine Latimer Martinez, *Lost* in *Space: An Exploration of the Current Gaps in Space Law*, 11 SEATTLE J. TECH., ENV'T. & INNOVATION L., 4 (2021), https://digitalcommons.law.seattleu.edu/cgi/viewcontent.cgi?article=1022&context=sjteil.

[120] *Celestial*, ONLINE ETYMOLOGY DICTIONARY, https://www.etymonline.com/word/celestial (last visited Sept. 15, 2023).

word was transferred to matter generally in Middle English (as in *heavenly body*, late 14c.).[121]

However, as a practical matter, and as our understanding of the cosmos grows and discoveries even beyond our solar system expand at a dizzying pace, what is or is not a "celestial body" has not been definitively determined. The Czech scholar Vladimir Mandl first introduced the term "celestial body" to the lexicon of space law in 1932,[122] and it appeared at the United Nations via a General Assembly resolution in December 1961.[123]

As noted previously, the IAU itself has certain categories of defined objects. These include, *inter alia*, Major Planets and the Moon, Dwarf Planets, Satellites of Planets in the Solar System, Minor Planets, Meteor Showers, and Comets. It should be noted that the IAU, either by implicit comparison or otherwise explicitly, provides reasonably clear definitions for these enumerated objects.[124] However, while the term "celestial body" is used by the IAU, nowhere is the term itself defined, and the IAU actually established, via Resolution B5, only three broad categories: Planets, Dwarf Planets, and All Other Objects.[125] Interestingly, for our purposes here, and at the risk of being repetitive, IAU Resolution B5 specifically states that a Planet or Dwarf Planet is a "celestial body" while omitting this term from "All Other Objects."[126] More challenging still is the fact that even where others have attempted to define "celestial bodies" beyond mere scientific terminology, the distinctions have been couched in notions of technical capabilities, which is itself ever-changing.[127]

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[121] *Body*, ONLINE ETYMOLOGY DICTIONARY, https://www.etymonline.com/search?q=body (last visited Sept. 15, 2023).

[122] VLADIMIR MANDL, DAS WELTRAUM-RECHT. EIN PROBLEM DER RAUMFAHRT (1932); *see also* Ernst Fasan, *Asteroids and Other Celestial Bodies—Some Legal Differences*, 26 J. Space L. 33, 33 (1998).

[123] G.A. Res. 1721 (XVI), (Dec. 20, 1961).

[124] *Naming of Astronomical Objects*, INT'L ASTRONOMICAL UNION, https://www.iau.org/public/themes/naming/#planetaryfeatures (last visited Nov 16, 2023).

[125] IAU Res. GA26-B5, https://www.iau.org/static/resolutions/Resolution_GA26-5-6.pdf.

[126] *Id*.

[127] Irmgard Marboe & Michael Friedl, *What Are Space Resources: What Are Celestial Bodies - The Need for Refined Legal Definitions in view of Recent Regulatory Efforts Concerning Space Resources*, *in* 61 PROC. INT'L INST. SPACE L. 749 (2018) (citing a March 15, 1964) Draft Resolution out of Working Group Three of the International Institute of

One should note that these definitions are of recent provenance and could change again in the future. As recently as August 2006, the IAU downgraded the status of Pluto to that of a "dwarf planet" from its previous inclusion as one of the "nine planets around the sun."[128] This means that, for now, only the inner Solar System's rocky worlds and the outer system's gas giants will be designated planets. However, many people alive still count Pluto amongst the planets or at least identify it as a named object, or "celestial body," they can identify, which elevates its status in the minds of much of humanity even if its designation has been reduced.[129] Certainly, the idea of any individual or entity taking possession of Pluto or exploiting the planet to the point it is unrecognizable or non-existent would be viewed as a violation of both law and common decency, even though it would likely have little to no bearing on the lives of anyone living today or for the foreseeable future.

B. Theories on the Question of What Is a "Celestial Body"

i. Defining and Using the Province of all Humankind or Common Heritage Principle

The principle of the "Common Heritage of Humanity" emerged at a time of dramatic social, economic, cultural, and political change around the globe—when decolonization was accelerating, and the Cold War was intensifying. Applied directly to the Outer Space Treaty, one of the founders of space law, Argentinian Ambassador, professor, and lawyer Aldo Cocca stated that "the international community [has] endowed that new subject of international law—[humanity]—with the vastest common property (*res communis humanitatis*) which the human mind could at present conceive of, namely outer space itself, including the Moon and the other *celestial bodies*."[130] Here is another example of a term used, without any

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Space Law (IISL), subsequently referred to by Aldo Armando Cocca, *Legal Status of Celestial Bodies and Economic Status of the Celestial Products, in* 7 PROC. INT'L INST. SPACE L. 15, 16 (1964); *see also* Fasan, *supra* note 122, at 36.

[128] DAVE MATTHEWS BAND, *Typical Situation*, *on* UNDER THE TABLE DREAMING (RCA 1994).

[129] *See e.g.,* Resnick, *supra* note 115.

[130] Comm. On the Peaceful Uses of Outer Space, Summary Records of the Legal Subcomm. On its 6th Sess., at 7-8, UN Doc. A/AC.105/C.2/SR.75 (June 19, 1967) (emphasis

defined meaning or limitation. Moreover, "outer space" itself is not defined and could not and should not, in this author's view, be reasonably considered to be the entirety of the universe as explained above. So, is all matter in the universe to be considered a "celestial body" and thus somehow protected as common heritage?" Clearly this cannot be. Nor should every object within our solar system. Space, writ large, cannot be deemed the Common Heritage of Humanity nor the Province of all Humankind.[131] However, perhaps select, explicitly enumerated and named objects within our solar system can and should be, excluding all else. One could imagine, for example, a time when comets would be freely harvested for their water ice, and other resources without objection, while humanity finds itself acutely protective of Haley's Comet or Saturn's Rings as part of the "common heritage of humanity."

The common heritage of humanity or the common heritage principle likewise is a principle of international law that holds that defined territory and elements of humanity's common heritage—cultural and natural—should be held in trust for future generations and be protected from exploitation by nations, entities, or even individuals.[132] As we can see from the language of the Artemis Accords, it may be that Neil Armstrong's footprint on the Moon and the *Curiosity* rover on Mars would be considered "historically significant human or robotic landing sites,"[133] while the detritus resulting from crashed rocket stages or failed landers may not be considered worthy of such veneration and preservation. The recently concluded agreement between the United States and Japan makes a similar effort to protect "Lunar Sites of Historical or Scientific Value,"[134] which would likely include Armstrong's historic footprint, but not necessarily some of the "junk" remaining on the lunar

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added). *See* Rudiger Wolfrum, *The Principle of the Common Heritage of Mankind*, 43 Zeitschrift für Auslandisches Offentliches Recht Und Volerrecht 312, 312 n.1; Aldo Amando Cocca, *The Advances in International Law Through the Law of Outer Space*, 9 J. SPACE L. 13, 14-15 (1981) (referring to this statement made in 1967).

131 *See* Outer Space Treaty, *supra* note 7, art. I. In the event we encounter sentient alien civilizations, of whatever level of technological advancement, they may also scoff at the idea that Space itself or all the objects therein are somehow the Common Heritage, Province, or possession, of any other race in the cosmos.

132 Alshdaifat, *supra* note 59, at 2, n.4.

133 Artemis Accords, *supra* note 12, § 9.

134 Press Statement, Antony J. Blinken, U.S. Secretary of State, The United States and Japan Sign Framework Agreement on Space Cooperation (Jan. 13, 2023).

surface such as a television camera lens or a urine collection assembly.[135] The author, however, readily concedes that these early space exploration items may all be revered for their historical and archeological value someday. It is, therefore, entirely possible that humanity will come to see nearly identical objects as having separate value for preservation as part of a shared province of humankind and thus deemed worthy of distinct classification, and this could apply to space objects such as asteroids or comets.

It should be noted that the issue of the Common Heritage Principal as applied to space is far broader than this article's consideration. In fact, it is a two-way street with terrestrial implications as well. When considering which objects humanity may deem worthy of preservation as part of our common heritage or as celestial objects, we must also consider a wider range of space activities, including those that impact our engagement with and appreciation of the cosmos from *terra firma*. Many indigenous peoples around the world, for example, embrace vast astronomical knowledge and intimacy in their traditions and cultures.[136] Human activity in on Earth and in outer space can affect terrestrial visibility of the cosmos and thus the opportunity for these communities to engage with celestial objects as they have done so for generations due to ground-based, and increasingly orbital, light pollution and other interference. Beyond the impact on indigenous communities, professional and amateur astronomers, as well as tourists, are also impacted.[137] To this end, the DarkSky International strives to combat light pollution and designates "Dark Sky" locations around the globe, such as the Mitzpe Ramon Crater in Israel, that benefit all peoples.[138]

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[135] Catalogue of Manmade Material on the Moon, NASA (Jul. 5, 2012). https://history.nasa.gov/FINAL%20Catalogue%20of%20Manmade%20Material%20on%20the%20Moon.pdf.

[136] *See generally* Karolina M. Zielinsak-Dabkowska and Kyra Xavia, *Looking Up to the Stars. A Call for Action to Save New Zealand's Dark Skies for Future Generations to Come*, 13 SUSTAINABILITY 13472 (2021).

[137] For more information, visit the DarkSky International website at https://darksky.org/.

[138] Editorial Staff, *Ramon Crater Named First International Dark Sky Place in the Mideast*, DARKSKY (Sept. 14, 2017), https://www.darksky.org/ramon-crater-named-first-international-dark-sky-place-in-the-mideast/.

ii. Terrestrial Analogs

As has been noted, the concept that we must establish a legal status for "celestial bodies" is not new and enjoys various treatments and approaches. Some schools of thought draw on the Law of the Sea, The Antarctic Treaty, the concept of *res nullius*, *res communis omnium*, as well as numerous intermediate or hybrid combinations of the same.[139] Thus, while the term itself has not been defined, the *need* to define it is recognized and well-established.[140]

Arguments have been made that the legal construct attaining to outer space is unique and separate from any terrestrial law and that, specifically, the laws of the Earth derive from the facts and conditions of the Earth and, therefore, space law will derive from the facts and conditions of space.[141] While the author not only concedes but embraces the unique, emerging and evolving nature of space law, there are certain corollaries that can be invoked, and the two are not so separate. For example, while nobody would credibly argue that any entity could claim ownership and exclusive use of the Jovian satellite Europa, just as one would not claim that any individual could seek to claim ownership or exclusive use of all the sand on a public beach, so too would no individual or group of individuals argue that a child could not collect some seashells on that same beach nor that a scientist could not collect samples of the ice and subsurface ocean of Europa. But where is the limit, and to what degree would such a limit inform our understanding and ability to define "celestial body?"

Each of the asteroids targeted by Japan and the United States for sample-return missions range in size from 330 meters to 1 kilometer in diameter, and each has names (162173 Ryugu, 25143 Itokawa, and 101955 Bennu), so limiting "celestial bodies" based on size or whether they possess names is either futile or must be considered as non-dispositive criteria. Should the samples or even the asteroids themselves be considered as the shared sand or the seashells? Such are the questions when considering "celestial bodies" and thus their legal definition, as this definition can then inform political, commercial, scientific, and security considerations and,

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[139] Byrd, *supra* note 118.
[140] Martinez, *supra* note 119.
[141] Byrd, *supra* note 118.

hopefully, advance the cause of space for all of humanity rather than serve to export our terrestrial conflicts into the cosmos.

That space should be used for peaceful purposes is not only a foregone conclusion but also an enshrined aspect of international law. The Outer Space Treaty states explicitly that "[t]he Moon and other celestial bodies shall be used…exclusively for peaceful purposes."[142] Although several concepts and provisions of the Outer Space Treaty were modeled on and often compared to the Antarctic Treaty,[143] the Antarctic Treaty is insufficient to understand the Outer Space Treaty and cannot be duplicated and merely applied to outer space. Other sources of inspiration for space law have come from both common and statutory law, such as the Convention on the High Seas,[144] which states that

> [t]he high seas being open to all nations, no State may validly purport to subject any part of them to its sovereignty. Freedom of the high seas is exercised under the conditions laid down by these articles and by the other rules of international law. It comprises, *inter alia*, both for coastal and non-coastal States:
>
> (1) Freedom of navigation;
>
> (2) Freedom of fishing;
>
> (3) Freedom to lay submarine cables and pipelines;
>
> (4) Freedom to fly over the high seas.

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[142] OST, *supra* note 7, art. IV.

[143] Armel Kerrest, *Outer Space as International Space: Lessons from Antarctica*, SMITHSONIAN (2011), https://repository.si.edu/handle/10088/16169.

[144] Convention on the High Seas, Apr. 29, 1958, 450 U.N.T.S. 11. The 1958 Convention on the High Seas was the result of the first United Nations Conference on the Law of the Seas. A second United Nations Conference on the Law of the Seas gathered in 1960 but did not result in any new agreements. The third United Nations Conference on the Law of the Sea concluded with an agreement in 1982: Convention on the Law of the Sea, Dec. 10, 1982, 1833 U.N.T.S. 397 [hereinafter UNCLOS]. While the United States has not ratified the UNCLOS, the United States, under President Ronald Reagan declared that the United States will accept and act in accordance with the provisions of the Convention relating to traditional (non-seabed) uses of the ocean, such as navigation and overflight. Statement on United States Ocean Policy, REAGAN PRESIDENTIAL LIBRARY (March 10, 1983), https://www.reaganlibrary.gov/archives/speech/statement-united-states-oceans-policy.

> These freedoms, and others which are recognized by the general principles of international law, shall be exercised by all States with reasonable regard to the interests of other States in their exercise of the freedom of the high seas.[145]

In considering space law in the context of maritime law, some objects in outer space are more akin to fish in the sea, rather than the sea itself or "any part" thereof.

Consider Pop's comparison of icebergs with comets (often referred to as dirty snowballs), which draws similar comparisons to the examples above contrasting seashells with the beach, or individual fish versus the whole sea.

> It is to be noted that icebergs have as well a rather unclear legal status as though their small-scale exploitation has already begun. Like asteroids and comets, icebergs have a spatial dimension but are used mainly in their material dimension as a floating mineral resource. While Article 89 of the UN Convention on the Law of the Sea prohibits the national appropriation of the high seas, we have no knowledge of states that have protested the appropriation of icebergs. In the same time, we have no knowledge of a formal declaration of ownership over icebergs by the entities using them in their material extension; the principle of extraction seems to apply, given that icebergs have been appropriated either in their entirety or displaced from their initial location, or parts of them have been moved away without claims being laid for the exclusion of others from the exploitation of that particular iceberg.[146]

We cannot speak about any and all space objects and/or objects in space as those can be artificial on the one hand and the compositional parts of a greater whole.[147] In fact, the definitive "A Guide to Space Law Terms" does not include a separate entry for "celestial bodies" but rather uses the term to help define other entries.[148]

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[145] Convention on the High Seas, *supra* note 144, art. II.

[146] POP, *supra* note 51, at 57.

[147] Henry R. Hertzfeld, Liana X. Yung & Daniel V. Osborne, *A Guide to Space Law Terms*, SECURE WORLD. FOUND. (2012), https://swfound.org/media/99172/guide_to_space_law_terms.pdf.

[148] *Id.*

iii. Movable versus Immovable

One argument that has been raised in defining "celestial bodies" is whether an object is moveable. This proposal, elegantly articulated by Pop, suggests that the distinction between moveable and immovable allows one to consider and "distinguish between immovables – celestial bodies – and movables in outer space literally, according to the actual ability to move them."[149] Pop argues that the fact of moveability and the actual movement of an object would render it appropriable and thus seemingly outside of the definition of "celestial bodies" under Article II of the OST.[150]

Smirnoff, in his work, also notes that the scholarly history on the subject dates to Working Group III of the International Institute of Space Law, which asserted that celestial bodies should be considered, in the legal sense, as "natural objects in outer space . . . which cannot be artificially moved from their natural orbits."[151] While, again, this view and the arguments extending therefrom are hugely helpful, they are incomplete as we must immediately recognize the rapid advances in technology that would allow an ever-growing number of objects in the cosmos to be moved at a later date. As far back as Archimedes, there was an understanding that even the Earth itself could be moved when he stated, "Give me a lever long enough and a fulcrum on which to place it, and I shall move the world."[152] Science fiction literature is replete with storylines envisioning the movement of objects with astounding mass. In fact, serious theorists have also posited strategies to move the Earth to maintain a favorable position relative to the sun throughout the coming eons to ensure continued habitability by life on the planet.[153] So, again, if one could eventually move the Earth itself,[154] any definition of "celestial bodies" would need not only to specify a list of objects and/or classes of objects more clearly but perhaps also

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149 POP, *supra* note 51, at 53.

150 *Id.*

151 SMIRNOFF, *supra* note 117; *see also* FASAN, *supra* note 122, at 40.

152 This remark, attributed to Archimedes, is quoted by Pappus of Alexandria in *Collection* or *Synagoge* Book VII, 340. More information and variations can be found here: https://math.nyu.edu/Archimedes/Lever/LeverIntro.html.

153 *See generally* D.C. Korycansky et al.*, Astronomical Engineering: A Strategy for Modifying Planetary Orbits,* 275 ASTROPHYSICS & SPACE SCI. 349 (2001).

154 *See*, e.g., Science and Futurism with Isaac Arthur, *Planet Ships*, https://www.youtube.com/watch?v=oim7VvUURd8.

take into account size, mass, and even current and future technological capabilities of humanity.

iv. Spatial versus Functional/Object Approaches

Another related, though distinct, discussion regarding "celestial bodies" relates to the spatial versus functional argument. We recall the metaphor above regarding the seashell on the beach versus the entire quantity of the sand. While this thought experiment helps make a point, it is limited in its practical application to the present question. What, for example, should we do with a child seeking to take home a bucket of sand from the beach? What about two buckets? Where do we draw the line?

Again, Pop provides a helpful, though insufficient, understanding of this framework. Pop explains that "[w]here there is no natural boundary, *or one cannot discover it*, law can set a conventional boundary. Such is the case with the age of legal adulthood – while virtually as [im]mature as a day ago, a person that just turned 18 has different rights and responsibilities than before."[155] This understanding identifies a set of criteria to consider but does not answer the question. To elucidate the point, Pop cites Gyula Gal, to demonstrate that determining the limits between outer space and air space has confounded experts for decades.[156] Pop also notes that "setting a spatial boundary between territorial sea and the high seas" is also illustrative of the challenges, arbitrariness, and mutability, or relying exclusively on a spatialist approach.[157]

However, noting that one *can* create an arbitrary boundary between different classes of things does not help determine where that boundary is or should be. Moreover, even within these distinctions, there are limitations and exceptions. Those individuals reaching the age of maturity but possessing serious, violent criminal records are often prohibited from exercising the right to vote, possess firearms, or engage in other activities otherwise granted to all other legal adults. Individuals with severe visual impairment, despite otherwise qualifying, are not permitted to operate a motor

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[155] *See* POP, *supra* note 51, at 52.

[156] *Id. See also* Gyula Gal, *Thirty Years of Functionalism*, *in* 40 PROC. COLL. L. OUTER SPACE 125 (1997).

[157] POP, *supra* note 51, at 52.

vehicle. Which crimes would trigger the former, and what degree of visual impairment would impose the latter?

Pop again employs Gal to suggest another approach to answering the question regarding "celestial bodies," which requires us to consider not the nature of the object or its characteristics but the actions applied to such objects or phenomena and how they are to be used—known as a "functionalist" approach.[158] One proposed functional or objective use of a natural space object would be the reformation of the same into a space habitat or space station,[159] losing its natural appearance, together with its possible legal status of "celestial body" by becoming a humanmade structure, i.e., legally a space object. This author would suggest that this approach is also insufficient as (a) once an object is deemed a "celestial body," the same prohibitions would apply regardless of the use in most cases, but especially in the use and consumption of the object, and (b) if the item is not deemed a "celestial body" the use to which it is put is irrelevant. Instead, once more, we could consider the idea of functionalism as part of a greater complexity of criteria in defining what is or is not a "celestial body."

v. Other matters for consideration: Physical Phenomena—Lagrange Points

Another area for consideration when discussing "celestial bodies" is whether intangible features should be considered. What are lawyers and scholars to think of Lagrange Points?[160] Currently, many Lagrange Points are occupied by artificial objects, such as the European Space Agency's (ESA) Solar and Heliospheric Observatory (SOHO); NASA's Global Geospace Science (GGS) *Wind*

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[158] POP, *supra* note 51, *Id.* at 55.

[159] One example of such structures, essentially space habitats of varying sizes and capacities, are colloquially known as O'Neill Cylinders in reference to their conception by Gerard K. O'Neill. O'Neill Cylinders could be created out of the raw materials of asteroids or other celestial objects through simply hollowing out the body or by refashioning the raw materials themselves. *See*, *e.g.*, Gerard K. O'Neill, *The Colonization of Space*, 27 PHYSICS TODAY 32 (1974).

[160] A Lagrange point is a location in space where the combined gravitational forces of two large bodies, such as Earth and the sun or Earth and the Moon, equal the centrifugal force felt by a much smaller third body. The interaction of the forces creates a point of equilibrium where a spacecraft may be "parked" to make observations, or engage in other activities. *See* Elizabeth Howell, *Lagrange Points: Parking Spaces in Space*, SPACE.COM (Aug. 21, 2017), https://www.space.com/30302-lagrange-points.html.

satellite; NASA's Advanced Composition Explorer (ACE or Explorer 71); NOAA's Deep Space Climate Observatory (L1); the ESA Gaia probe; the joint Russian-German high-energy astrophysics observatory Spektr-RG; and the NASA, ESA and CSA James Webb Space Telescope (L2).[161] These locations are of great value as theoretically, less energy would need to be expended to maintain an object, such as a satellite or even a space station, at those locations. Moreover, as Lagrange Points can exist between any two large bodies, numerous Lagrange Points exist throughout the solar system outside of the Earth-Sun or Earth-Moon systems.[162] In considering the idea of what a "celestial body" is or is not, we must also entertain the notion of including Lagrange Points. How we consider Lagrange Points would then naturally lead to the legal precedent to apply. If they are to be considered "celestial bodies," their treatment would be governed by one set of principles and restrictions, whereas if they were excluded from this definition, new questions would arise as to whether they would be treated as *res communis omnium*, and, in that case, whether objects occupying any one Lagrange Point would be subject to the legal framework of "innocent passage."

IV. POSSIBLE DEFINITIONS AND SOLUTIONS:

We must first acknowledge and accept the idea that every speck of dust in the cosmos is not and cannot be considered a "celestial body." Lacking any further clarifying definitions or limitations on the meaning of the term "celestial bodies," we cannot, therefore, just assume that any natural object, or phenomenon for that matter, in space, is a "celestial body." Beginning from that premise and the self-evident notion that there are objects in the solar system that are indisputably "celestial bodies," we must find the boundary or defining criteria of what is and is not a "celestial body." We must also accept that prior scholarship is a helpful guide but insufficient. We must recognize that the proposition offered by Pop[163] that we can limit ourselves merely to the objects (or

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[161] *What is a Lagrange Point*?, NAT'L AERONAUTICS AND SPACE ADMIN. (Sept. 4, 2023), https://solarsystem.nasa.gov/resources/754/what-is-a-lagrange-point/.

[162] For an informal community-sourced list of objects at Lagrange Pints, *see* Wikipedia, List of Objects at Lagrange Points, https://encyclopedia.pub/entry/33490 (last visited Nov. 16, 2023).

[163] *See* POP, *supra* note 51.

phenomena) under consideration and not the actors physically interacting with them has been superseded by national legislation and international agreements. We are forced to engage in a formulaic application of science and law. Some areas for consideration follow.

A. Current or Near-Term Anticipated Technology

Just as with the beach and seashell analogy described above, looking at what current or near-term anticipated technology might achieve could be a basis for aiding in defining "celestial bodies." Several private enterprises have declared their intentions to exploit the solar system's resources both for-profit and to support humanity's expansion into the cosmos, which appears to be permissible if not endorsed by several nations' commercial space legislation and international agreements, as described above. Any limitations to these plans lie not with the technical capability to achieve these objectives, as they will surely be achieved depending on the timescale considered, but rather the legal framework when considering mining and resource exploitation in outer space. While the Outer Space Treaty would seem to prevent any and all such extraterrestrial mining undertakings, there could be a solution if we limit the definition of "celestial body." If "celestial body" is read to exclude any objects that could be captured, manipulated, or consumed in its entirety within a reasonable period of time, say within the technological capabilities we anticipate being possible within the next 100 years, these proposed activities would not run afoul of the OST.

To consider a possible example: The Bingham Canyon open-pit copper mine is the largest mine in the world.[164] It has been in operation for over 100 years and "is estimated to hold around 19 million tons of copper."[165] The pit is over 1.2 km deep, approximately 4km wide, and covers nearly 8 km^2.[166] If we were to assume that, eventually, the ability to capture, exploit, and consume an object equal in size and mass to the Bingham Canyon mine, we could, through

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[164] India Berry, *Top 10 Largest Mines in the World*, MINING (OCT. 29, 2021), https://miningdigital.com/top10/top-10-largest-mines-world.

[165] *Id.*

[166] Cecilia Jamasmie, *Rio Tinto's Kennecott Wins Clean Air Lawsuit in the US*, MINING (June 9, 2016). https://www.mining.com/rio-tintos-kennecott-wins-clean-air-lawsuit-in-the-us/.

legislation at the national level and via international agreements, exclude such objects from classification as "celestial objects." Objects within the solar system that could be captured and placed within the exclusive control of any operator and subsequently exploited or consumed within an expected 100-year time-horizon using current or near-term technical capabilities would open significant commercial and scientific opportunities to humanity.

We must also appreciate the fact, however, that allowing such limitations to the definition of "celestial bodies" alone would not be sufficient and could undermine the other purposes of the Outer Space Treaty, namely, the peaceful use of Outer Space and the avoidance of the export of terrestrial conflict into Outer Space if it triggered a resource free-for-all that saw nations, entities and individuals competing over each and every resource as it became accessible. Terrestrial actors (and eventually even extraterrestrial actors, such as those based on or incorporated under a Moon- or Mars-based legal regime) would need to agree how even these excluded objects would be claimed for ownership, appropriation, and use.

B. Establish an Arbitrary but Agreeable Definition and Catalogue of Celestial Bodies

The above criterion of a technology-based, size and mass-derived definition of what is or is not a "celestial body" is, itself, arbitrary. Who is to say, for example, what technological capabilities may exist in the coming decade or century? Moreover, technological capability does not, *ipso facto*, result in a feasible or economically viable deployment of such capabilities. Much like the arbitrary but agreed-upon age of maturity for the purposes of certain rights and responsibilities in the myriad terrestrial jurisdictions, national legislation and international agreements could seek to define "celestial bodies" in an arbitrary but agreeable fashion. In addition to the size and mass as mentioned above, Earth-based authorities could establish a list of those objects deemed part of the "Common Heritage of Humanity" and, therefore, "celestial bodies" within the Solar System, at the exclusion of any and all other objects of any mass. This list could be subject to revision, much like Pluto was expelled from the IAU's list of "planets" not so long ago. However, here, objects or "celestial bodies" would not need to fit into nice and orderly categories but could be individually listed. The author would also propose

that any celestial objects heretofore undiscovered or unidentified would not meaningfully be called a "celestial object" protected from appropriation and use in any event, so the list could be exhaustive and would likely get parred down over time rather than expanded. Therefore, in addition to other considerations, we could add an arbitrary agreed date of discovery to the definition of "celestial bodies" and exclude any and all objects or phenomena discovered thereafter.[167]

Such a list could recognize that there are certain objects that, due to their role in humanity's history, either as inspiration for religion, culture, literature, or otherwise, possess a special place and are, thus, the preserved "celestial bodies" of the OST. Most legislative or deliberative bodies would likely include in this list all the named planets, many if not most or all of their natural satellites, and numerous asteroid belt and Kuiper belt objects. Beyond this list, however long it may become, extraterrestrial objects, materials, and phenomena might be available for legally recognizable appropriation and use. Such a formula may be deemed to suit the needs of terrestrial authorities hoping to encourage scientific and economic activity in outer space.

V. CONCLUSION

Humanity rightly sought to preempt the exportation of Earthly conflict into the cosmos. In crafting the Outer Space Treaty, the authors of space law's *Magna Carta* identified the pressing issues that could, would, and today imminently will confront nations and private actors alike. As technology advances, however, greater clarity is required to refine and define the terms of the OST further in such a way that its purpose—peaceful use of outer space for all humanity, whether scientific or commercial—can be realized. The solutions offered in the past provide laudable guideposts, too, to advance this discussion, though national and international actions, as well as technical and scientific discoveries, reveal that further discussion must continue to define and apply the terms and

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[167] The author would suggest that given the vast number of auspicious dates in extraterrestrial exploratory history, many dates will do, but some suggestions are as follows: October 4, 2007 to honor the 50th anniversary of earth's first artificial satellite, *Sputnik 1*; July 20, 2019 to commemorate the 50th anniversary of the first human to set foot on the Moon.

applicability of the Outer Space Treaty more fully. The above examination of the issue aims to advance that discussion further and provide some additional elements for consideration in determining what a "celestial body" is. Building off the works of the likes of Gorove and Pop, the above analysis and considerations are designed to fill in the outstanding gaps in this field while remaining flexible in the face of future developments. Take, for example, the possibility that at some future date, humanity will discover biology on an otherwise unremarkable object. Whether an asteroid or, more likely, a Kuiper Belt Object, this mass, whatever its size or other characteristics, can quickly be included in the finite list proposed above for protection and preservation without otherwise altering the proposed "celestial bodies" classification system. To begin, each of the named planets and dwarf planets, along with their largest natural satellites, should be included in such a listing. So, too, should the most recognizable comets, such as Haley's and Hale-Bopp, although the latter will not return to the inner solar system for millennia. Beyond that, it would be for humanity to decide.