ASTEROID MINING: ECOLOGICAL JURISPRUDENCE BEYOND EARTH

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I. INTRODUCTION

"An absolute, must be an exclusive title, or at least a title which excludes all others not compatible with it."

John Marshall, Chief Justice of the United States.[1]

"Outer Space, including the moon and other celestial bodies, shall be free for exploration and use by all States without discrimination of any kind, on a basis of equality and in accordance with international law, and there shall be free access to all areas of celestial bodies."[2]

A notoriously recalcitrant Congress passed legislation, which President Obama signed without fanfare, in November of 2015. The occasion was remarkable, in part because of rare bipartisan support for the United States Commercial Space Launch Competitiveness Act ("Space Act"),[3] but mostly because of Congress' audacity in granting property rights to private entities and individuals who harvest resources from asteroids or other celestial bodies:

> A United States citizen engaged in commercial recovery of an asteroid resource or space resource under this chapter shall be entitled to any asteroid resource or space resource obtained, including to possess, own, transport, use and sell the asteroid resource or space resource obtained in accordance with

[1] Johnson v. M'Intosh, 21 U.S. (8 Wheat.) 543, 588 (1823).

[2] 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, Oct. 10, 1967, 18 U.S.T. 2410, 610 U.N.T.S. 205 [hereinafter Outer Space Treaty].

[3] U.S. Commercial Space Launch Competitiveness Act of 2015, Pub. L. No. 114-90 (codified at 51 U.S.C. §§ 51301–51303 (Supp. III 2015)).

> applicable law, including the international obligations of the United States.[4]

For some, this is just the sort of audacity that makes us human. It permits us to solve our earthly problem of dwindling natural resources and tap into a promising new frontier. According to John Lewis, lead scientist of Deep Space Industries, one of the companies prospecting near-Earth asteroids and planning their profitable utilization, "The emerging asteroid mining industry has extremely ambitious intentions. It is within the realm of possibility that their work may usher in a change in global economics as profound as the Industrial Revolution."[5]

Those familiar with the "bundle of rights" metaphor of property will recognize the attributes of ownership, or "sticks," in the bundle in the Space Act provision.[6] These straddle the hierarchy of property incidents from use and possession all the way through the superior right to transfer owned resources for profit.[7] For some property commentators, these aggregated rights reduce to the paramount right of exclusion, or the right to control—grant or deny—access to the owned thing.[8] While remaining agnostic on reducing ownership to a primary right, it is clear that the Space Act contemplates exclusion. It directs the President to "promote the right of United States citizens to engage in commercial exploration for and commercial recovery of space resources free from harmful interference . . ." to the extent compatible with international law and under the authority and oversight of the federal government.[9]

This article takes the position that the Space Act is a grave misstep. First, it is of questionable international legality, as others have noted, in that it belies the longstanding commitments of the United States to international cooperation regarding outer space. Second, I argue that—*if* asteroid resources are to be treated as property—this is a precious and probably unique opportunity to fashion the ownership of space natural

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[4] 51 U.S.C. § 51303 (Supp. III 2015) (section entitled "Asteroid Resource and Space Resource Rights").

[5] JOHN S. LEWIS, ASTEROID MINING 101: WEALTH FOR THE NEW SPACE ECONOMY 6 (2015).

[6] *See, e.g.*, JESSE DUKEMINIER ET AL., PROPERTY 102–04, 108–09 (8th ed. 2014) (employing the "bundle of rights" metaphor to differentiate various rights, such as use, exclusion, and transfer).

[7] *See id.*; *see also* Johnson v. M'Intosh, 21 U.S. (8 Wheat.) 543, 591 (1823) (finding that Indian tribes lacked right to transfer valid title).

[8] *See, e.g.*, Hanoch Dagan, *Pluralism and Perfectionism in Private Law*, 112 COLUM. L. REV. 1409, 1413–15 (2012) (discussing the view that the bundle of rights is reducible to exclusion); Blake Gilson, Note, *Defending Your Client's Property Rights in Space: A Practical Guide for the Lunar Litigator*, 80 FORDHAM L. REV. 1367, 1372–74 (2011) (discussing exclusion as core minimum of property rights).

[9] 51 U.S.C. § 51302(a)(3) (Supp. III 2015).

resources on a model based on the ideals of shared benefits and reciprocal obligations instead on one based on exclusivity.[10]

More deeply, the Space Act's assumptions of ownership in this context completely bypass fundamental questions about whether materials in space *should* be viewed as resources for humans in the first place. Proponents of ecological law have urged changes in environmental law to reflect the interrelatedness of all of nature and the mutual benefits of preserving and restoring Earth's systems and processes.[11] Because scientific knowledge now shows the connections between Earth and the universe in terms of origins, energy, and capacities for living systems, "Earth" jurisprudence should likewise expand to include off-Earth bodies and processes as they become increasingly subject to human intervention. This is both a necessity and an opportunity to remake our ethical selves as we nurse a ravaged planet and venture beyond. Environmental law and ethics must expand quickly to consider non-earthly questions lest we unleash the harms humans have visited on our home planet with unsettling and unforeseen dimensions in the universe. Instead, we have a chance to reveal ourselves as the kind of beings who truly understand our interdependency and the limits of our knowledge, which is vital to salvaging Earth as well as the heavens.

Further exploration of outer space is profoundly exciting for both the knowledge promised and possible material benefits. But we must enlarge our ethical standpoint beyond Earth before improvidently, and even recklessly, expanding outmoded and potentially destructive ideas.[12] The Space Act reflects deficient collective environmental character, lauding traits like rashness, hubris, arrogance, glory, and greed over sorely needed doses of humility, beneficence, gratitude, patience, respect for living and non-living nature, and ongoing reflection about these matters in everyday life. The ethical issues in space exploration are profound, although

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[10] *See, e.g.*, Gregory S. Alexander et al., *A Statement of Progressive Property*, 94 CORNELL L. REV. 743, 743–44 (2009) (stating five main principles of a more inclusive and responsible concept of property).

[11] *See, e.g.*, THOMAS BERRY, THE GREAT WORK: OUR WAY INTO THE FUTURE (1999) [hereinafter BERRY, THE GREAT WORK] (law should reflect the common origin of the universe, recognizing a community of life); CORMAC CULLINAN, WILD LAW: A MANIFESTO FOR EARTH JUSTICE 30, 36, 53 (2d ed. 2011) [hereinafter CULLINAN, WILD LAW] (law should reflect inter-relationship and inter-dependence of all things in universe).

[12] *See* Debra Werner, *Luxembourg, Serious about Mining Asteroids, Prospects for Silicon Valley Partners*, SPACENEWS (Apr. 19, 2017), http://spacenews.com/luxembourg-serious-about-mining-asteroids-prospecting-for-silicon-valley-partners/ (Luxembourg seeking investment partnerships with Silicon Valley companies for space mining).

current discussion is largely limited to the problems of potential collisions and orbital debris.[13]

Following this Introduction, Part II of this article explains asteroids and Part III discusses their potential uses for humans. Part IV briefly examines obligations of the United States under the Outer Space Treaty of 1967 and argues, joining some others, that the Space Act violates the principles and terms of that treaty. Part V concerns the imposition of a traditional property framework on space material, presenting the Space Act as a first in time, first in right platform that lacks any limitations of the Lockean proviso. Part VI explores the growing international reform movement toward "ecological" or "Earth" law and argues that expanding this approach to outer space, notwithstanding its difficulties, is logical and necessary. Part VII, the heart of the argument, assesses the flawed environmental ethics of the Space Act's approach and the components of an improved framework for Earth and beyond. Finally, Part VIII recommends timely attention to merging Earth and cosmic ethics.

II. ASTEROIDS AND THEIR TYPES

A. What Are Asteroids?

Relative to planets, asteroids are quite small, but, like planets, they orbit the sun.[14] There are many asteroids in our solar system and most are located in the Asteroid Belt between the orbits of Mars and Jupiter.[15] These asteroids were formed during the origin of the universe about 4.6 billion years ago when a cloud of gas and dust collapsed and material at the center became the sun and some dust condensed into planets.[16] Yet, "the notion of an 'average' asteroid is rather naïve."[17] From a human control perspective, asteroids are "wild" in their irregular shapes and

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[13] *See, e.g.*, Melissa Davey, '*We've Left Junk Everywhere': Why Space Pollution Could be Our Next Big Problem*, THE GUARDIAN (Mar. 25, 2017), https://www.theguardian.com/science/2017/mar/26/weve-left-junk-everywhere-why-space-pollution-could-be-humanitys-next-big-problem. *But see* BEYOND SPACESHIP EARTH: ENVIRONMENTAL ETHICS AND THE SOLAR SYSTEM (Eugene C. Hargrove ed., 1986) [hereinafter BEYOND SPACESHIP EARTH]; COMMERCIAL SPACE EXPLORATION: ETHICS, POLICY AND GOVERNANCE (Jai Galliot ed., 2015) [hereinafter COMMERCIAL SPACE EXPLORATION]; JACQUES ARNOULD, ICARUS' SECOND CHANCE: THE BASIS AND PERSPECTIVES OF SPACE ETHICS (2011); THE MEANING OF LIBERTY BEYOND EARTH (Charles S. Cockell ed., 2015) [hereinafter LIBERTY BEYOND EARTH]; TONY MILLIGAN, NOBODY OWNS THE MOON: THE ETHICS OF SPACE EXPLORATION (2015) [hereinafter MILLIGAN, NOBODY OWNS THE MOON].

[14] *Asteroids: Overview*, NASA SCIENCE, https://solarsystem.nasa.gov/planets/asteroids (last visited July 24, 2017).

[15] *Id.*; *Asteroids: In Depth*, NASA SCIENCE, https://solarsystem.nasa.gov/planets/asteroids/indepth (last visited July 24, 2017).

[16] *Asteroids: In Depth*, *supra*.

[17] LEWIS, *supra* note 5, at 76.

"tumbling motions," sort of like sand dunes on Earth.[18] Asteroids are extremely varied in size, shape, and composition, and some contain metals such as iron and nickel.[19] Meteorites, in contrast, are bits of asteroids (and comets or other bodies) that break off and make it through Earth's atmosphere. Both asteroids and meteorites carry information about planetary and solar history.[20]

For example, some scientists claim to have found bacterial life embedded in a rare carbonaceous meteorite.[21] The NASA space probe Dawn also discovered localized organic material on the largest asteroid Ceres.[22] Scientists believe that hydrothermal processes, similar to hot springs, in Ceres' past may have combined with clay minerals to produce organic molecules.[23]

B. Types of Asteroids

Asteroids are classified into three main categories from an instrumental or human resource perspective. Type C (carbonaceous) asteroids contain mostly water, metal, and organic compounds.[24] Type S (stony) asteroids contain metals that are in the platinum group on Earth (platinum, osmium, iridium, rhodium, ruthenium, and palladium).[25] Type M (metal) asteroids contain metals.[26]

C. Location of Asteroids

Although most asteroids orbit the sun in the wide Asteroid Belt,[27] asteroids within a certain distance of Earth, including those within Earth's orbit, are called near-Earth asteroids ("NEA").[28] Those populating the near-Earth category sometimes migrate, and often originate, from the more distant Asteroid Belt.[29] Thus, asteroid classes are dynamic by

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18 LEWIS, *supra* note 5, at 116, 118.

19 *See id.* at 116; *Asteroids: In Depth*, *supra* note 15.

20 *See* LEWIS, *supra* note 5, at 32–33.

21 Charles Cooper, *NASA Scientist: Evidence of Alien Life on Meteorite*, CBS NEWS (March 7, 2011), http://www.cbsnews.com/news/nasa-scientist-evidence-of-alien-life-on-meteorite/.

22 *Organic Molecules Found on Giant Asteroid Ceres—Why That's Such a Huge Deal*, THE CONVERSATION (Feb. 16, 2017), https://theconversation.com/organic-molecules-found-on-giant-asteroid-ceres-why-thats-such-a-huge-deal-73147.

23 *Id.*

24 Philip Metzger, *The Type of Asteroid to Mine, Part 3*, BLOG: SPACE MINING, SPACE SETTLEMENT, AND SPACE SCIENCE! (May 20, 2013), http://www.philipmetzger.com/blog/type-of-asteroid-to-mine-part-3/.

25 *Id.*; LEWIS, *supra* note 5, at 63, 109, 116.

26 LEWIS, *supra* note 5, at 63, 104.

27 *Id.* at 12.

28 *Id.* at 13–14.

29 *Id.* at 19–21.

nature, and humans hope to make them more so. Within ten years NASA aspires to capture and move a small NEA to orbit around the moon through the Keck Institute Asteroid Retrieval Mission.[30]

III. WHY DO PEOPLE WANT PROPERTY INTERESTS IN ASTEROID RESOURCES?

A. Access to Space

Once humans can create stable and accessible orbits, they can use the relocated asteroids to reach other destinations.[31] These can include valuable asteroids farther from Earth in the Asteroid Belt as well as other celestial bodies deeper in space. Not only will this process increase the economic prospects of space exploration, but it will also provide greater knowledge about our solar system, its origins, and possible future.[32] Eventually, increased access has the potential to add to knowledge of the universe beyond our galaxy, and perhaps even to the discovery of life.

Increased access to the heavens may also become a necessity if humans continue to overpopulate Earth and deplete its resources. Earth's vital resources, such as water quality and quantity, are showing signs of strain.[33] Someday, therefore, people may find it desirable to inhabit other bodies besides Earth; scientists and ethicists usually suggest the moon or Mars as possible candidates for human habitation.[34] Finally, success in moving smaller asteroids could also prevent future damaging collisions of these bodies with Earth.[35]

B. Water

1. Life Support in Space

The most obvious and realizable value of water available on asteroids, plentiful in NEA Type C, is to sustain organisms traveling and living in

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[30] *Id*. at 131.

[31] *Id*.

[32] *Id*.

[33] *See, e.g.*, Julie Beth Zimmerman et al., *Global Stress on Water Quality and Quantity*, 42 ENVTL. SCI. & TECH. 4247, 4248 (2008).

[34] *See, e.g.*, Robert Sparrow, *Terraforming, Vandalism and Virtue Ethics*, *in* COMMERCIAL SPACE EXPLORATION, *supra* note 13, at 161, 163, 165 (discussing ethical problems with changing, or terraforming, the features of other planets for the habitability of humans).

[35] *See, e.g.*, Tony Milligan, *Asteroid Mining, Integrity and Containment*, *in* COMMERCIAL SPACE EXPLORATION, *supra* note 13, at 123; William K. Hartmann, *Space Exploration and Environmental Issues*, *in* BEYOND SPACESHIP EARTH, *supra* note 13, at 134 (discussing preference for changing asteroid orbits to prevent collisions with Earth).

space, including humans, animals, and plants.[36] Water from asteroids could support space stations and even future colonies of humans who might settle in space. Access to nearby water would avoid heavy transportation costs associated with bringing water from Earth. Because asteroids have nearly non-gravity surfaces,[37] moving water within space may also be cheaper and more efficient. Access could also potentially mitigate the effects of current and future water shortages on Earth caused by climate change, population growth, lack of sanitation, and environmental pollution.

2. Fuel for Space Transport

Asteroid water also could be used to make rocket fuel, thus overcoming an impediment to deeper space travel.[38] The separation of hydrogen and oxygen from water molecules can produce fuel, and if this could be done in situ, rocket operation could avoid the expense and risk of transporting volatile fuels from Earth. Relocated asteroids in stable orbits could even be used as fueling stations, in part because the negligible gravity surface facilitates takeoff and landing.[39]

3. Radiation Shielding

Finally, humans spending significant time in space, for example, while exploring Mars, would face periodic exposure to large amounts of solar radiation, especially from solar flares.[40] In Earth's atmosphere, nitrogen provides most of the protection.[41] In spacecraft, tanks of water can also be used for effective shielding.[42] Asteroids could serve as a source of water for these tanks.

C. Mining for Profit

The biggest draw of asteroids to private companies is, however, the prospect of finding valuable metals on them. Type S and M Asteroids are most likely to contain metals such as iron, gold, and commercially valuable metals in the platinum group—"platinum, osmium, iridium, rhodium, ruthenium, and palladium."[43] Asteroids are composed of the same materials as Earth at the time of origin in the Big Bang. Many of

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36 *See* LEWIS, *supra* note 5, at 99, 106, 127 (describing uses of water for life support in space).
37 *Id*. at 119, 124.
38 *Id*. at 128.
39 *See id*. at 119, 133 (describing accessible asteroids as "stepping stones").
40 *Id*. at 129, 109.
41 *Id*. at 108.
42 *Id*.
43 *Id*. at 109.

the materials on Earth, however, sank to the planet's core due to their weight and gravity.[44] Thus, extraction on Earth requires invasive and often irreversibly destructive techniques that make it expensive in terms of both production and environmental consequences.[45] On asteroids the same minerals are closer to the gravity-free surface and would therefore be more easily extractable, according to the companies involved in the burgeoning industry.[46] By increasing the supply of these valuable metals, asteroid mining might also reduce the human costs associated with mining practices on Earth, including armed conflict and violence against women in mining regions.[47]

Although the profitability of asteroid metal extraction is not well established,[48] at least two companies, Planetary Resources and Deep Space Industries, are currently using drone-like and telescopic technology to prospect for metals in stages and, eventually, to take samples.[49] Planetary Resources has plans to probe and mine asteroids deep in space.[50] Deep Space Industries mostly plans to use extracted metals in situ to produce products for use in space exploration and settlement support.[51] In speaking about platinum-group metals—those metals most economically valuable on Earth—chief company scientist John Lewis asserts, "There is absolutely no prospect of importing even a tiny portion of these materials to Earth."[52] Despite these different ambitions, both companies have pushed the Space Act as providing necessary incentives for risky and expensive space ventures and for attracting capital investors.[53]

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[44] *Id*. at 114–16.

[45] *Id*. at 8–9, 114, 115–16, 121.

[46] *See id*. at 114–15 (placement of minerals in asteroids is not differentiated as on Earth, so accessible on surface).

[47] *See, e.g.*, *South Africa Rape: 'Shocking' Levels of Violence in Mining Area*, BBC (Aug. 16, 2016), http://www.bbc.com/news/world-africa-37097941.

[48] *See* Thomas Heath, *Space-Mining May Be Only A Decade Away. Really.*, WASH. POST (April 28, 2017), https://www.washingtonpost.com/business/space-mining-may-be-only-a-decade-away-really/2017/04/28/df33b31a-29ee-11e7-a616-d7c8a68c1a66_story.html (claiming that profitability is an open question requiring further cost-benefit analysis).

[49] *See, e.g.*, Milligan, *supra* note 35, at 125 (describing preparatory work of Planetary Resources and Deep Space Industries); Kevin Mac Whorter, Note, *Sustainable Mining: Incentivizing Asteroid Mining in the Name of Environmentalism*, 40 WM. & MARY ENVTL. L. & POL'Y REV. 645, 652–54 (2016) (describing the diverse methodologies of the two companies).

[50] *Timeline*, PLANETARY RESOURCES, https://www.planetaryresources.com/company/timeline/ (last visited Aug. 15, 2018) (Planetary Resources, Inc., self-describing launches of exploratory technology from 2015 through 2018).

[51] *See* LEWIS, *supra* note 5, at 113 (discussing establishment of in-space market for metals).

[52] *Id*.

[53] Richard Yonck, Guest Blog, *The Dawn of the Space Mining Age*, SCI. AM. (Nov. 24, 2015), https://blogs.scientificamerican.com/guest-blog/the-dawn-of-the-space-mining-age/.

Some have questioned the realism of profitability estimates, arguing that few metal-rich asteroids are proximate and accessible for mining.[54] Although the vastness of space may contain numerous such bodies, the technological and financial challenges may severely limit access to them. As a result, a few companies may be able to secure a near-monopoly, which is inconsistent with the principle of free access for the benefit of all mankind that is central to the foundational international treaty on outer space, known as the Outer Space Treaty.[55]

IV. COMPATIBILITY WITH THE OUTER SPACE TREATY OF 1967

The United States was a prime architect of policies promoting the peaceful use of space and the principle that no country can assert sovereignty over any celestial body.[56] The Soviet launch of Sputnik in 1958 took most Americans by surprise and posed a threat to U.S. military and technological dominance, thereby fueling a space race between the two countries.[57] In this atmosphere, the United States and Soviet Union led the charge in developing a legal framework for the exploration and use of outer space. Article I 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," "OST") declares: "The exploration and use of outer space, including the moon and other celestial bodies, shall be carried out for the benefit and interests of all countries, irrespective of their degree of economic or scientific development, and shall be the province of all mankind."[58]

A. The Meaning of the "Province of All Mankind"

To say that the exploration and use of outer space is the "province" of all mankind could mean that outer space is held in common ownership, belonging to everyone. Under this reading, the OST precludes claiming material in outer space as exclusive individual property as the recent Space Act contemplates. Alternatively, "province" might not refer to ownership but instead to joint management responsibilities of space resources accessible to humans. "Province" can also describe a territory

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[54] *See* Heath, *supra* note 48.

[55] Outer Space Treaty, *supra* note 2, art. I; *See also* James S.J. Schwartz, *Fairness as a Moral Grounding for Space Policy*, *in* LIBERTY BEYOND EARTH, *supra* note 13, at 83 (discussing resource monopoly as violating fairness).

[56] *See, e.g.*, *Treaty on Principles Governing the Activities of States, Including the Moon and Other Celestial Bodies, Narrative*, U.S. DEP'T OF STATE, https://www.state.gov/t/isn/5181.htm (last visited July 27, 2017); Outer Space Treaty, *supra* note 2, art. II (principle of no sovereignty).

[57] Paul Dickson, *Sputnik's Impact on America*, NOVA (Nov. 6, 2007), http://www.pbs.org/wgbh/nova/space/sputnik-impact-on-america.html.

[58] Outer Space Treaty, *supra* note 2, art. I.

or region, a meaning that can be extended to refer to a field of learning (such as the province of mathematics), or a sphere of authority that places decisions within someone's province.[59] In the context of the OST, the latter two meanings suggest that all humans have an interest in the treatment of celestial bodies once any human obtains access. In other words, because it is everyone's business what happens in outer space, the access to and use of outer space are matters of joint oversight.

Support for the view that "province of all mankind" contemplates joint governance of space exploration and use comes from different language in the Moon Treaty, which declares that the "[t]he Moon and its natural resources are the common heritage of mankind."[60] Most interpreters think that the Moon Treaty bans commercial exploitation of celestial bodies based on the common heritage idea, which is also part of the history of the Law of the Sea and the current international consensus regarding Antarctica.[61] Instead, the Moon Treaty dictates appointing an international body to work out the details of lunar exploration in a manner equitable to all nations.[62]

The "common heritage" concept does not appear in the OST. Yet, the "province of mankind" concept appears in both the OST and the Moon Treaty,[63] which both contain language about ideal space exploration as a peaceful enterprise that benefits all, including developing states that lack resources to undertake it directly.[64] Thus, both treaties express commitments to shared purposes and equitable outcomes. Unlike the Moon Treaty,[65] however, the OST does not explicitly prohibit commercial development. Thus, the primary distinction between the two concepts of "province of mankind" and "common heritage of mankind" may relate to the potential for commercial activities. Perhaps because of this commercial distinction, nations broadly accepted the OST, but not the Moon Treaty.[66] Also noteworthy, the United States and other major

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[59] *Province*, THE OXFORD ENGLISH DICTIONARY (3d ed. 2007).

[60] *See* Agreement Governing the Activities of States on the Moon and Other Celestial Bodies art. 11, para. 1, Dec. 18, 1979, 1363 U.N.T.S. 3 [hereinafter Moon Treaty].

[61] *See* Samuel Roth, *Developing a Law of Asteroids: Constants, Variables, and Alternatives*, 54 COLUM. J. TRANSNAT'L L. 827, 843 (2016) (discussing Moon Treaty, *supra*, arts. 7 and 11).

[62] Moon Treaty, *supra* note 60, art. 11.

[63] Outer Space Treaty, *supra* note 2, art. I; Moon Treaty, *supra* note 60, art. 4.

[64] Outer Space Treaty, *supra* note 2, art. I; Moon Treaty, *supra* note 60, art. 4.

[65] Moon Treaty, *supra* note 60, art. 11, para. 3 (natural resources in place cannot be subject of property).

[66] *See* Nathan C. Goldman, *Space Law and Space Resources*, *in* NAT'L AERONAUTICS & SPACE ADMIN., SCI. & TECHNICAL PROGRAM, NASA SP-509, Vol. 4, SPACE RESOURCES: SOCIAL CONCERNS 143, 144–47 (Mary Fae McKay et al., eds. 1992), *available at* https://ntrs.nasa.gov/archive/nasa/casi.ntrs.nasa.gov/19930007668.pdf.

space-faring nations never signed the Moon Treaty because of its guarantees of equity to developing countries.[67]

B. State Sovereignty and Jurisdiction over Activities in Space

Although the OST prohibition on state sovereignty over any celestial body does not literally apply to private individuals and entities, the OST makes each signatory state responsible for authorizing and supervising any launches from its territory.[68] The separate Liability Convention explicitly grants jurisdiction to a launching state to determine strict liability damages for injuries inflicted on Earth and negligence-based damages for off-Earth harms.[69] Thus, it does not appear from the terms of international laws regarding space that exercising United States jurisdiction over private activities or persons in space amounts to making a prohibited claim of state sovereignty. It is also important to recognize that the state signatory retains complete liability for damages incurred through space activities, even by private but authorized actors.[70]

The distinction between jurisdiction and sovereignty in the asteroid context is puzzling in practice, however. Is authorizing a private company to enter space, land on an asteroid or celestial body, and extract material, equivalent to an assertion of United States sovereignty over the celestial body, when accompanied by legislative assurances in the Space Act that materials so obtained constitute property? One thorny issue is the American view of real property itself, which includes natural material attached to or embedded in the soil.[71] The traditional *ad coelum* principle of American property law deems that the owner of the land owns everything "to the sky and to the depths."[72] Severing ownership of the surface and underlying material is also common in property law[73] But neither principle applies well to asteroids because no one owns the severable surface. Instead, under the Space Act, an asteroid miner owns an original title to the extracted material but not to the asteroid itself. Governmental authorization under the OST, would involves monitoring asteroid exploration, accepting liability for damage, but no assertion of

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67 *See, e.g.*, Lawrence A. Cooper, *Encouraging Space Exploration Through a New Application of Space Property Rights*, 19 SPACE POL'Y 111, 112 (2003).

68 Outer Space Treaty, *supra* note 2, art. VI.

69 The Convention on International Liability for Damage Caused by Space Objects art. II, Mar. 29, 1972, 24 U.S.T. 2389, 961 U.N.T.S. 187. *See also* Roth, *supra* note 61, at 844–45.

70 Outer Space Treaty, *supra* note 2, art. VI.

71 *See, e.g.*, Black Hills Inst. Geological Res. v. South Dakota Sch. Mines & Tech., 12 F.3d 737, 742 (8th Cir. 1993) (finding that dinosaur fossil, as natural material, was part of the land).

72 *See* DUKEMINIER ET AL., *supra* note 6, at 148 n.10.

73 This separation of ownership is consistent with the "bundle of rights" metaphor.

sovereignty over the celestial body.[74] Under the Space Act, the United States would be granting property rights in something that the terms of the OST prohibit a country from owning.

Extracted material as property also raises problems of consistency with the OST principle of benefits that are the "province of all mankind"[75] and the idea that space "shall be free for exploration and use by all States."[76] The property rights designated in the Space Act to "possess, own, transport, use, and sell,"[77] asteroid or space resources and promote "commercial recovery of space resources free from harmful interference . . . ."[78] preclude free common access once a person or company acquires protected rights. Although the Space Act declares several times that its provisions are in accordance with international law and obligations,[79] saying this, even multiple times, does not make it so. A United States grant of exclusive property rights in extracted space resources (even if not territory itself) is incompatible with the commitments to free access and common benefit that are central to the OST. Congress has disregarded the overarching commitment to international cooperation that the Treaty affirms in "[d]esiring to contribute to broad international co-operation in the scientific as well as the legal aspects of the exploration and use of outer space for peaceful purposes"[80] and "believing that such cooperation will contribute to the development of mutual understanding and to the strengthening of friendly relations between States and peoples."[81] Unilateral legal action that grants resource rights to the private entities of one nation is a direct affront to the OST commitments of cooperation and consultation.

Another foreseeable problem is settling disputes among property claimants. Assuming the United States granted particular property rights in asteroid resources under the Space Act— contrary to the Treaty's prohibition of private ownership by one citizen nation to the exclusion of other—American courts would be acting unilaterally and ignoring international obligations in settling internal citizen disputes.[82] If other signatories were then to respond in kind by passing legislation permitting their national companies to extract and own resources, those nations would also presumably resolve internal disputes in their own courts.

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74 Outer Space Treaty, *supra* note 2, arts. II, VI, VII.
75 *Id*. art. 1.
76 *Id*.
77 51 U.S.C. § 51303 (Supp. III 2015).
78 *Id*. § 51302(a)(3).
79 *Id*. § 51303.
80 Outer Space Treaty, *supra* note 2, pmbl.
81 *Id*.
82 *Id*. art. 1 (principle of inclusion).

Parallel actions would thus result in inconsistent principles governing outer space activities with no clear mechanism or forum to resolve disputes among mining entities from different countries. Without consensus to establish an international regime to govern the use of outer space,[83] as proposed by the ill-fated Moon Treaty, uncertainty of jurisdiction over international space usage would result in chaos at best and a free-for-all at worst.

Such disputes seem inevitable in this context if only because of the nature of asteroids. Because of the low-gravity surface, especially on small, low-mass asteroids, any equipment being installed for mining or other operations would need to be secured to the asteroid surface.[84] One method of doing this on a small asteroid is to "harpoon" the asteroid and allow a tether to wrap itself entirely around the asteroid body in rotation until the craft or equipment at the end of the tether is tightened to the surface.[85] With this technique, the lasso encircles the entire celestial body, thus creating problems with the "no sovereignty" requirements of the OST since the asteroid itself is being captured. Other methods under consideration for anchoring spacecraft appear to be too imprecise to stake clear claims of resource property rights. For example, sending several anchors toward an asteroid's surface is a trial and error method for finding a viable secure landing spot.[86] On a larger, partially occupied asteroid, this imprecise technique seems fraught with conflict because of potential interference with a preexisting commercial site. Thus, the only way to avoid property conflicts using the anchor method may be to claim exclusive ownership rights to an entire asteroid body, which is clearly a prohibited claim of sovereignty.[87] Indeed, the challenges of conducting mining operations in a low-gravity environment may make clean demarcations of property boundaries infeasible.

V. PROPERTY IN ASTEROID OR SPACE RESOURCES

A. Space Commons

Assuming for the sake of argument that a system of private property rights in celestial resources is ethically sound, an assumption I later challenge, many questions emerge about the model of property reflected in the Space Act. A traditional theorist of the origins of property might view celestial objects as being in a state of nature, or commons, open to

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[83] Moon Treaty, *supra* note 60, art. 11.
[84] LEWIS, *supra* note 5, at 120.
[85] *Id.* at 120–21.
[86] *Id.* at 121.
[87] Gilson, *supra* note 8, at 1378.

appropriation under a Lockean model. According to this model, as defined by English philosopher John Locke, a person who mixes his labor with natural material acquires a claim to that thing he removes from the state of nature.[88] Locke's mode of original acquisition is limited by a dual concept of waste. On the one hand, it is wasteful to leave nature idle and fail to convert it into something useful and productive.[89] Yet, if one appropriates an excess of materials that spoil from nonuse, one has committed waste and cannot legitimately claim property in the excess.[90] For Locke, an important proviso that overshadows ownership is that one must leave as much and as good for others.[91]

The Supreme Court tacitly applied Lockean principles to land in America, reasoning that the original inhabitants of the land did not have title because their use of the land was insufficiently productive,[92] thus leaving it to European countries in the New World to settle priorities amongst themselves through conquest and eventually treaties granting title to the victorious governments.[93] All legitimate titles to land in America must then be traced to United States governmental grants, authorized through discovery of the New World and victory against Great Britain in the American Revolution.[94] Thus, unlike celestial resources, property interests in American territory and goods ultimately derive from governmental property. The Space Act grants property interests in asteroid and other space resources that cannot, however, be traced to government ownership because no state party to the OST is capable of such sovereignty over bodies in space, which belong to all.

B. Unlimited Rights and Alternatives to the Individual Property Model

Significantly, the Space Act does not even limit the scope of ownership rights the United States may grant in asteroid and other space resources. Although not explicitly first in time rubric, the Act implies that the first to claim the resource obtains the incidents of ownership specified in the legislation, "free from harmful interference."[95] The Space Act does not limit the amount of asteroid material a miner can extract. Nor is there any limit on the duration that private companies may exploit the resources

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88 John Locke, *An Essay Concerning the True Original, Extent, and End of Civil Government*, *in* BLACKWELL'S POLITICAL TEXTS 3, paras. 26, 27 (J.W. Gough ed., 1948).

89 *Id*. paras. 31, 40, 42, 43.

90 *Id*. paras. 35, 37, 38.

91 *See id*. paras. 26 ("where there is enough, and as good left in common for others"), 35 (use without prejudice).

92 Johnson v. M'Intosh, 21 U.S. (8 Wheat.) 543, 590–91, 95 (1823).

93 *Id*. at 584.

94 *Id*. at 574, 584.

95 51 U.S.C. § 51302(a)(3) (Supp. III 2015).

over which they are granted property rights to possess, use, move, own, and sell.[96] Thus, the Act does not honor even traditional constraints on ownership such as taking more resources than would leave as much and as good for others, which is the essence of Locke's proviso. It appears, instead, that the first to exploit obtains an indefinite right to continue, and probably enlarge, that activity without "harmful interference."[97]

The Space Act could have at least bowed stiffly to the OST commitment to sharing the benefits of space with all members of humanity. For example, Congress could have devised a method of allocating rights in advance to actors not yet financially or technologically equipped to visit asteroids, similar to the allocation of satellite orbits before an actor is ready to launch and operate.[98] Developing countries could receive some future mining rights, and overall acquisitions could be limited to prevent concentrations of wealth. Or, private exploiters of asteroid resources could be required to pay a considerable fee for property rights that could be distributed among OST nations. Another means to address international interests would be a royalty system that would distribute corporate profits on some equitable basis rather than unlimited property rights. Rights of exploration and extraction could also cap the time a company can mine a particular area and restrict the number of places available to any single entity. The Space Act of 2015, however, deliberately leaves the asteroid property framework unregulated for at least eight years, providing time for the companies themselves to sort out challenges.[99] Thus, the fundamentally questionable private property rights the Space Act grants in extracted materials are essentially unlimited at least for now.

C. Corporate Incentives and Public Subsidies

The companies interested in asteroid mining argue that restrictive measures would dampen their incentive to innovate and to take on the risks and expense of space prospecting and extraction. They urge that the

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[96] *Id*.

[97] *Id*.

[98] *See*, *e.g.*, Carol R. Buxton, *Property in Outer Space: The Common Heritage of Mankind Principle vs. the "First in Time, First in Right" Rule of Property Law*, 69 J. AIR L. & COM. 689, 703 (2004) (discussing satellite slot allocation administered under the International Telecommunications Convention).

[99] Loren Grush, *Private Space Companies Avoid FAA Oversight Again, with Congress' Blessing*, THE VERGE (Nov. 16, 2015), https://www.theverge.com/2015/11/16/9744298/private-space-government-regulation-spacex-asteroid-mining.

Space Act is needed to support such purposes.[100] Yet, these companies fail to acknowledge that "private" innovation is fundamentally dependent on more than fifty years of public investments in space programs around the world.[101] Governments should not give corporations unfettered property rights as rewards for their creative energy based on an individualistic model because public commitments, priorities, and sacrifices of other public goods have paved the way for that innovation. In short, the Space Act has not only bypassed the treaty obligations of the United States by creating rights of private property in space resources, but it has done so through a simplistic, exclusive, unlimited model of ownership that overlooks enormous public interests and contributions.

The Space Act represents an aborted opportunity to shape space law on an improved idea of property based more on cooperative relationships and reciprocal obligations than exclusive ownership.[102] Some existing property laws illustrate this tendency toward a more communal view. Even current rights to exclude are subject to more important rights of access in some instances to safeguard public rights,[103] protect people

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[100] *See, e.g.*, Mac Whorter, *supra* note 49, at 651 (describing large investment and need for certain ownership); Roth, *supra* note 61, at 839 (incentives to invest in "expensive, high-risk endeavors").

[101] *See, e.g.*, Barton Beebe, *Law's Empire and the Final Frontier: Legalizing the Future in the Early Corpus Juris Spatialis*, 108 YALE L.J. 1737, 1738, 1742, 1744–45 (1999) (describing intensive "space age" mobilization); Patrick Lin, *Space Ethics: Look Before Taking Another Leap for Mankind*, 4 ASTROPHYSICS J. 281 (2006) (describing diversion of taxpayer funds to space exploration and away from human needs).

[102] *See, e.g.*, Gregory S. Alexander et al., *A Statement of Progressive Property*, 94 CORNELL L. REV. 743, 744 (2009) (stating five main principles of a more inclusive and responsible concept of property).

[103] *See*, Gregory S. Alexander, *The Social-Obligation Norm in American Property Law*, 94 CORNELL L. REV. 745, 808–09 (2009) (discussing the opinion in State v. Shack, 217 A. 2d 369, 372–73 (N.J. 1971), which required a private farm owner to allow public service workers access to his property to provide federal services to migrant farmers). In my property class, I discuss the implications of enforcing strict rules of ownership in *Shack*. Although clarity and nearly unfettered exclusion rights have intuitive appeal in the law, they depend for their legitimacy on an overall framework of just distribution of basic goods and services, which migrant farmers do not enjoy. In making this point, I ask students to read an article, entitled *Give and Take*, by Katherine Hussman Klemp in the *Sesame Street Parent's Guide*, at 36 (December 1989). Ms. Klemp recounts her impulse as a young mother to require her children to share possessions among themselves and friends, with ensuing arguments about ownership that she had to resolve, sometimes inconsistently, in an unprincipled manner. This led her to a hard rule: "Never bring anything into the home without designating clear ownership. The owner is not required to share." Then I ask the students whether this exclusionary rule would work in *Shack*. The students readily see that the family rule assumed the benevolent governance of Mom, roughly equal distribution of vital resources, and the satisfaction of fundamental human needs, whereas *Shack* had none of those attributes. Toys differ from the health and basic legal information the migrant workers needed, and no just governance ensured migrants' basic dignity. Property law should limit strict owner exclusion involving vital interests and grossly disproportionate distribution relating to those interests.

against discrimination,[104] and protect residential tenants from unsafe and unhealthful conditions.[105] Environmental law and land use regulation also significantly limit the use of private property, sometimes interfering with development plans.[106] The companies on the verge of reaping the advantages of the Space Act have benefited from a common human venture with potential to affect posterity. The narrow concept of exclusive private property does not match this posture.

The Space Act conceives a pre-regulatory framework, essentially leaving the right to define any constraints on extraction and use to the first companies that arrive. Of course, legal limitations do not apply in outer space beyond relatively sparse treaty obligations. Yet, allowing unfettered private control is ethically concerning. Not only would actors claiming the exclusive mining and ownership rights on asteroids violate treaty prohibitions against asserting state sovereignty over space bodies, but the extraction, use, and transport of materials from those bodies could also significantly alter the territory itself.

D. Environmental and Other Possible Risks

The Space Act takes advantage of a regulation-free environment to allow early exploiters to identify needed limits, which is unjustified for numerous reasons. For all of the uncertainties on Earth about the long-term and remote effects of tampering with the environment, the unknowns in space are orders of magnitude greater. Scientists know very little about the composition of unvisited space bodies and even less about the possible interactions of activities in space. Private corporations, however, have primary legal obligations to shareholder profits and thus too narrow a legal perspective to make judgments that consider the overall public good and the long-term consequences of their actions.[107] For the same reason, corporations are inappropriately situated to craft property-sharing schemes that respect international interests and to place greater value on general scientific significance than corporate potential.

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[104] *See, e.g.*, Fair Housing Act, 42 U.S.C. § 3604 (2012) (prohibiting various means of exclusion in housing transactions of people belonging to protected categories).

[105] *See, e.g.*, Javins v. First National Realty Corp., 428 F.2d 1071 (D.C. Cir. 1970) (finding warranty of habitability implied in all leases), *cert. denied*, 400 U.S. 925 (1970).

[106] *See, e.g.*, Penn Central Transportation Co. v. City of New York, 438 U.S. 104, 129, 132, 138 (1978) (city landmark laws, precluding airspace development, ruled not taking).

[107] *See, e.g.*, Jessica Chu, *Filling A Nonexistent Gap: Benefit Corporations and the Myth of Shareholder Wealth Maximization*, 22 S. CAL. INTERDISC. L.J. 155, 155–56 (2012) (critically discussing requirement of corporations to maximize shareholder wealth and short-term profitability); Justin Fox & Jay W. Lorsch, *What Good Are Shareholders?* HARV. BUS. REV. (July–August 2012), https://hbr.org/2012/07/what-good-are-shareholders (discussing factors that limit effective shareholder influence on corporations).

Specifically, some of the target bodies may contain unknown material that could help to explain the origins of microbial life in mineral environments.[108] Asteroids may not turn out to be "lifeless rocks,"[109] but instead may contain irreplaceable information that can add to humanity's knowledge of life. Yet, it is not possible to anticipate when a landing and retrieval project would disrupt material of scientific importance.

Private control of asteroids also presents the risk of "backward contamination," in retrieving space matter and bringing it to Earth.[110] So far we have charged mostly public agents with managing this risk.[111] The OST and Liability Treaty also create public financial incentives to instill care by holding responsible the state that launches a craft or from whose territory the launch occurs.[112] The OST also covers "forward contamination," which is contamination affecting the target celestial bodies.[113] The Space Act invites private visitors to scarify unexplored places but provides no mechanisms to monitor and control the potential for microbial contamination of those places. These are just a few of the uncertainties, risks, and corporate disabilities that infect the idea of private property in asteroid resources. The central ethical questions of how to handle vast uncertainties and risks are hard enough to decide on Earth but are both novel and daunting beyond. Self-interested parties should not be deciding (or ignoring) these formidable questions.

Equally concerning, mining asteroids magnifies the risks of disrupting space processes. Deep Space Industries scientist John Lewis implies that mining gets a bad name because of its highly invasive nature on Earth, where valuable minerals are deep in the Earth's core and difficult to extract without heavy equipment and chemical processes.[114] Because asteroids never differentiated into layers, metals and other material are available mostly at the surface and require less invasive extractive

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[108] *See*, *e.g.*, Roth, *supra* note 61, at 829, 865–66 (discussing discovery of meteorite containing "chemical building blocks of life").

[109] Brian Merchant, *The Problem with Asteroid Mining*, VICE MOTHERBOARD BLOG (Jan. 23, 2013), https://motherboard.vice.com/en_us/article/d77jj7/the-problem-with-asteroid-mining (recommending further scientific study of asteroid environments before mining).

[110] MILLIGAN, NOBODY OWNS THE MOON, *supra* note 13, at 123 (discussing concerns with bringing a harmful substance, such as a virus, to Earth through space exploration).

[111] Outer Space Treaty, *supra* note 2, art. VI (States internationally responsible for governmental and non-governmental activities), art. IX (States responsible to avoid "adverse changes in the environment of the Earth resulting from the introduction of extraterrestrial matter . . . .").

[112] Outer Space Treaty, *supra* note 2, art. VII (State where space vessel launched liable for international damages).

[113] Outer Space Treaty, *supra* note 2, art. IX (explorers of celestial bodies must "avoid their harmful contamination").

[114] *See* LEWIS, *supra* note 5, at 8–9, 114–15, 121 (describing significant differences between mining on Earth and on asteroids).

methods in a low gravity atmosphere. According to Lewis, this makes launching and removals less cumbersome.[115] Yet, the same low-gravity atmosphere will require experimental methods to secure any mining equipment to the asteroid body, which Lewis admits will be a process of trial and error that may involve the entire asteroid.[116] Moreover, asteroid prospectors like Lewis know too little at this point about which asteroids might have value in terms of accessibility and composition to develop specific methods of extraction or in situ production of resources have not yet been developed. It is premature to pronounce, therefore, that the environmental damage of asteroid mining should not be a concern.

Some recommend a moratorium on this exploration so that further study may be done on the asteroids humans intend to exploit.[117] Such a freeze would be limited and would not preclude the slow return of samples from the NASA OSIRIS project,[118] a carefully planned and controlled public endeavor. Company representatives seeking a competitive private race to any reachable asteroids have responded to a moratorium proposal by claiming that the public can neither afford to delay space exploration and lose vital access to water for extraterrestrial residence and rocket fuel,[119] nor wait for precious metals on Earth to dwindle or run out, increasing environmental damage and human conflict.[120] Those who argue that immediate property rights are the only way to reduce environmental harm from mining overlook unpredictable harms from their own endeavors. Those who declare they are owed financial incentives to spur innovative explorations fail to acknowledge their incalculable debt to years of public and international investment and effort. They disregard their nation's treaty commitments to a more equitable and inclusive use of outer space.

Whatever system for allocating priorities develops, caution must be a pervasive principle. The gaps in knowledge about the universe are huge and may never be surmounted.[121] Despite humanity's scientific and technological prowess and achievements, a property framework that

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115 *Id*. at 8–9, 115.

116 *See id*. at 116–23 (describing possible mining methods).

117 *See, e.g.*, Merchant, *supra* note 109.

118 *About OSIRIS-Rex*, NASA, https://www.nasa.gov/osiris-rex (last visited Jan. 4, 2018) (OSIRIS traveling to nearby asteroid, Bennu, intending to return with sample in 2023).

119 *See* LEWIS, *supra* note 5, at 99, 107, 127 (discussing the importance of water to life and propulsion in space).

120 *See id*. at 9 (humans facing depletion of metals on Earth but a "potentially limitless future" of mining on asteroids).

121 HANNAH ARENDT, BETWEEN PAST AND FUTURE 262, 268–69, 270–71 (Penguin Books 2006) (1954) (immensity of universe and limits of human perception and mortality restrict exploration much beyond near space).

accelerates action over understanding, via first in time, regulation-free competition, is a reckless idea.

VI. PROPERTY AND EARTH JURISPRUDENCE

A. Earth Jurisprudence Explained

A growing movement variously identified as "Earth Jurisprudence," "Ecological Law," and "Earth Law," urges that laws be modified to reflect the ecological interdependency and interrelationship of everything in the universe.[122] Revised property law would therefore not place individual human rights of ownership above the rights of other beings, including present and future humans, nonhumans, and natural processes. Owners would have ecological responsibilities to refrain from degrading the land.[123] Land rights would be defined by the features of the land itself and would vary among parcels.[124] A view of conservation would be "updated by ecological realities and clearly tied to a vision of responsible land use."[125]

The task of re-visioning the law and its ethical foundations, as implementing Earth Jurisprudence would require, is formidable because of the weight of cultural and legal precedent. Dominant Western belief supports human separation from the rest of nature and superiority over the nonhuman world.[126] At best, humans deem themselves planetary managers who "can do things better than nature."[127] At worst, this has resulted in the exploitative attitude that has led to despoiling our planet and caused a "sixth mass extinction," according to lawyer and Earth Jurisprudence advocate, Cormac Cullinan.[128] Underlying this ecological crisis is the Western notion of individualistic and corporate control, which fails to protect ecological interests and nonhuman species.[129] Not only does this outlook reduce the Earth and its nonhuman inhabitants to "objects for the use of humans,"[130] it is also incompatible with a modern

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122 *See, e.g.*, CULLINAN, WILD LAW, *supra* note 11, at 78, 112 (laws should respect natural systems over individual human claims).

123 *See, e.g.*, Eric Freyfogle, *Private Rights in Nature: Two Paradigms*, *in* EXPLORING WILD LAW: THE PHILOSOPHY OF EARTH JURISPRUDENCE 270, 275 (Peter Burdon ed., 2011) [hereinafter EXPLORING WILD LAW].

124 *Id*. at 276.

125 *Id*. at 278.

126 CULLINAN, WILD LAW, *supra* note 11, at 44–45.

127 *Id*. at 52.

128 *Id*. at 36.

129 *Id*. at 63–64.

130 *Id*. at 63.

scientific worldview.[131] Quantum physics poses "webs of relationships interacting in a network fashion with other systems" with parts inseparable;[132] nature is complex, structurally diverse and interdependent.[133]

The ethical implications of this interrelationship and interdependency are that power over other aspects of land or place for the benefit of select individual interests violates the welfare of the whole.[134] According to Earth Jurisprudence founder and Catholic theologian Thomas Berry, all individual things in the universe reach their realization in the "Great Self" of the universe, which is the source of all value.[135] Thus, an appropriate ethic seeks mutual benefit and reciprocity in relationships, aiming to heal and remedy damage to the Earth.[136] Caring for the Earth community changes the duties of property owners to include caring for the land for its own sake. It shifts the burden from defending interference with owners' rights to owners justifying any changes to the land that degrade its natural features.[137]

B. Expanding "Earth" Jurisprudence off Earth

Although Earth Jurisprudence advocates an ecocentric approach that aspires to restore and preserve Earth systems and processes, its language frequently strays beyond planetary boundaries. Principles of quantum physics apply to the universe as a whole, and the common origins of our solar system,[138] planet, and life itself invite, and even demand, a broader frame of reference.

Given the challenges of rewriting embedded laws and dispelling longstanding ideas about human separation and superiority on Earth, it is no wonder that proponents could be wary about expanding these ideas to outer space. In some respects, however, outer space might be an easier platform for reforming our thinking because there are fewer conceptual obstacles to overcome. A nearly blank legal slate offers an opportunity to rethink some of our more confounding and destructive ideas.

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131 Peter Burdon, *Eco-Centric Paradigm*, *in* EXPLORING WILD LAW, *supra* note 123, at 85, 88 (interrelated networks and systems central in modern biological and physical sciences).

132 *Id.* at 88.

133 *Id.* at 89.

134 Cormac Cullinan, *A History of Wild Law*, *in* EXPLORING WILD LAW, *supra* note 123, at 12, 13.

135 BERRY, THE GREAT WORK, *supra* note 11, at 190.

136 Cullinan, *supra* note 134, at 13.

137 *Id.* at 21.

138 NEIL DEGRASSE TYSON ET AL., WELCOME TO THE UNIVERSE: AN ASTROPHYSICAL TOUR 24, 218–21 (2016) (solar system originating from the rapid expansion of dense and very hot material making all things in the universe interrelated).

The little international guidance that exists—for example, the OST—is actually conducive to a more inclusive and sharing approach, albeit in a human-centered document.[139] Applying law from Earth, some commentators have suggested that the model for sharing and conserving resources in Antarctica could be useful in space.[140] The Antarctic is internationally available for scientific research and preservation, and mining is prohibited without full consent (not yet granted).[141] The Antarctic model could be extended to treat outer space as something more than a human commons. This framework would include greater consideration of the nonhuman bodies and discoveries, instead of assuming that space is a merely a container of potentially inexhaustible resources for humanity to exploit.

Such an approach would not prohibit all uses of asteroids. For example, it could allow water extraction to maintain human life in space. But it would require justifying the treatment of space elements as resources, distributing benefits and burdens equitably among nations and peoples, demonstrating necessity to exploit a particular space object, mitigating environmental effects of the tampering (applying caution toward unintended consequences), allowing little to no interference with scientific understanding of origins of past or primitive life, and respecting the aesthetic and other values of the outer space realm.[142] These principles would significantly tilt future space law, and perhaps, upon reflection, even aid in Earthly law reform. The window of opportunity to apply a significantly different legal approach to a largely unexplored domain is closing, however, and the Space Act of 2015 narrows this opportunity. At least one other nation has begun to pursue a similar legal approach,[143] and we can predict that at least competitive space-faring nations will follow the United States framework without much reflection, unless they can be convinced to act differently.

Still, several considerations weigh against expanding Earth Jurisprudence to space. First, the difficulty of applying an Earth-based theory to outer space plagues this novel framework. Entering an arena where the issues are highly speculative and mostly undiscovered may add

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139 *See* Outer Space Treaty, *supra* note 2, arts. I, IX, X (stating strong principles of cooperation).

140 *See, e.g.*, Norry Ham, *Commercial Mining of Celestial Bodies: A Legal Roadmap*, 27 GEA. INT'L ENVTL. L. REV. 629, 643–44 (2015), Carol R. Buxton, *Property in Outer Space: The Common Heritage of Mankind Principle vs. The 'First in Time, First in Right' Rule of Property Law*, 69 J. AIR L. & COM. 689, 696 (2004).

141 *Id.*

142 *See infra* Part VII.F.2.

143 Jonathan Amos, *Luxembourg to Support Space Mining*, BBC (Feb. 3, 2016), http://www.bbc.com/news/science-environment-35482427.

to what Al Gore once called "the bone-weariness of the damned,"[144] or a feeling of being overwhelmed by the scale of environmental problems and a resulting loss of motivation. A response to this concern is that some of the obstacles of human-centered Earth law would not pervade the new domain, and a clean slate could be inspiring and motivating.

Hannah Arendt raised another off-Earth problem about space exploration that applies to Space Jurisprudence. Arendt wondered whether a celestial perspective might decenter human beings by alienating them from their experienced home and highlighting their vulnerabilities as finite humans.[145] Arendt projected that the life span of human beings, combined with their current inability to move at the speed of light through space, would prevent man from exploring "more than his immediate surroundings in the immensity of the universe."[146] Astronauts have reported a sense of "awe and belonging" upon viewing our planet from space,[147] but Mike Mullane also described "a powerful sense of detachment from the rest of humanity" from his perspective on a space shuttle.[148] In short, an expanded universe identity may be conceptually and psychologically straining for humans.

Yet, it is questionable whether human identity must be entirely Earthly. Others have recounted how human identity has historically expanded in unimagined ways in the progression of the idea of persons to encompass slaves, married women, and children and the gradual normalcy of these ideas.[149] Similarly, attitudes about humanity's standing in relation to other beings are now becoming more favorable to nonhuman animals.[150] Perhaps humans could also expand their identity beyond Earth. Provided a swelled sense of self does not lead human beings to consign their earthly home to ruination, or deny their collective role in the wreckage, a decentered human identity may be a positive reorientation.

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144 AL GORE, EARTH IN THE BALANCE: ECOLOGY AND THE HUMAN SPIRIT 241 (1992).

145 ARENDT, *supra* note 121, at 266–67, 271–73 (discussing limits of human to earthbound perspective).

146 *Id*. at 270–71.

147 Tony Milligan*, Fear of Freedom: The Legacy of Arendt and Ballard's Space Skepticism*, *in* LIBERTY BEYOND EARTH, *supra* note 13, at 33, 39.

148 *Id*.

149 *See, e.g.*, Christopher Stone, *Should Trees Have Standing? Toward Legal Rights for Natural Objects*, 45 S. CALIF. L. REV. 450, 450–55 (1972) (recounting extensions of legal rights and hesitant initial responses of public).

150 *America is Becoming A Kinder, Gentler Place (Toward Animals, Anyway)*, CONSERVATION THIS WEEK (Aug. 3, 2016), http://www.conservationmagazine.org/2016/08/changing-attitudes-towards-wildlife/ (noting particular improvement toward once-disliked wildlife since the Kellert 1978 survey).

C. Concrete Challenges with Earth Jurisprudence

1. Conflict Resolution: Lack of Concrete Guidance

Earth Jurisprudence itself has many internal problems despite its exciting possibilities, and it will need careful development before it can generate workable laws beyond aspirational principles. Some of these deserve attention before expanding the jurisprudential scope. The largest problem involves a central purpose of law, which is to settle conflicts. The literature of Earth Jurisprudence outlines lofty principles of mutual rights of all members of the universe but says little about how these rights should be weighed in resolving inevitable clashes. Thomas Berry emphasizes that rights are qualitatively, not quantitatively, different, such that an insect would hold different rights than a river based on its particular role within a functioning system.[151]

Unfortunately, Berry offers few insights on what would happen when these rights conflict in cases where, for example, river temperatures fluctuate enough to threaten insects, or insect populations create river pollution. We only know that, under Earth Jurisprudence, both entities would have a voice and that the contextual resolution would be for the mutual benefit of all affected, even those not legally parties to the conflict. Some issues that would emerge from this kind of adjudication include the proper boundaries of the river, the causes of temperature changes, the stability of insect populations, the rarity of the insect species, the other living beings affected, and the flow of the river. This illustrates the problem of numerous categories having presumptively equal rights—here nothing less than all living individuals and long-term riverine and other ecological processes. Although the law can draw lines, it is a difficult task to set priorities and criteria to guide adjudication starting with radically egalitarian principles that cross such diverse categories. This challenge is not insurmountable in law and will be necessary with an ecological or systems approach, but those developing the theory need to apply much more attention to applications of ecological law to illustrate how the ideals can work in practice. A crucial challenge would be to build predictability into the law.

Similar problems have impeded any extension of legal standing to nonhumans, proposed long ago in Justice Douglas' famous dissent in *Sierra Club v. Morton*[152] and the publication of Christopher Stone's

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[151] *See* Thomas Berry, *Rights of the Earth: We Need A New Legal Framework Which Recognizes the Rights of* All *Living Beings*, *in* EXPLORING WILD LAW, *supra* note 123, at 227, 229 (the nature of rights is specifically linked to the type of being).

[152] 405 U.S. 727, 741–53 (1972) (Douglas, J, dissenting) (recommending standing for environmental entities such as rivers and meadows).

widely read article, *Should Trees Have Standing?*.[153] Since then, lawyers have creatively approached certain issues by invoking familiar procedural devices such as guardianships,[154] but a worthy debate persists regarding what counts as the interests of "beings," especially environmental entities like valleys or rivers.[155] In spite of the general resistance to giving animals standing in a legal system that has always treated them as property, sympathetic judges wrestle with such questions as what a dog's interests are and who can best represent those interests, for example, in a marital dissolution case.[156] Now that the Whanganui River, in New Zealand, is a legal person by an agreement between the New Zealand government and the Iwi, Maori people culturally aligned with the river,[157] it will be interesting to see how particular problems are resolved that may involve river boundaries, temperatures, wildlife, recreational and navigational uses, and myriad potential issues. Other legal declarations of holistic rights include Ecuador's Constitution[158] and legislation in Bolivia,[159] which both grant rights to Pacha Mama, or Mother Earth. Some American cities and towns have passed ordinances declaring the power of residents over their natural resources that corporations seek to exploit.[160] These brave and novel legal frameworks generate questions related to the breadth of citizen enforcement powers and consistency with other legal guarantees regarding commercial uses of land.[161] Hard work is ahead for any legal regime prepared to reorient itself toward a less destructive model of humans in relation to the rest of nature.

Outer space offers many additional challenges because we know so little about the issues travelers, including potential miners, will face and

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153 Stone, *supra* note 149.

154 *See, e.g.*, *id*. at 464–65, 480.

155 *See, e.g.*, *Sierra Club*, 405 U.S. at 743 (people with a "meaningful relation" must speak for the river or other being).

156 *See, e.g.*, *Travis v. Murray*, 42 Misc. 3d 447, 451, 460 (N.Y. Sup. Ct. 2013) (New York court orders hearing to determine "best for all concerned" in placing dog, Joey).

157 Te Awa Tupua (Whanganui River Claims Settlement) Act 2017 s 14 (N.Z.).

158 CONSTITUCIÓN DE LA REPÚBLICA DEL ECUADOR, Oct. 20, 2008, tit. II, ch. 7, arts.71–74.

159 See Franz Chávez, *Bolivia's Mother Earth Law Hard to Implement*, INTER PRESS SERVICE (May 19, 2014), http://www.ipsnews.net/2014/05/bolivias-mother-earth-law-hard-implement/ (discussing The Framework Law on Mother Earth).

160 Mari Margil, *Stories from the Environmental Frontier*, *in* EXPLORING WILD LAW, *supra* note 123, at 249, 249–53 (describing activities within the United States). *But see* Mark Hand, *The New Legal Threat to Environmental Attorneys: Sanctions from Judges and Attorneys General*, THINK PROGRESS (Feb. 5, 2018), https://thinkprogress.org/environmental-attorneys-under-attack-ed3c865aac4b/ (describing industry actions against towns and lawyers arguing right of sovereignty over local natural resources).

161 *See* Rikard Lalander, *Nature and the Indigenous Peoples in Bolivia and Ecuador: A Straitjacket for Progressive Development Politics?*, 3 IBEROAMERICAN J. DEV. STUDIES, no. 2, Oct. 22, 2014, at 148, 150–51, 162–65 (discussing some challenges with ecological constitutional law).

the information they will learn. Yet, the novelty of the issues might be an advantage in shedding embedded thinking about human superiority that could provide insights for dealing with more familiar problems on Earth. Humans certainly do not need to work out all details of Space Jurisprudence in advance if they embark on a track poised to rectify some key failures of law on Earth.

VII. ENVIRONMENTAL ETHICS BEYOND EARTH

A. Why Space Mining is Fundamentally an Issue in Environmental Ethics

Like all law, space law will ultimately imply judgments about what things have value and how values should be weighed in relation to each other. The Space Act grants exclusive commercial rights in extracted material from celestial bodies that have potential scientific and resource value to humanity as a whole. In this legislative scheme, the profitability of a few wealthy corporations that manage to develop the technology and resources to mine asteroids outweighs the interests of humans and nations lacking the capacity to explore celestial bodies at that level. The Space Act bypasses environmental issues in space mining, leaving an ethical cavern. Most importantly, the legislation ignores deeper questions about why humanity has despoiled the Earth despite rapidly increasing knowledge of the harms we are inflicting. Why is it that humans simply assume that outer space is our resource, which is there for us to exploit? What does that say about our sense of our relationship to the nonhuman world? If something in that outlook needs change, for the sake of human survival if not ethics, what traits should human individuals and societies try to develop that will establish more constructive attitudes in the new celestial world and possibly reorient attitudes at home? These are all core questions of environmental ethics.

B. Environmental Ethics as Earth-Centered

Much of environmental ethics is tethered to Earth. This is neither surprising nor parochial, given the numerous issues of great complexity on our planet and humans' relative unfamiliarity with worlds beyond. Still, the Space Act of 2015 shows that human-centric environmental ethics may soon lead us to wreak havoc on other worlds in addition to our own. The audacity of the Space Act shows how little consideration policymakers have given to their ethical obligations in space. Rather, people glibly assume that space is there to provide adventure, resources, and even substitute habitat if conditions worsen at home.

C. Environmental Ethics as Anti-Enlightenment

A barrage of accusations against humans has struck some as a denial of the special capacities of *homo sapiens*, particularly humans, to reason critically and modify their behavior for the betterment of the planet. Political scientists Lewis P. Hinchman and Sandra K. Hinchman have labeled this unforgiving critique of the human devastation of nature as anti-enlightenment environmentalism. In emphasizing negative ideas about people controlling and conquering the natural world from which they are separated and emotionally distant,[162] anti-enlightenment environmentalists refuse to recognize the more positive enlightenment ideas of tolerance, cosmopolitanism, individualism, and human rights.[163] For example, Murray Bookchin scorned environmentalists who worship nature and lack the courage to use their reason to resolve some of the political and social problems that he believed were at the root of environmental harms.[164] Critics such as Aldo Leopold rejected exclusive anthropocentrism but still accepted the importance of human morality evolving from a focus on social issues within human societies to membership in the broader ecological collective of the community of life.[165] Even ethicists who place central moral importance on the human impacts of environmental damage still recognize that plundering the environment is against long-term human interests.[166] Thus, critique of enlightenment excesses of human privilege remains vital.

D. Environmental Ethics as Life-Centered

"Non-anthropocentric" ethics that finds intrinsic value in nonhuman nature apart from its utility to humans has emphasized the value of living beings.[167] Much of the debate has centered on which nonhuman forms and scales of life have value because of, and apart from, their benefits to humans. Regarding forms, for example, is it sentient beings that deserve

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[162] Lewis P. Hinchman & Sandra K. Hinchman, *Should Environmentalists Reject the Enlightenment?*, 63 REV. POL. 663, 665–66 (Autumn, 2001).

[163] *Id*. at 665.

[164] Murray Bookchin, *Ecological Problems Are Social Problems*, CLIMATE & CAPITALISM (March 25, 2011), http://climateandcapitalism.com/2011/03/25/murray-bookchin-what-is-social-ecology/.

[165] Aldo Leopold, *Ecocentric Ethics: The Land Ethic*, *in* ENVIRONMENTAL ETHICS: READINGS IN THEORY AND APPLICATION 237, 239–40 (Louis P. Pojman et al., eds., 7th ed. 2017) [hereinafter ENVIRONMENTAL ETHICS].

[166] *See, e.g.*, Bryan G. Norton, *Environmental Ethics and Weak Anthropocentrism*, 6 ENVTL. ETHICS 131 (1984) (supporting reflective anthropocentrism that involves evaluation and selection among human preferences).

[167] *See, e.g.*, Paul Taylor, *Biocentric Egalitarianism*, *in* ENVIRONMENTAL ETHICS, *supra* note 165, at 177, 177–78.

moral consideration because of their capacity to experience pain and pleasure?[168] Or, does ethical status depend more broadly on consciousness of having a past and future and awareness of oneself as a "subject of life?"[169] Broader still, does any living being, including a plant, have ethical value because it has interests reflecting the nature of its species?[170] Regarding issues of scale, does life at a micro level, for example, micro-bacteria, have value because of capacities of creative adaptation?[171] This question becomes very important in the context of outer space, where the likely accessible forms of life are not complex or sentient.[172] Finally, on a macro level, can a functioning system have the self-generating qualities of life, such as reflected in the Gaia hypothesis that Earth is a self-regulating system?[173]

The contemporary field of environmental ethics has a distinctly life-centered bias that may render it less applicable in the few regions of outer space that are accessible. These places do not promise to hold sentient life, and almost certainly not life as complex as human.[174] Without critical examination applied to space contexts, this life-oriented bias might free space explorers from thinking they are under ethical constraints and encourage an unfettered human-centered attitude. Rocky asteroids might receive especially slight concern, since rocks are often considered the epitome of dead and valueless objects.[175]

Another scalar question in a life-centered framework is whether it is only individuals or also living systems that have value. Most life-based ethics are tied to the special value of living individuals, although the eligible individuals will differ according to varying criteria. In contrast, holistic life-centered ethics extend value to systems, with Gaia a large-scale extension to planet Earth and its regenerative processes as a whole.[176] Aldo Leopold's assertion that the land has collective value is a

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168 *See, e.g.*, Peter Singer, *A Utilitarian Defense of Animal Liberation*, *in* ENVIRONMENTAL ETHICS, *supra* note 165, at 96, 100 (sentience necessary for having interests).

169 Tom Regan, *The Radical Egalitarian Case for Animal Rights*, *in* ENVIRONMENTAL ETHICS, *supra* note 165, at 106, 111–12.

170 *See* Taylor, *supra* note 167, at 178–79.

171 *See* Holmes Rolston, III, *Naturalizing Values: Organisms and Species*, *in* ENVIRONMENTAL ETHICS, *supra* note 165, at 132–33 (discussing immunological memory, molecular clocks as creative adaptions important to living beings even though the beings do not value them).

172 *See* TYSON ET AL., *supra* note 138, at 156–57, 161–63 (discussing factors necessary for complex life and slim possibilities for locating intelligent beings).

173 LYNN MARGULIS, SYMBIOTIC PLANET (A NEW LOOK AT EVOLUTION) 114–15, 119 (1998) (explaining that Gaia is not a "single organism" but an "emergent property of interaction among organisms").

174 *See* TYSON ET AL., *supra* note 138, at 156–57, 161–63.

175 MILLIGAN, NOBODY OWNS THE MOON, *supra* note 13, at 106–07 (discussing view of rocks as "lifeless" and public's disappointment over no discoveries of life in space).

176 *See, e.g.*, MARGULIS, *supra* note 173, at 2.

prescient example of holistic environmental ethics.[177] Some early Western environmental ethicists claimed that the field was distinctive because of its emphasis on holistic concepts like species and ecosystems.[178] According J. Baird Callicott, traditional ethics do not apply well to environmental issues because of its focus on individuals acting alone or in human society, applying their reason.[179] Rather, systemic effects on collectives like species and ecosystems exemplify environmental considerations, even if this sometimes means that the individual must give way—deer must be culled to manage the herd.[180]

Another scalar perspective is temporal. Environmentalists emphasize that overuse of the Earth will lead to long-range, ripple effects on future humans and seemingly abstract matters such as loss of biodiversity. Although the scale of these concerns goes well beyond the present and individuals, the life-centered emphasis of prevailing environmental ethics remains. This core consideration may seem irrelevant to outer space as we can reach and know it. The probability of encountering contemporaneous life within our galaxy has appeared to wane with our increasing knowledge,[181] and the discovery goal has shifted more to the possibility of discovering past life on Mars or elsewhere.[182] Such a finding would not invoke typical ethical concerns about protecting living beings but would, instead, involve conserving things of historical and scientific value.[183] Of course, it may be probable that galaxies outside of the Milky Way hold complex life, but the limits of humanity make that discovery practically irrelevant since we cannot communicate beyond the speed of light and may never obtain access to more than a small slice of the universe.[184] Thus, policymakers might say that we should invoke space ethics only when and if we need it, rather than speculate on problems we might someday have.[185] Better to focus on the many known and intractable problems on Earth than to turn ethics into a fantasy pursuit, so the thinking goes.

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177 Leopold, *supra* note 165, at 239 (including "soils, waters, plants and animals, or collectively: the land").

178 *See, e.g.*, J. Baird Callicott, *The Conceptual Foundations of the Land Ethic*, *in* ENVIRONMENTAL ETHICS, *supra* note 165, at 248, 254.

179 *Id.* at 250–51.

180 *Id*. at 253–54 (individual welfare expendable for sake of community).

181 *See, e.g.*, J. Baird Callicott, *Moral Considerability and Extraterrestrial Life*, *in* BEYOND SPACESHIP EARTH, *supra* note 13, at 227, 242 (hypothesis of life not subject to confirmation). *See also* MILLIGAN, NOBODY OWNS THE MOON, *supra* note 13, at 135–36.

182 *See* MILLIGAN, NOBODY OWNS THE MOON, *supra* note 13, at 116–17 (discussing possibility of finding basic life, or evidence of past life, deep within Mars).

183 *Id*. at 123–24.

184 Callicott, *supra* note 178, at 240.

185 *Id*. at 242 (asking this question).

E. Life and Non-Life

All of this makes sense if life is all that counts ethically. Even if life counts most, exploring beyond our planet raises unsettling questions about the narrowness of current ethics. Space exploration might raise new ethical questions about the things we are seeking to reach and exploit.

Because recent space exploration suggests that no complex life resides on Mars (or probably on any accessible celestial body within the solar system), we are not likely to encounter extraterrestrial life, a la E.T., anytime soon. If life is present on Mars, it is probably microbial and embedded deep within the planet.[186] Such a discovery would not expose us to beings with sentience but would offer possible clues about the origins of all life and the beginnings of our solar system.[187] Traces of life would be worth preserving not so much to promote its interests or purposes but as a source of vital and possibly irreplaceable information. In that sense, life would be important but possibly only for instrumental purposes.

Or, perhaps microbial life discovered deep within Mars would have intrinsic value simply because it is life. That would be an ethic that values life well beyond sentience,[188] or the capacity of a living individual to have interests related to its biological nature,[189] and it would be closer to a view that all of nature objectively has inherent value.[190] Yet, microbes on Earth do not have moral standing in most ethical views, despite growing knowledge about their vital role in all earthly processes and systems.[191] When microbial life threatens human well-being, scientists demonstrate little compunction about suppressing and even eradicating it. Thus, the ethical starting place seems to be that the special status of celestial microbes is related to their unknown features more than any inherent value of this form of life. If so, any judgment of intrinsic value would be provisional and weak, and the most evident reasons for preserving newly discovered forms of life would be related to the importance of acquiring unique knowledge that may help us to understand the origins of the universe, life, or myriad other matters.

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186 MILLIGAN, NOBODY OWNS THE MOON, *supra* note 13, at 123–24.

187 Gbenga Oduntan, *Who Owns Space? US Asteroid-Mining Act Is Dangerous and Potentially Illegal*, THE CONVERSATION (Nov. 25, 2015), http://theconversation.com/who-owns-space-us-asteroid-mining-act-is-dangerous-and-potentially-illegal-51073 (arguing that Space Act threatens the "cradle of nature" with information about origins of Earth and humans).

188 *See, e.g.*, Singer, *supra* note 168, at 75 (ethical consideration based on sentience).

189 *See, e.g.*, Taylor, *supra* note 167, at 206–07 (living individual right to pursue interests of biological being of its kind).

190 *See* Rolston, *supra* note 171, at 105, 117 (objective value in creative and self-organizing nature).

191 *See* MILLIGAN, NOBODY OWNS THE MOON, *supra* note 13, at 118.

The physical context in which the earliest forms of life are discovered is generally not itself living—microbes are likely embedded in rocks, and rocks are considered dead objects. An object's status as "not living" should not be equated with being "lifeless," however, because this attitude does not reflect the caution appropriate for a "cradle of nature"[192] that possibly contains unique and irreplaceable information. Referring to asteroids as lifeless rocks devalues them and makes their plunder appear harmless. Scientists have found some of the oldest ingredients of potential life in off-Earth discoveries of "lifeless" rocks, including NASA exploration of the largest asteroid, Ceres.[193] Another object from Mars that potentially revealed fossilized life in bacterial form arrived as a meteorite,[194] a smaller piece of an asteroid or other celestial body that breaks off and survives the fall to Earth.[195] Thus, the *context* of life is not confined to Earth and includes even "lifeless" rocks like asteroids. Rocks may not be living, but they may contain vital information about the features of early life and how it developed. Importantly, the line between life and non-life is not morally decisive when we view objects as providing insight into the universe.

F. "Last Person Vandals"

What then are our duties to celestial objects that do not directly live or support life? Apart from important instrumental reasons for protecting potential evidence of life on asteroids, and the absence of any evident sentient beings in need of protection, philosophers have struggled with hypothetical questions such as whether it would be wrong for the last existing human to destroy an unoccupied inanimate celestial body, or some earthly object, if no one faced harm.[196] Such questions are neither

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192 Oduntan, *supra* note 187.

193 *See, e.g.*, Monica Grady, *Organic Molecules Found on Giant Asteroid Ceres—Why That's Such a Huge Deal*, THE CONVERSATION (Feb. 16, 2017), https://theconversation.com/organic-molecules-found-on-giant-asteroid-ceres-why-thats-such-a-huge-deal-73147 (organic compounds most likely original to Ceres are similar to ingredients that led to chemical formation of life on Earth).

194 Lisa Zyga, *New Study of Meteorite Provides More Evidence for Ancient Life on Mars*, PHYS.ORG (Dec. 17, 2009), https://phys.org/news/2009-12-meteorite-evidence-ancient-life-mars.html (new technology suggesting that structures observed in the meteorite from Mars are probably of bacterial rather than inorganic origin).

195 *Asteroid or Meteor: What's the Difference?*, NASA SPACE PLACE, https://spaceplace.nasa.gov/asteroid-or-meteor/en/ (last updated Apr. 5, 2017).

196 Richard Routley posed similar questions in a talk to a group of philosophers in 1973 with the aim of showing that traditional human-centered ethics could not provide an adequate foundation for environmental ethics. Richard Routley, *Is There A Need for A New, An Environmental, Ethic?*, *in* PROC. OF THE XVTH WORLD CONGRESS OF PHIL.; 17TH TO 22ND SEP., 1973, VARNA, BULG. 205–10 (Sofia Press, 1973). *See also* MILLIGAN, NOBODY OWNS THE MOON, *supra* note 13, at 31, 99 (discussing intuitive force of last person arguments).

literal nor unreasonably speculative; they are rather a way to test ethical intuitions about inanimate things we neither know nor appreciate. Such questions provide a way to examine beliefs about whether we owe any obligations to such non-living things. The following two subsections provide alternative but related approaches to this question.

1. Virtue Ethics

Such an act of destruction seems immoral to some, despite a guarantee of no harmful consequences.[197] Some people argue that the act is analogous to vandalism, involving wanton destruction for no good reason[198] and showing meanness of spirit in the deliberate infliction of gratuitous harm. The act also reflects the flawed character of a person who has no sense of self-restraint. Such reasoning implicates virtue ethics, the field of moral philosophy that places more importance on people's traits, and how to cultivate them, than on right action, with the guiding idea that the person of good character is likely to act well much of the time.[199]

Why should we care about the character of the last human? Consider how relatives across generations feel shame for the horrors dead family members unleashed, even though the distant relatives bore no responsibility for those travesties. For example, the descendants of slave owners have expressed feelings of transposed accountability for the acts of their slave-holding ancestors.[200] In those cases, descendants might feel shame because others are around to judge their family history, unlike the last person in the original hypothetical who judges only himself or herself. On a virtue ethics analysis, however, this self-appraisal matters because the worth of a person emerges from patterns of conduct and motivations throughout one's life, and the cultivation of one's own character is one of the purposes of a good life.[201]

Carrying the destruction hypothetical over to activities in space at least suggests that tampering with space has ethical implications apart from repercussions on Earth. Even absent destruction, a virtue ethicist could argue that a space visitor who has the intention of mining celestial bodies

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197 *See* Routley, *supra*, at 207 (recognizing the wrong without committing to "esoteric values").

198 *See, e.g.*, MILLIGAN, NOBODY OWNS THE MOON, *supra* note 13, at 97.

199 *See, e.g.*, ROSALIND HURSTHOUSE, ON VIRTUE ETHICS 1–3, 108 (1999) (moral philosophy addressing motives, emotions, and character). CHRISTINE SWANTON, VIRTUE ETHICS: A PLURALISTIC VIEW 19, 20–22, 26 (2003) (defining virtues as dispositions toward responding sensitively to the world).

200 *See, e.g.*, EDWARD BALL, SLAVES IN THE FAMILY 14 (1998) (describing feelings of accountability for his family's slave-owning history and shame for the post-slavery "broken society").

201 *See* HURSTHOUSE, *supra* note 199, at 10 (virtue related to personal "well-being").

for commercially valuable resources disrespects unexplored terrain that may contain important scientific information,[202] disregards other people and countries that lack the capital to conduct such expensive exploration and extraction,[203] and displays arrogance about unlimited property acquisitions of humans who happen to make a discovery first.[204] Such behavior might demonstrate hubris about the knowledge and capacities humans have to utilize the untapped universe[205] and reckless defiance of grave environmental and safety risks.[206] The potential vices in those who seek to exploit space resources do not necessarily settle the matter from a virtue ethics perspective, however.

In fact, the proponents of asteroid mining are not shy about making virtue-based arguments of their own. Addressing the charge that would-be miners like John Lewis, chief scientist of Deep Space Industries, are "crazy," Rick Tumlinson, cofounder of Deep Space Industries, asserts: "This is the kind of crazy that applies thought and imagination to observations of the real world, inventing new ways to defend ourselves or to increase the abundance of our vital supplies—by using the tools available in crazy new ways."[207] Tumlinson lauded the Space Act for, "the opening of space to the people."[208] Peter Diamandis, cofounder of Planetary Resources, takes the populist appeal a step further, asserting that we have a "moral obligation to become an interplanetary species . . . ."[209] Jim Benson, a proponent of commercial space development, is more straightforward about his perceptions of the *companies'* deserved benefits: "[W]e took the risk, we paid the money, we flew our spacecraft, and we analyzed the content and the value of that asteroid. We landed on it. It's ours."[210]

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202 *See* Oduntan, *supra* note 187.

203 Outer Space Treaty, *supra* note 2, art. I.

204 This criticism implicates the earlier considered view that the first in time and first discovery principles of property ownership that the Space Act of 2015 revives are not viable on our planet with increasing scarcity, let alone in new worlds largely undiscovered. *See supra* Part V.B. The author argues that it is foolhardy to reinstate principles off-Earth that wreaked so much historical damage to the people and the environment here.

205 *See* Sparrow, *supra* note 34, at 176 (describing hubris as excessive pride in human abilities).

206 ARNOULD, *supra* note 13, at 34 (interpreting the Greek myth of Icarus as a story of the prideful incaution of youth, rather than hubris).

207 Rick N. Tumlinson, *Preface* to LEWIS, *supra* note 5, at 2.

208 Victoria Turk, *The US Says Asteroid Mining Is Legal for Americans. What about Everyone Else?*, VICE MOTHERBOARD BLOG (Dec. 1, 2015), https://motherboard.vice.com/en_us/article/ezp4yk/the-us-says-asteroid-mining-is-legal-for-americans-what-about-everyone-else.

209 Rachel Riederer, *Silicon Valley Says Space Mining Is Awesome and Will Change Life on Earth. That's Only Half Right*, THE NEW REPUBLIC (May 19, 2014), https://newrepublic.com/article/117815/space-mining-will-not-solve-earths-conflict-over-natural-resources.

210 *Voyage to the Milky Way* (Pub. Broad. Serv. television broadcast May 19, 1999).

As virtue-based justifications go, these self-perceptions of altruism ring hollow as genuine virtues. The private explorers do take financial risks and deserve some respect for being first to innovate in this manner. Yet, these distinctions do not justify the Space Act in bestowing unfettered property rights short of outright ownership of celestial bodies. The Space Act's framework for mining asteroids does nothing to encourage, let alone ensure, that benefits will accrue to anyone but the corporate miners who first reach an asteroid. To Americans, the virtues of heroism, adventure, and courage in the face of risk have particular resonance with national frontier history and the pioneers who bravely penetrated the New World. Yet, those virtues should not overshadow the environmentally destructive and genocidal features of that venture.[211] The ambitious asteroid miners possessing the resources and expertise to exploit space for profit are risking the destruction of vital information about the evolution of the universe and of irreplaceable and unique material, possibly including forms or residues of life about which we know almost nothing. Virtue analysis therefore weighs strongly against this venture.

2. Value Ethics

Another ethical perspective on inanimate objects has to do with how we value them. A deeply embedded strain of Western thought treats the natural world as essentially valueless in itself, but susceptible to acquiring value through human perceptions and activities. According to John Locke, "Nature and the earth furnished only the almost worthless materials as in themselves;"[212] rather, "[i]t is labour, then, which puts the greatest part of value upon land, without which it would scarcely be worth anything . . . ."[213] This split between human value and the rest of nature infects American property law down the ages. Making the land productive and economically valuable are core values of the Western ideology, as argued earlier,[214] and it is time to realign commitments more toward serving community values[215] and respecting the "land" itself.[216]

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211 *See* William Cronon, *The Trouble with Wilderness; or, Getting Back to the Wrong Nature*, *in* UNCOMMON GROUND: RETHINKING THE HUMAN PLACE IN NATURE 79 (William Cronon ed., 1996) (noting that this cultural history erases the conflict and violence toward Indian people who were ousted from their home places).

212 Locke, *supra* note 88, para. 43.

213 *Id.*

214 *See supra* Part V.A.

215 *See* State v. Shack, 277 A.2d 369, 372 (N.J. 1971).

216 *See* Freyfogle, *supra* note 123, at 276–78.

To environmental ethicist Holmes Rolston III, value "is present in living organisms and their species lines."[217] For Rolston, "[a] sentient valuer is not necessary for value."[218]

Value is present in creativity, including living beings, species maintaining enduring identity, and in planetary history.[219] Rolston warns of "Earth chauvinism,"[220] emerging from the recognition of the stunning natural coincidences that make Earth uniquely suitable as the planetary home of life.[221] He discovers value in productive creativity and randomness as a formative principle of creativity, and diversity.[222] He also recognizes the aesthetic and wondrous values of particular space features, such as canyons.[223]

Critics say that a human perceiver capable of valuation projects value on nature, so the idea of independently valuable nature makes no sense.[224] Although philosopher J. Baird Callicott rejects the idea of objective value independent of the observer, he finds a "functional equivalent" in ethical consensus, attributed to natural selection through evolution.[225] Consensus is a fragile basis for valuing outer space enough to protect it. It has not succeeded in preventing the ravishing of Earth despite a shared sense of urgency to protect it. Perhaps more thorough education about the pre-chemical origins of life in processes far distant in time and foreign to our experience would help humans to appreciate Rolston's more abstract approach. Motivating people to question the rights granted to corporations by the Space Act of 2015 is challenging, given the multitude of problems humans face on earth. We may already be buckling under that "bone-weariness" that Al Gore described, given the strains of climate change and other major environmental challenges.[226] Still, if we do not pause soon to consider the appropriate human place in outer space, a rapidly evolving extractive stance will be upon us before we have a chance for appraisal.

One other way to find value in the Earth and beyond may be through appreciation of the strikingly coincidental emergence of our planet and life itself. Here virtue and value ethics intertwine. Gratitude can be a

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217 Rolston, *supra* note 171, at 105, 106.

218 *Id*. at 111.

219 *Id*. at 117.

220 Holmes Rolston, III, *The Preservation of Natural Value in the Solar System*, *in* BEYOND SPACESHIP EARTH, *supra* note 13, at 154.

221 *Id*. at 150–52.

222 *Id*. at 157–61.

223 *Id*. at 155–56.

224 *See, e.g.*, Ned Hettinger, *Comments on Holmes Rolston's 'Naturalizing Values'*, *in* ENVIRONMENTAL ETHICS, *supra* note 165, at 144, 145 (overly straining idea of value).

225 J. BAIRD CALLICOTT, IN DEFENSE OF THE LAND ETHIC 164 (1989).

226 GORE, *supra* note 144, at 241.

motivating emotional virtue even without a particular benefactor.[227] Environmental gratitude responds to the natural world as a source of mystery, wonder, and awe that both connects humanity to the wider universe and shrinks the human role within it.[228] In this vein, Thomas Berry argues that people today live in a "moment of grace," defined as a transitional time with an undefined direction.[229] This is not a time of complacency or repose. Birth in the modern world carries grave duties, and people have no choice but to accept these or face destruction.[230] Earth is on the brink because of centuries of distorted vision, supported by powerful systems of economics and law, that reinforce the notion that nature is merely a human resource and endlessly available for human use. Berry's "great work" involves disrupting these models to respect the rights of natural beings, systems, and processes.[231] Finding support for this expansive sense of value in the origins of the universe, Berry tells a unifying origin story of planet formation and life from common processes and materials, despite the idiosyncratic coincidences that also created astonishing diversity within our galaxy.[232] Interestingly, Berry does not extend the great challenge beyond Earth, although he taught about the interconnection and value of all things in the universe.

G. Stranger Ethics and Space

Curiously, many proponents of ecological jurisprudence emphasize place and attachment ethics as a way to foster priority for Earth and its systems.[233] Because environmental ethics on Earth involves some abstraction, emphasis on particular places[234] and on Earth as home can be an effective source of motivation.[235] Since contemporary ethics appeals

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227 Reed Elizabeth Loder, *Gratitude and the Environment: Toward Individual and Collective Ecological Virtue*, 10 J. JURIS. 383, 384, 403, 406–14 (2011) ("diffuse gratitude" for environment as teacher, healer, source of inspiration, attachment to place, material sustainer, and being).

228 *See id*.

229 BERRY, THE GREAT WORK, *supra* note 11, at 196.

230 *Id*. at 200–01.

231 *Id*. at 7.

232 *See id*. at 22, 25–29.

233 *See, e.g.*, CULLINAN, WILD LAW, *supra* note 11, at 82 (describing "intimate" relationships of mutually important connectivity). Joel Catchlove, *Place as Inspiration*, *in* EXPLORING WILD LAW, *supra* note 123, at 97, 99, 102 (describing deep connections with particular places). Peter Burdon, *The Great Jurisprudence*, *in* EXPLORING WILD LAW, *supra* note 123, at 66 (principles of ecology, or "study of organisms 'at home,'" less abstract and "overwhelming" than law of nature).

234 *See, e.g.*, Thomas Moore, *Ecology: Sacred Homemaking*, *in* THE SOUL OF NATURE: CELEBRATING THE SPIRIT OF THE EARTH 137, 137–39 (Michael Tobias & Georgianne Cowan eds., 1996). Mark Sagoff, *Zuckerman's Dilemma*, 21 HASTINGS CTR. REP. 32, 35–36 (Sept.–Oct. 1991) (discussing non-instrumental reasons for saving the Chesapeake Bay).

235 *See, e.g.*, Sallie McFague, *A Square in the Quilt*, *in* SPIRIT AND NATURE: WHY THE ENVIRONMENT IS A RELIGIOUS ISSUE 41, 56 (Steven C. Rockefeller & John C. Elder eds., 1992)

to an emotional as well as rational component,[236] the limits of an individual's psychological capacities to care and time available to reflect, restrict the effectiveness of this ethical approach.[237] While outer space ethics may offer a nearly blank slate to deliberate, and the potential to shatter some constrictions of ethical thinking that have failed to prevent serious environmental harms, humans face such grave and pervasive problems on Earth that off-Earth ethics may seem indulgent.

Still, we do not know the extent to which destructive actions in space may affect Earth in unanticipated ways. Nor can we foresee how our actions may deprive humanity of opportunities for a flourishing future. Lessons learned from a more holistic and decentered off-Earth ethic may help us to change habits before it is too late. Of course, those setting out to exploit space would respond that humanity needs access to abundant new resources and the exciting information to be gained by exploration of deeper space[238]—all of which can be acquired without harming living beings.

Educating people about the common origins of the universe, including life, may be the best response to such arguments and a step towards developing off-Earth ethics. Still, it is challenging to encourage a bioregional or place-based ethic toward space since so few have ventured there and we know so little about it. Affection for place is not likely to spread into a wider environmental ethic in the same way that Thomas Berry's love for the meadow beyond his house expanded,[239] or British writer Michael McCarthy's recollection of the Dee estuary he hiked as a child enlarged.[240] We do have some limited, common experiences with moon landings, and even the tragedy of the Space Shuttle *Challenger* indelibly marks our history and culture. The first photos of Earth from space are a kind of family album that teaches about the fragility and uniqueness of our home[241] and also about its connection to the rest of the galaxy.

[hereinafter SPIRIT]. Tenzin Gyatso, His Holiness the 14th Dalai Lama, *A Tibetan Buddhist Perspective on Spirit in Nature, in* SPIRIT, *supra*, at 109, 117.

[236] *See, e.g.*, NEL NODDINGS, CARING: A FEMININE APPROACH TO ETHICS AND MORAL EDUCATION 30, 33, 34 (1984) (emotional and motivational components of ethics important but not exclusive).

[237] *Id.* at 47, 51, 89–90 (limits to burdens of universal caring).

[238] *See, e.g.*, LEWIS, *supra* note 5, at 37, 99, 109, 126, 138 (asteroids useful for scientific information, life support in space, metals, rocket fuel, and increased access to space).

[239] BERRY, THE GREAT WORK, *supra* note 11, at 12–13.

[240] MICHAEL MCCARTHY, THE MOTH SNOWSTORM: NATURE AND JOY 12 (2015) (seeking birds and discovering wilderness).

[241] *See, e.g.*, Erin Blakemore, *Fifty Years Ago, This Photo Captured the First View of Earth From the Moon, and Earth's View of Itself Changed Forever,* SMITHSONIAN.COM SMARTNEWS (August 23, 2016), https://www.smithsonianmag.com/smart-news/fifty-years-ago-this-photo-

To protect space, however, we must recognize that not all of space ethics can emerge from familiarity, memory, or affection for things of our experience apart from scanty relational stories and artifacts. For instance, when I began reading about asteroids, I thought of them as rocks, and of rocks as the epitome of non-living things. I no longer can make such stark distinctions having learned that these, and other space rocks, sometimes contain fossilized information about the earliest ingredients of life. I have not come to love rocks in the way I do nonhuman animals, for example, but I cringe to think of one being harpooned or lassoed as a first step in harvesting its water and minerals for profit.[242] Respect is the appropriate attitude for things simply existing, and plunder is the epitome of disrespect.

This is not to conclude that an ethic of respect must be too measured or distant. Ecofeminist Karen Warren illustrates this in her narrative of rock climbing: "I realized then that I had come to care about this cliff which was so different from me, so unmovable and invincible, independent and seemingly indifferent to my presence."[243] Although I do not expect ever to draw near to an asteroid, I can respect its integrity enough to think an extraction free-for-all should be against the law. The methods are crude, the results unpredictable, and it is hard to imagine competing companies doing this without conflict. If a system of property rights for asteroid exploration is developed, it should be minimally compatible with international principles of common benefit and should be crafted with abundant caution.

More generally, a commonsensical "do no intentional or foreseeable harm" ethic should guide space exploration, just as it does for vehicle operators, archeologists, bird watchers, and hikers who enter lightly or untrammeled earthly places. Yet, a negative "do no harm" ethic is not comprehensive enough because it does not set forth duties owed to others or benefits one should bestow if able. Some "stranger ethics" do have affirmative components. For example, Peter Singer argues that every person has a duty to donate a portion of income to unknown people who lack food and basic resources if doing so will not compromise his or her personal or family well-being.[244] Albert Schweitzer argued that everyone has some obligations to assist living beings when possible—for example,

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captured-first-view-of-earth-from-the-moon-180960222/ (describing lunar photos from the first black and white image in 1966).

[242] *See supra* notes 84–86, and accompanying text.

[243] Karen Warren, *The Power and Promise of Ecological Feminism, in* ENVIRONMENTAL ETHICS, *supra* note 165, at 395.

[244] *See* Peter Singer, *Rich and Poor, in* ETHICS ACROSS THE PROFESSIONS: A READER FOR PROFESSIONAL ETHICS 382, 384–385, (Clancy Martin et al., eds., 2d ed. 2017).

by rescuing an insect from a pool of water.[245] Singer's ethic begins with sentient beings capable of suffering,[246] while Schweitzer's is based on overall "reverence for life."[247] The two views share empathy for life.

One might also conceive of an affirmative "stranger ethic" that is not life-centered, but its pull would be weaker. For example, hikers' codes ask the hiker to pick up refuse, even that of others, out of respect for the land.[248] A casual walker might do this reflexively to correct observed degradation and improve a place that he or she most likely will never see again. Noticing a birch limb bent over with snow might prompt someone on snowshoes to shake off the load lest the branch break, or a desert visitor to shade a small and rare pool of water. People gather to clean beaches and waters of detritus, human caused, or not.

An ethic extended to celestial bodies would most likely be based on a similar respect for natural objects and mostly involve a call for restraint in interference. This certainly would not prevent humans from stopping an asteroid headed for a collision with Earth,[249] or from exploring deeper space with the support of asteroid water;[250] stopping a collision is planetary self-defense and using some water to facilitate further exploration increases understanding of the universe and its wonders.

Given what we know now, it is unlikely that we would owe many affirmative duties to space objects, but that could change with increasing familiarity if necessary to fix human damage, or even possibly to "improve" an observed state produced by destructive forces such as radiation. Still, we should not scorn planets like Venus knowing of its scorching, radioactive environment that could never accommodate human or other familiar life.[251] It would be "Earth chauvinism"[252] to measure the interest and values of celestial places in human terms. The astonishing aspects of space include its stark diversity and unfathomable differences from what we know, not its comparisons to our habitable human world. This nonhuman character and unfitness is itself a source of wonder, mystery, and respect.

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245 Albert Schweitzer, *Reverence for Life*, *in* ENVIRONMENTAL ETHICS, *supra* note 165, at 171.

246 Singer, *supra* note 168, at 100.

247 Schweitzer, *supra* note 245, at 171–72.

248 *See, e.g.*, *The Leave No Trace Seven Principles*, LEAVE NO TRACE CENTER FOR OUTDOOR ETHICS, https://lnt.org/learn/7-principles (last visited Feb 23, 2018).

249 *See, e.g.*, Valerie A. Olson, *Political Ecology in the Extreme: Asteroid Activism and the Making of an Environmental Solar System*, 85 ANTHROPOLOGICAL Q. 1027, 1037–38 (2012) (describing need and effort to predict and prevent impacts of celestial bodies with Earth).

250 *See* LEWIS, *supra* note 5, at 99, 106, 127 (water necessary for life support in space).

251 TYSON ET AL., *supra* note 138, at 132 (describing high temperature and atmosphere of carbon dioxide on Venus).

252 Rolston, *supra* note 220, at 154.

Because we will inevitably learn more about the moons of planets, probably land a person on Mars, and discover more about water and possible past life on that planet, less distant, place-based ethics may become increasingly relevant over time. If so, a space ethic will combine "stranger" components of awe, wonder, and respect with something like the attachment and caring orientation of place ethics. As we shall see next, some indigenous worldviews display simultaneous attachment to place and the wider universe, including the heavens. These stories and beliefs might illustrate how it is possible to follow a local ethic that also encompasses connection to the universe.

The Native American Graves Protection and Repatriation Act,[253] ("NAGPRA"), protects the rights of Indian tribes, lineal descendants, and Native Hawaiian groups to cultural items, including sacred places, requiring agencies, such as the National Park Service to review claims of cultural patrimony regarding park recreational uses.[254] When the National Park Service was developing a Climbing Management Plan for Devils Tower National Monument in Wyoming, it received complaints from Plains Indian tribes that the "Tower," a natural butte of volcanic rock,[255] was important to the ancestral history and spiritual practices of the tribes and that recreational rock climbing on the butte was disrespectful.[256] An Ethnographic Review Report prepared pursuant to NAGPRA found that from six to twenty-three tribes considered the Black Hills as their ancestral homeland,[257] and several had developed similar creation stories about the rock's origins that had passed down orally through the generations.[258] N. Scott Momoday relates the Kiowa creation story of the "Tower" that expresses strong links through ancestry between the local place and the stars:

> Eight children were there at play, seven sisters and their brother. Suddenly the boy was struck dumb; he trembled and began to run upon his hands and feet. His fingers became claws, and his body was covered with fur. Directly there was a bear where the boy had been. The sisters were terrified; they ran, and the bear after them. They came to the stump of a great tree, and the tree spoke to them.

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253 25 U.S.C. § 3001 *et seq.* (2012).

254 *Id.* § 3002.

255 NAT'L PARK SERV., DEVILS TOWER GEOLOGY (2018), *available at* https://www.nps.gov/deto/planyourvisit/upload/Geology-2017.pdf.

256 Jeffrey R. Hanson & David Moore, *Ritual and Recreational Perception and Use at Devils Tower National Monument: An Applied Ethnographic Study* ii, 1, 53 (March 17, 1993) (unpublished study prepared for the Nat'l Park Serv. pursuant to Cooperative Agreement CA 1268-2-9006) (on file with author).

257 GEORGE L. SAN MIGUEL, NAT'L PARK SERV., HOW IS DEVILS TOWER A SACRED SITE TO AMERICAN INDIANS? 1 (Aug. 1994) (ethnographic review).

258 *Id.* at 1–4.

> It bade them climb upon it, and as they did so it began to rise into the air. The bear came to kill them, but they were just beyond its reach. It reared against the tree and scored the bark all around with its claws. The seven sisters were borne into the sky, and they became the stars of the Big Dipper.[259]

According to Momoday, "From that moment, and so long as the legend lives, the Kiowas have kinsmen in the night sky."[260]

Another example of human connection between heaven and Earth is the New Zealand Maori story that explains the origin of the tangible world through physically united parents whose children pried them apart so that father Ranginui became the sky and mother Papa-tu-a-nuku formed the Earth, letting forth light into darkness.[261] Their children were wind, forest, plants, sea, rivers, and animals, who bore great responsibilities to tend the land and people, and preserve the balance and wellness of systems and processes.[262] These insights about interrelationships throughout the universe may show remarkable prescientific ecological knowledge. They also illustrate how emotional connections can span otherwise unfathomable distance and support an ethic that transcends Earth without the alienation that worried Hannah Arendt.[263]

VIII. ECOLOGICAL JURISPRUDENCE AND COSMIC ETHICS

The ecological approach to ethics and law naturally extends beyond Earth. So-called "Earth Jurisprudence" is founded on a broader connection to the universe beyond, acknowledging astronomical knowledge of the Big Bang, other celestial bodies, and life from a supernova star collapsing in on itself and dispersing neutrinos in a moment of massive violence.[264] Knowing that the composition of stars shares the elements that compose life supports a world-view not unlike that of some indigenous people. Science tells us of this link across time and space, but we are stuck on planet Earth in our ethical frame. As

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[259] N. Scott Momaday, *The Way to Rainy Mountain*, *in* NATIVE NORTH AMERICAN LITERARY COMPANION 327, 330, (Joseph Bruchac ed., 1998).

[260] *Id.*

[261] Garth R. Harmsworth (Te Aeawa, Ngati Tuwharetoa, Nagati Raukawa), Shaun Awatere (Ngati Porou), *Indigenous Māori Knowledge and Perspectives of Ecosystems*, *in* ECOSYSTEM SERVICES IN NEW ZEALAND 274, 275 (John Dymond ed., 2013).

[262] *Id.*

[263] *See* ARENDT, *supra* note 121, at 266–67, 270–72 (describing alienation of humans and loss of stature with universe, not Earth, as center of things).

[264] *See, e.g.*, BRIAN SWIMME & THOMAS BERRY, THE UNIVERSE STORY: FROM THE PRIMORDIAL FLARING FORTH TO THE ECOZOIC ERA—A CELEBRATION OF THE UNFOLDING OF THE COSMOS 48–49 (1992).

Thomas Berry urges, an "intimate rapport with the Earth community and the entire functioning of the universe" can restore humanity's place on the planet.[265] In healing the planet, people must tap "that same power that brought the Earth into being, that power that spun the galaxies into space, that lit the sun and brought the moon into its orbit."[266]

It is time to expand our ethical framework, not leaving Earth behind, but preventing humanity from transporting planetary damage throughout the universe. The Space Act of 2015 projects our flawed institutions and sense of ourselves into a new arena. International law sets a cooperative tone for a more thoughtful view of our place in the heavens that could improve faulty ideas about ownership and ethics that have dominated far too long. Now is a "moment of grace," to borrow Thomas Berry's phrase,[267] not just to remake Earth but also to create new ideals for the space beyond Earth we hardly know. This push outward might just make the "great work" at home easier to imagine.

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265 BERRY, THE GREAT WORK, *supra* note 11, at 19.

266 *Id.* at 175.

267 *Id.* at 196–97.