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# Private Property Rights and the Public Interest in Exploration of Outer Space

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## Abstract

The impending missions to exploit natural resources of celestial bodies may at some point start interfering with the scientific interests, including those of astrobiology, in these bodies. While the legal status of celestial bodies at the highest level is clear, uncertainty has arisen as to the extent private property rights over such objects or over their resources are legally acceptable, legally impossible, or potentially legal. This also provides for a considerable amount of uncertainty regarding how the legal framework could or may need to be changed to accommodate private interests. The article analyzes the two main international treaties relevant from this perspective, as well as their backgrounds, in order to outline the current legal status of celestial bodies and the resulting legal rights and obligations pertinent to both private exploitation and exploration. Based on such an analysis, it concludes by highlighting an approach that could actually incentivize the private sector and the science community to work together in a manner conducive to their interests in exploitation and exploration respectively.

**Keywords:** celestial bodies, global commons, Moon Agreement, natural resource exploitation, Outer Space Treaty, private property rights, public international law, scientific exploration

## Introduction

Over the last few years (at least) two serious US companies, Planetary Resources, Inc., and Deep Space Industries,<sup>1,2</sup> have announced plans to develop space missions intended to harvest water and valuable minerals from asteroids. They aim to either bring certain rare and precious mineral resources back to earth or use them in space for further space projects—whether their own or those of others interested in buying such materials, whether unprocessed or processed. In particular, water, as a crucial element both for rocket fuel and for sustaining human life anywhere, might come to be used in outer space itself rather than be brought back to earth. Water is also considered the most likely if not indeed indispensable environment for any extraterrestrial life, and consequently at the same time represents a target of major scientific interest and exploration, especially for astrobiology and the search for extraterrestrial life.

Water is where private interests in space resource utilization and public interests in the exploration of outer space might interact and possibly even interfere with each other. The likelihood of potential overlap is outside the scope of this contribution, which aims to discuss legal dimensions that thus far govern the private property rights of commercial enterprises and the public interest, represented in scientific and governmental institutions, in the exploration of outer space.

The plans of Planetary Resources and Deep Space Industries were given a first legal basis by the US government when it enacted, in November 2015, the Commercial Space Launch Competitiveness Act (2015), Title IV of which addresses “Space Resource Exploitation and Utilization.” The United States is not the only country interested in legislating such ventures favorably; notably Luxembourg has recently announced “it would seek to jump-start an industrial sector to mine asteroid resources in space by creating regulatory and financial incentives,”<sup>3</sup> and also the United Arab Emirates are clearly interested in this new sector.<sup>4</sup> These developments come on the heels of discussions regarding ordinary individuals making surreal claims of ownership of the Moon and other celestial bodies and selling plots to other individuals. One such mala fide US entrepreneur has made a fortune already (von der Dunk et al. 2004).

Thus, worries may arise in some quarters of the international community that exploiting the global commons of outer space for commercial purposes would also have a (potentially detrimental) effect on missions exploring the cosmos scientifically, including when it comes to the possibilities of life in outer space—especially where water is concerned. The question also arises as to how the legal regime applicable to both scientific exploration and commercial exploitation of outer space resources has achieved a proper balance between these two categories of space activities.

This article presents an effort to analyze precisely such legal aspects. I briefly summarize the relevant key aspects of international space law as acknowledged by all spacefaring nations. These laws address the legal status of outer space and the celestial bodies orbiting in it, and the paramount provisions on exploration and use for the benefit of all mankind, with a specific focus on efforts to exploit natural resources available there, whether for private or for public purposes. I also assess the legal impact of the aforementioned US Act in this framework, as well as the possible consequences it might entail for the exploration

of outer space from the perspective of space science broadly speaking, including astrobiology. This analysis will allow for some conclusions as to how public interests in the exploration of outer space for useful purposes could be protected and even further enhanced, in the context of such private commercial endeavors.

### **The Outer Space Treaty, Exploration, and Exploitation**

While international space law, at least as far as the key treaties were concerned, did not explicitly or specifically address the commercial exploitation of outer space, it did prominently reference scientific exploration, as essentially one of the broad rationales for the 1967 Outer Space Treaty (Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, including the Moon and Other Celestial Bodies), the framework treaty providing the general legal framework for all space activities (von der Dunk 2015a, pp. 44–49).

Thus, the Outer Space Treaty proclaims that “[t]here shall be freedom of scientific investigation in outer space, including the Moon and other celestial bodies, and States shall facilitate and encourage international cooperation in such investigation” (Article I, Outer Space Treaty). Furthermore, “[i]n the exploration and use of outer space, including the Moon and other celestial bodies, States Parties to the Treaty shall be guided by the principle of cooperation and mutual assistance” (Article IX, Outer Space Treaty), and “States Parties to the Treaty shall pursue studies of outer space, including the Moon and other celestial bodies, and conduct exploration of them so as to avoid their harmful contamination and also adverse changes in the environment of the Earth resulting from the introduction of extraterrestrial matter and, where necessary, shall adopt appropriate measures for this purpose” (Article IX, Outer Space Treaty; also Article X). Most specifically, activities perceived to potentially give rise to “harmful interference” with other legitimate space activities require consultations between all states concerned—which is interpreted by most as a *prohibition* of harmful interference unless, following such bona fide consultations, overriding reasons would tell against this (Marchisio 2009, pp. 179–182).

The freedom of use and exploration was fundamentally underpinned moreover by the prohibition on “national appropriation by claim of sovereignty, by means of use or occupation, or by any other means” (Article II, Outer Space Treaty). The applicability of (territorial) sovereignty in particular would have meant that the state in question would be entitled to determine the conditions for access by nationals and spacecraft of other states, or even to completely prohibit such access—whether for scientific explorative or commercial exploitative purposes. Instead, though the establishment of stations, installations, and space vehicles on celestial bodies is allowed, these “shall be open to representatives of other States Parties to the Treaty on a basis of reciprocity” and following reasonable advance notice (Article XII, Outer Space Treaty). Likewise, “there shall be free access to all areas of celestial bodies” (Article I, Outer Space Treaty).

Legally speaking, the absence of territorial sovereignty in outer space means that any claim of “ownership” over a celestial body is legally void, if not indeed a matter of fraud. Since a celestial body cannot be subjected to any single state’s territorial jurisdiction, also no single state’s domestic laws on how a private individual or company can come to own

a piece of “land” can apply on any celestial body (International Institute of Space Law). Such claims, by contrast, sow unnecessary uncertainty about the exact legal status of celestial bodies, and as they are effectively incompatible with the legal realm, should be refuted unequivocally.

Finally, with a view specifically to the interests of science and exploration, states have the obligation “to inform the Secretary-General of the United Nations as well as the public and the international scientific community, to the greatest extent feasible and practicable, of the nature, conduct, locations, and results of [peaceful space exploration] activities. On receiving the said information, the Secretary-General of the United Nations should be prepared to disseminate it immediately and effectively” (Article XI, Outer Space Treaty). While obviously broader than *scientific* results (read, scientific knowledge gained in the context of space activities) alone, science and humanity’s interests in advancing science figure prominently also in this context (Mayence and Reuter 2009, pp. 195–199). In other words: the Outer Space Treaty provides for a general obligation to share scientific knowledge gained by space activities with the rest of the world—at least in principle.

In stark contrast with “exploration” and “use,” phrases like “exploitation” or “commercial (use)” are completely absent from the Outer Space Treaty. Private entities were indirectly referenced once, as being subsumed under the concept of “nongovernmental entities” whose activities in outer space would give rise to the international responsibility of the state concerned for compliance of such activities with international space law (Article VI, Outer Space Treaty). At the time of drafting, the possibility of commercial exploitation of outer space broadly speaking was simply not taken into consideration. Moreover, following its communist political ideology the Soviet Union, one of the two space superpowers at the time, was fundamentally against involvement of any private commercial actors in outer space (Jankowitsch 2015, p. 6). The only exception as far as commercial use was concerned arose in the context of the use of radio frequencies and orbital locations for satellite communications. These were already being addressed through a state-centered system of coordination and responsibility in the framework of the International Telecommunication Union (ITU), whereby states could effect the allotment of particular radiofrequencies and attendant orbital locations for private satellite operators within their jurisdiction (Articles 1, 6, 44, ITU Constitution (1993)).

Discussion of the legal possibilities for any future commercial exploitation outside the satellite communications sector remained therefore largely theoretical, based on two major clauses of the Outer Space Treaty and their proper interpretation.

On the one hand, the same Article establishing the freedom of scientific investigation also pronounced that the “exploration and use of outer space, including the Moon and other celestial bodies, shall be carried out for the benefit and in the interests of all countries (...) and shall be the province of all mankind” (Article I, Outer Space Treaty). Here, debate centered around whether this general clause defining the legal status of outer space as the “province of all mankind” would also mean that any *exploitation of resources* in that domain would somehow be the “province of all mankind.” The latter presumably meant that no unilateral exploitation could be allowed; an international regime likely including an international licensing system would be called for to allow such exploitation—if it was to be allowed at all (Lachs 2010, pp. 41–46).

The closest example of such an international regime currently available concerns the aforementioned legal framework for satellite communications, whereby the ITU system ensured the proper allocation of space frequencies and attendant orbital slots or orbits (Lyll 2011). It must be said, however, that the regime was in many ways an international version of a “gentlemen’s agreement” dependent upon the goodwill of all actors (von der Dunk 2015b, pp. 484 ff.) considerably helped, moreover, by the laws of physics—these imposed a penalty for interference upon the interferer also, in that both contemporaneous users of the same frequency in the same area would actually be unable to draw much benefit from such usage.

The question remained, however, whether (satellite communications aside) the “province of all mankind” clause would allow states at their discretion to license private entrepreneurs to commercially exploit that realm or whether an *international* licensing regime would need to be established before such private commercial exploitation would be allowed.

On the other hand, the reference to freedom of exploration and use pronounced by the same Article I of the Outer Space Treaty became subject to a debate as to whether “use” also included “commercial use”—an interpretation increasingly hard to counter as the use of outer space for commercial satellite communications turned out to be a rapidly growing field—and next, as to whether “commercial use” would also encompass the exploitation of natural resources such as minerals or water where more room for diverging interpretations remained (Mayence and Reuter 2009, pp. 34–35). Obviously, once the freedom of use was unequivocally agreed to include *commercial* use, nothing would stand in the way of individual states licensing private operators, provided other international obligations would (continue to) be complied with.

The closest example of freedom of use of an area outside national jurisdiction including commercial use concerned the high seas, where such freedom explicitly included the freedoms of navigation, of overflight, to lay submarine cables and pipelines, to construct artificial islands and other installations permitted under international law, and of fishing (Article 87(1), United Nations Convention on the Law of the Sea), subject to such internationally agreed law as regarding pollution, overfishing, and suchlike.

Thus, the other question here became whether this approach would, could, or should also be validly transplanted to the realm of outer space. More definitive answers to either question, however, first require discussion of another relevant international treaty.

### **The Moon Agreement, Exploration, and Exploitation**

The prospect of actually exploiting any mineral resources became a distinct possibility after the last of the Moon landings occurred. Apollo-17 astronaut Harrison Schmitt (Schmitt 2006) in particular promoted the idea of harvesting helium-3 as a potential major energy source. While others have meanwhile expressed serious doubts about the (commercial) feasibility of such an endeavor (Crawford 2015), it *did* raise the general prospect of potential commercial benefits of lunar resources to a new level of awareness.

Thus, in order to elaborate the rather summary regime under the Outer Space Treaty with regard to both the scientific exploration and the commercial exploitation of the Moon,

the 1979 Moon Agreement (Agreement Governing the Activities of States on the Moon and Other Celestial Bodies) was drafted, which “shall also apply to other celestial bodies within the solar system, other than the Earth [such as asteroids], except insofar as specific legal norms enter into force with respect to any of these celestial bodies” (Article 1(1), Moon Agreement).

The Moon Agreement essentially reiterated the main provisions of the Outer Space Treaty: “[t]he exploration and use of the Moon shall be the province of all mankind and shall be carried out for the benefit and in the interests of all countries” (Article 4(1), Moon Agreement); the freedom of scientific investigation continues to apply and calls for international cooperation in this respect (in Article 4(2), Moon Agreement); and information concerning the exploration and use of the Moon shall be shared as soon and widely as possible (in Article 5(1), Moon Agreement). More novel in the Moon Agreement, while still in the spirit of the Outer Space Treaty, was the clause that Moon stations may be established by states, but also need to limit “use” of an “area (...) required for the needs of the station” to the minimum necessary (Article 9(1), Moon Agreement) and shall not “impede the free access to all areas of the Moon” (Article 9(2), Moon Agreement).

While these obligations were all addressed to states, once more they included any possible private involvement in such ventures along the same lines as the Outer Space Treaty: “States Parties to this Agreement shall bear international responsibility for national activities on the Moon, whether such activities are carried on by governmental agencies or by nongovernmental entities, and for assuring that national activities are carried out in conformity with the provisions set forth in this Agreement. States Parties shall ensure that nongovernmental entities under their jurisdiction shall engage in activities on the Moon only under the authority and continuing supervision of the appropriate State Party” (Article 14(1), Moon Agreement; also Article VI, Outer Space Treaty).

It was thus mainly in the area of possible commercial exploitation (“as such exploitation is about to become feasible” (Article 11(5), Moon Agreement)) that the Moon Agreement developed a new regime, “[b]earing in mind the benefits which may be derived from the exploitation of the natural resources of the Moon and other celestial bodies” (5th paragraph, Preamble, Moon Agreement; emphasis in original). Even more interesting, “[i]n order to facilitate the establishment of the international regime referred to in paragraph 5 of this article, States Parties shall inform the Secretary-General of the United Nations as well as the public and the international scientific community, to the greatest extent feasible and practicable, of any natural resources they may discover on the Moon” (Article 11(6), Moon Agreement).

### **The Concept of the “Common Heritage of Mankind”**

The baseline approach here was reflected in pronouncing “[t]he Moon and its natural resources [to be] the common heritage of mankind” (Article 11(1), Moon Agreement). Unfortunately, however, as the concept of the “common heritage of mankind” was fairly novel in international law and hardly unequivocally accepted or even understood, only three main aspects were noted and discussed, leaving many other issues open (Jakhu et al. 2013, pp. 388–399). The first was a question of the relationship between the initial core

principles of the Outer Space Treaty and the Moon Agreement. The second was whether the call for an international regime to interpret and regulate exploitation of the Moon's natural resources amounted to a moratorium on such exploitation until such a regime would have been established. The third concerned the lack of clarity about exactly what such an "international regime" was to do.

First, as presumably a core part of the "common heritage of mankind" principle, "[n]either the surface nor the subsurface of the Moon, nor any part thereof or natural resources *in place*, shall become property of any State, international intergovernmental or nongovernmental organization, national organization or nongovernmental entity or of any natural person. The placement of personnel, space vehicles, equipment, facilities, stations and installations on or below the surface of the Moon, including structures connected with its surface or subsurface, shall not create a right of ownership over the surface or the subsurface of the Moon or any areas thereof. The foregoing provisions are without prejudice to the international regime referred to in paragraph 5 of this article" (Article 11(3), Moon Agreement; emphasis added).

In particular, the reference to "natural resources in place" raised the issue of whether one could then, *a contrario*, assume that ownership over natural resources as of the moment of extraction would be allowed, at least if properly authorized and supervised by a particular state. In other words: whether the nonappropriation principle already applicable pursuant to Article II of the Outer Space Treaty would not limit itself to a prohibition of the exercise of jurisdiction to keep others out of an area and reserve the right to extract exclusively to oneself regardless of when one would actually start extracting resources contained therein. To that extent, the distinction between the two concepts of "province of all mankind," as espoused by Article I of the Outer Space Treaty; and Article 4(1) of the Moon Agreement in its "common heritage of mankind" specifically targeting commercial exploitation as per Article 11(1) of the Moon Agreement, would be relatively minor—which would however raise the question why the latter, novel concept should have been introduced at all.

Second, and further confusing the issue in this respect, the Moon Agreement called for "an international regime, including appropriate procedures, to govern the exploitation of the natural resources of the Moon (...). This provision shall be implemented in accordance with article 18 of this Agreement" (Article 11(5), Moon Agreement). The reference to the international regime, according to some, represented a moratorium on undertaking such exploitation activities prior to the establishment of such a regime, whilst others by contrast claimed that at least until such establishment would occur unilateral exploitation might be allowed, as long as it was compliant with other relevant obligations under space law. The international regime referred to, it may be added, never materialized; neither was a review conference as suggested by Article 18 of the Moon Agreement ever convened.

Third, the Moon Agreement itself did not provide for anything more than a general approach to what such an international regime was to look like: "The main purposes of the international regime to be established shall include: (a) The orderly and safe development of the natural resources of the Moon; (b) The rational management of those resources; (c) The expansion of opportunities in the use of those resources; (d) An equitable sharing by all States Parties in the benefits derived from those resources, whereby the interests and

needs of the developing countries, as well as the efforts of those countries which have contributed either directly or indirectly to the exploration of the Moon, shall be given special consideration" (Article 11(7), Moon Agreement).

While the first three such purposes did not raise many concerns, as few would dispute they would derive already in more or less straightforward fashion from the Outer Space Treaty, its reference to the "province of all mankind," and even general public international law, it was the fourth that, in the absence of further guidance by the Moon Agreement itself with respect to the "common heritage of mankind" principle, became a major bone of contention (Tronchetti 2009, pp. 45–61).

The concept of the "common heritage of mankind" was elaborated in some detail in the major convention adopted on international maritime issues—the 1982 Convention on the Law of the Sea (Viikari 2002, pp. 51–69). Part XI of that convention, comprising over thirty pages of text, applied the "common heritage of mankind" concept to the deep seabed. It established an international authority for managing it, operating an international enterprise for exploitation on behalf of, especially, the developing countries, and licensing other ("normal") enterprises interested in exploiting the natural resources of the deep seabed; and it also required mandatory transfer of technology from such licensees to the international authority and its enterprise (Articles 133–191, United Nations Convention on the Law of the Sea 1994).

This development took place largely contemporaneously with the Moon Agreement. The result was a general (largely unspoken) assumption that the law of the sea approach to the "common heritage of mankind" would also come to be applied to the Moon. This was no longer acceptable to most countries in the fundamentally changing politico-economic climate of the early 1980s. Though the Moon Agreement did enter into force in 1984 (as per Article 19(3), Moon Agreement), it does not carry the ratifications of any major spacefaring nations. As of January 1, 2017, the Agreement had 17 state parties (COPUOS 2015, 12), whereas only among the four signatories (states that have signed but not ratified the treaty) could two major spacefaring nations be found: France and India. Their signatures, however, by now are decades old, and neither nation has since then shown any intention to actually become a party. Thus, fairly little legal meaning could be attached to those signatures in the context of any obligations of those two countries "to refrain from acts which would defeat the object and purpose of" the Moon Agreement, as would otherwise have been demanded by international law (Article 18(a), Vienna Convention on the Law of Treaties 1969).

As a consequence, the obligations enshrined in the Moon Agreement as briefly examined above may be seen as relevant and binding only for those states that actually ratified the Agreement, whereas all nations with the likely capability to actually start exploitation in the foreseeable future are limited in their freedom of action *only* by obligations pursuant to the Outer Space Treaty (and, if applicable, possible customary international law or general public international law). This is why the understanding of the relation between the Outer Space Treaty and the Moon Agreement is critical: here, the Moon Agreement does *not* provide a widely accepted interpretation of the Outer Space Treaty on this issue.

It may be noted that, as for the law of the sea, following serious and substantial opposition against the rather antiprivate-sector implementation of the "common heritage of mankind"

principle, a major adjustment has meanwhile taken place. The 1994 New York Agreement essentially reinterpreted Part XI of the 1982 Convention on the Law of the Sea by fundamentally changing the international management structure, deleting the obligation of technology transfer and generally implementing more market-oriented concepts to deep seabed exploitation (Tronchetti 2015, pp. 795–796).

Similarly, in the recent reinvigorated discussions on the Moon Agreement and its future perspective and prospects, this approach of reinterpretation is often presented as the best or even only way forward to implement a feasible international regime for commercial exploitation if one is to remain within the framework of the present Moon Agreement. However, all such discussions—at least until very recently—took place at an academic and largely theoretical level; very few countries (if any) found it worthwhile to seriously become engaged in them.

### **The Road to Extraction: Title IV of the US Commercial Space Launch Competitiveness Act**

As a consequence of the vagueness of the Outer Space Treaty on the issue of extraction rights and the widespread lack of legal relevance of the Moon Agreement, considerable uncertainty and divergence of opinion remained at the international level, and the question of proper interpretation and implementation was far from unequivocally and authoritatively resolved. Then, Planetary Resources and Deep Space Industries came forward with their substantiated plans to start asteroid mining projects—thereby almost forcing the United States to take *some* action, which was, understandably, unilateral in nature, in the absence of any coherent international agreement or regime—and which resulted in Title IV of the Commercial Space Launch Competitiveness Act being adopted November 2015. Title IV of the Act essentially takes a three-pronged approach to the request by the two companies to provide them with some legal certainty with regard to their rights to start space mining activities, so as to convince interested investors to actually provide the funds necessary to continue with their, for the moment, exploratory activities.

First, Title IV of the Act recognizes the right of “[a] United States citizen engaged in commercial recovery of an asteroid resource or a space resource (...) to possess, own, transport, use, and sell the asteroid resource or space resource obtained in accordance with applicable law, including the international obligations of the United States” (Section 51303, United States Code). While the word “property” is not used, the list of entitlements which relevant US citizens (which includes companies “organized or existing under the laws of the United States or a State” thereof (Section 50902(1)(B), United States Code)) may claim is identical to the standard list of entitlements which a formal property right entails.

By definition, the reach of this clause is formally confined to any dispute within US jurisdiction; obviously US law cannot dictate how any dispute as to property rights would have to be settled in any other state’s courts, nor can it dictate how such a dispute can be settled in an international setting—before an international arbitral tribunal or the International Court of Justice, for instance. At the same time, it commits the US government, in case a US citizen falling within the scope of the clause becomes engaged in such a dispute before a non-US or international court or arbitration tribunal, to (try and) defend the property rights of such a citizen, politically and/or legally.

It should be reiterated in this respect, that the Act expressly refers to compliance with US obligations under international law and even states that the Act by no means “assert[s] US sovereignty or sovereign or exclusive rights or jurisdiction over, or ownership of, any celestial body” (Section 403, Commercial Space Launch Competitiveness Act 2015), such as required by Article II of the Outer Space Treaty as discussed before. In other words, the United States believes that the mere grant of *de facto* property rights over extracted resources does *not* contradict the prohibition of national appropriation of (parts of) outer space or the “province of all mankind” status of the Moon and any of its resources, following the Outer Space Treaty—noting once more that the United States is not among the parties to the Moon Agreement.

Second, further to the references to US international obligations, the Act calls for the initiation of legislation effectuating the “authorization and continuing supervision” of space mining activities obligatory under Article VI of the Outer Space Treaty and recommending the proper “allocation of responsibilities among Federal agencies” in this respect (Section 51302(b), United States Code).

As the first proper asteroid missions into outer space by either of the two relevant companies are likely a few years away, there is still time to develop such a regime and solve the US conundrum of intragovernmental allocation of the relevant licensing powers (von der Dunk 2015c). In the event such legislation might *not* be ready by the time of the first of such space missions, the existing licensing regime could be used as a stop-gap temporary tool: as it requires among other items a payload review, the license to launch could be tailored to ensure continuing US compliance with its international obligations also in the context of asteroid mining (Section 50904(b), United States Code).

It could be added here that Article IX of the Outer Space Treaty in conjunction with some broader clauses of that Treaty already imposes upon a commercial asteroid mining operation the prohibition of harmful interference with other legitimate space activities. Other key obligations in this respect (such as acceptance of any third-party liability for damage caused by such operations in accordance with the Liability Convention (Convention on International Liability for Damage Caused by Space Objects 1971) and of registration-related obligations in accordance with the Registration Convention (Convention on Registration of Objects Launched into Outer Space 1975)) effectively rest upon the United States itself, which in turn could then derogate those as relevant and/or desired to the operators themselves concerned.

Third, the Act effectively recognizes both the limited reach of the provisions of Title IV as being confined to US citizens and territory and the ultimate need to achieve an international regime, preferably of course along the lines of the US approach, as otherwise relevant companies might be confronted with major legal and/or political problems in trying to sell their harvested resources to other countries or their operators. Notably, the US president is charged by the Act to “promote the right of United States citizens to engage in commercial exploration for and commercial recovery of space resources free from harmful interference, in accordance with the international obligations of the United States and subject to authorization and continuing supervision by the Federal Government” (Section 51302(a)(3), United States Code).

This last aspect brings the discussion back to the international arena: since the likes of Planetary Resources and Deep Space Industries plan to operate in a global commons for the sake of serving global markets, the US recognition of their right to do so is not really sufficient for their purposes—they, preferably, need an international “regime” of sorts recognizing such rights also in all or at least most important other jurisdictions. Even if under current international trade law a principle exists which posits that once a product can be validly traded any “like product” can be equally so traded lawfully (Macrory et al. 2005, pp. 102–105)—meaning that to the extent certain minerals mined on earth can be validly traded, likely so too could the same minerals mined on asteroids; that would not in real terms help those companies serve markets in or of countries principally not in agreement with the US approach.

Tellingly, in this respect, is once again the realm of the law of the sea. Recently Lockheed Martin, a US company, did become interested in exploiting deep seabed resources. Legally speaking it might, following continued nonadherence by the United States to the United Nations Convention on the Law of the Sea (1994) even as reinterpreted by the New York Agreement, have considered itself to be under no obligation to obtain a license under the international regime now realized by the latter Agreement and might have satisfied itself with obtaining a US license only under the US Deep Seabed Hard Mineral Resource Act (1980). Instead, however, it opted to establish a daughter entity in the United Kingdom in 2013 in order to piggyback on the UK’s adherence to the New York Agreement, obtain a license in conformity with that Agreement, and thus avoid any politico-legal repercussions when serving future markets outside the United States (Sohn et al. 2014, p. 592). The value of access to a virtually global market apparently considerably outweighed the benefits of a presumably much less burdensome license under US national law alone.

### **Back to International Law: Toward Parameters for a Future Legal Regime?**

From that perspective, the US national legislative initiative giving rise to Title IV could be viewed as temporary—substituting for an international regime (at least one that essentially follows the basically enterprise-friendly US approach), which in itself did not seem to be on the horizon. At the same time, the initiative is thereby a veiled invitation to the world community to arrive at such an international regime.

The way developments are working out now, such an international regime would likely develop “bottom-up”—that is, by individual states developing their own national initiatives on the issue of space mining, possibly incrementally developing into customary international law, rather than “top-down”—that is, by way of an international treaty setting forth such a regime in quite clear terms. The initiatives by Luxembourg and the United Arab Emirates mentioned earlier should be viewed from precisely this perspective. More voices of indirect, caveated, and/or conditioned support can meanwhile be heard from several other quarters as well. Interesting in particular from this perspective are the European Union and China. A basic tenet of EU law is that once a commodity is validly brought into one EU member state (read Luxembourg) it can be legally traded throughout the Union (Article 28(2), TFEU 2012). China, usually perhaps tempted to chastise the United States from a political perspective, but being very interested in the Moon itself, might well sit on

the fence to see whether an ultimate international regime would give them the right to unilaterally license mining operations on the Moon.

So far, the only country having clearly spoken out against the US approach is Russia, but the arguments were basically political, and in some instances, even a blatant misrepresentation of current international space law (Russian Federation, 5–7). Brazil has also been critical, but its criticism—which so far, moreover, was expressed orally only—largely focused on the lack of prior international consultation and the ideal of having an international regime first before allowing national legislative, regulatory, and/or licensing regimes to be elaborated within its parameters. It did not seem to claim the US approach was fundamentally illegal. On the one hand that would be a hard claim to make in view of the aforementioned uncertainty and lack of clarity at the international level; on the other hand, to the extent that the United States recognizes the need for an international regime as well, the two positions are not that far apart either.

Without a crystal ball, it is, of course, difficult to predict what is going to happen. Still, a growing understanding might come around that a single state's licensing of space mining activities is basically permitted, and that the only international "regime" limiting that discretion is not structural/institutional—that is, that national licensing should be replaced with international licensing—but substantive namely to ensure compliance with applicable rules of international (space) law. This approach to compliance means that any potential issue of interference of commercial space exploitation with scientific exploration is left to existing international (space) law rules to solve, or alternatively to require new rules at such level. In other words: existing international space law, not future international licensing, has to balance the principles underpinning scientific exploration with the principles presumably allowing for commercial exploitation.

In the absence of any real experience with commercial exploitation of celestial bodies' resources, it is fair to say that, apart from general risks that space activities may always generate, for scientific exploration the major risks lie in potential "competition" for a particular celestial body. If a commercial operator were to actually land somewhere, a scientific mission to the same celestial body would effectively be precluded for at least as long as the commercial activities continue there, pursuant to the aforementioned principled prohibition of harmful interference. More likely, however, certainly in the short-to-medium term, the "competition" will be for valuable information regarding such celestial bodies. In both cases the actual risk of collision of interest of course depends on the extent to which science and the space-mining sector might eye the same particular asteroids.

Commercial operators are going to have to spend considerable efforts and funds in investigating which asteroids would likely offer valuable mining targets and how to mine them safely and efficiently. Consequently, such information might also provide a lot of scientifically valuable knowledge about targeted asteroids. However, at the same time such information becomes commercially valuable as well, and commercial operators might be rather reticent to share knowledge if there is a serious risk that a potential competitor may piggyback on it and beat the original investigator to actual exploitation of the asteroid. A balance has to be found, further to Article XI of the Outer Space Treaty, which already calls for information sharing "to the greatest extent feasible and practicable." Also, where relevant the interpretation of Article IX as, in principle, disallowing harmful interference

in the absence of bona fide consultations and an overriding national need, should be construed to protect the interests of the first commercial explorer of the asteroid against any potential piggybacking competitors, in order to allow the former to share information with less reluctance.

If indeed national licensing within a framework of mandatory international legal parameters is the most likely outcome of current international discussions and developments, it is through the license that any particular commercial operator would have to commit to the principles of nonharmful interference and of sharing as much scientifically relevant information with the rest of the world as possible, *at least as long as* such sharing does not give rise to the risk of being parasitized. As indicated, this is probably the largest risk commercial operators might see in this context. The United States by way of Title IV has committed to both comply with general international space law—in other words, including the principles calling for the sharing of scientific information, international cooperation, and consultation, not to mention basic avoidance of harmful interference—and to develop an appropriate mechanism for governmental authorization and supervision of such activities.

As long as the United States will faithfully execute such commitments, therefore, the emphasis in protecting the interests of science in the context of commercial space mining would shift to other countries, and then on to the international level toward a call for an ultimately global regime. Commercial operators would be expected to comply with the duty to share information as widely as possible. As a counterpart to elaborating and specifying the details of information sharing, that regime should also offer a reasonable and feasible level of legal certainty that certain business operations can be successfully undertaken. For example, once a duly licensed operator can prove investment of substantial amounts of money and time in a particular asteroid, such an operator has a legal right of “first-come, first-served” in order to assuage his worst fears about being overtaken by a (parasitizing) competitor.

An interesting corollary here might be gleaned again from the first sector of space activities where commercial exploitation of space became a fact of life: satellite communications. The “space resources” of value to that sector consisted of the orbital positions and the interference-free usage of frequencies to be used by satellites in such positions. These are, moreover, scarce resources: any orbital position can only be occupied by one satellite at the time, and some positions are more valuable than others. Equally so, mitigated to some extent only by smart technologies, a frequency can only be used by one transmitter at the time within the same geographical area, and some frequencies are more valuable than others. Since satellite communications became a feasible operation, in the framework of the ITU, an international system for coordination of the use of satellite orbital positions and satellite frequencies arose. This system was principally premised on the principle of “first-come, first-served,” subject to compliance with international obligations—notably those of prohibition of harmful interference (!) and adherence to the ITU process. That worked well, at least until politico-economic concerns over the rapid crowding of these resources and the presumed inability of developing states to join the game before there were no resources left to benefit from gave rise to a mix of “first-come, first-served” and a priori allocation of those, now truly “scarce,” resources (von der Dunk 2015b, pp. 475–484).

The current commercial wisdom as to asteroids is that there would not be any real scarcity in the foreseeable future, as millions of asteroids in the asteroid belt would be available for exploitation, and the current number of serious commercial projects to harvest them is fairly limited. However, it could be that certain asteroids may turn out to be much more valuable than others—not just in terms of their resources but also in terms of their “accessibility.” It could be imagined, for instance, that it would be far easier to send a harvesting mission to the small percentage of asteroids actually leaving the asteroid belt in the general direction of the Earth’s orbit. Such nearby asteroids would turn out to represent a scarce resource after all, meaning a regime along the lines of the ITU system could be envisaged.

Thereby “first-come, first-served” would rule international recognition of an operator, duly licensed to comply with such international obligations as the avoidance of harmful interference and the sharing in principle of any scientific knowledge gained in the process, being entitled to exploit a particular asteroid. If the principle of “first-come, first-served” were elaborated in such a manner as to take away commercial operators’ valid fears of parasitizing competitors, this might well present a valid way forward toward, at the international level, protecting the interests of the astronomical sciences as they are currently visible—at least until true and well-defined scarcity sets in. This puts a(nother) premium on decent behavior of private operators in outer space directly benefiting also space science (both concerning astrobiology and more broadly speaking)—to the extent, once more, that the interests, exploitation respectively exploration, of these two sectors of society would indeed ultimately collide in this context.

## Notes

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