REFLECTIONS OF DEEP SPACE ACTIVITIES ON INTERNATIONAL RELATIONS

CEREN GÖNCÜ

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IZMIR UNIVERSITY OF ECONOMICS

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Approval of the Graduate School of Social Sciences

Assoc. Prof. Mehmet Efe BİRESSELİOĞLU

I certify that this thesis satisfies all the requirements as a thesis for the degree of Master of Science in Political Science and International Relations.

Prof. Dr. Çiğdem KENTMEN

This is to certify that we have read this thesis and that in our opinion it is fully adequate, in scope and quality, as a thesis for the degree of Master of Science in Political Science and International Relations.

Assist. Prof. Sıtkı EGELİ

Examining Committee Members

Assoc. Prof. Mehmet Efe BİRESSELİOĞLU

Assist. Prof. Sıtkı Egeli

Assoc. Prof. Dr. Sinem KOCAMAZ

ABSTRACT

REFLECTIONS OF DEEP SPACE ACTIVITIES ON INTERNATIONAL RELATIONS

Göncü, Ceren

Political Science and International Relations

Supervisor: Dr. Sıtkı Egeli

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Activity in space has so far been confined mostly to the Earth's orbit. Man-made objects' travel and presence in deep space beyond Earth's orbit has been seldom and limited to scientific excursions. But this is about to change due to advances in relevant technologies; space beyond Earth's immediate orbit may soon be opening to commercial activity and perhaps to human settlement. When it happens, the presence of state and non-state actors in deep space and their competition to own and exploit its resources will be adding new, problematic, even controversial dimensions to international relations,

along with which a range of ramifications should be expected. Among them are legal status and property rights under international law, international security and economy, and the nature of relationship between state and non-state actors in space environment. This thesis will seek to identify and elaborate some of those ramifications. In order to facilitate and place on more solid ground the task of generating foresights about the future, at the end parallels would be drawn with the circumstances and consequences of the great age of maritime explorations of 15th to 17th centuries.

Keywords: space, deep space, space mining, space exploration, space colonization, space law, space security, international relations, international security, science and technology studies, non-state actors.

ÖZET

DERİN UZAY AKTİVİTELERİNİN ULUSLARARASI İLİŞKİLER ÜZERİNE YANSIMALARI

Göncü, Ceren

Siyaset Bilimi ve Uluslararası İlişkiler

Tez Yöneticisi: Dr. Sıtkı EGELİ

Temmuz 2019

Uzaydaki aktivitelerbugüne kadar çoğunlukla Dünya'nın yörüngesiyle kısıtlı kalmış; insan yapımı nesnelerin yolculuğu ve derin uzaydaki varlığı nadiren gerçekleşmiş ve bilimsel amaçlıolmuştur. Ancak bu, ilgili teknolojilerdeki gelişmeler nedeniyle değişmek üzeredir ve Dünya'nın yakın yörüngesinin ötesindeki alan kısa bir süre sonra ticari faaliyete ve belki de insan yerleşimlerine açılıyor olabilir. Bu gerçekleştiği zaman, devlet ve devlet dışı aktörlerin derin uzaydaki varlıkları ve göksel cisimlerdeki

kaynaklara sahip olma ve bunları sömürme üzerinde yürüttükleri rekabetleri, bir dizi sonucun yansıması beklenen uluslararası ilişkilere yeni, problemli, hatta tartışmalı bir boyut katacaktır.Bunlar arasında uluslararası hukuka göre yasal statü ve mülkiyet hakları, uluslararası güvenlik ve ekonomi, ve devlet ile devlet dışı aktörler arasındaki ilişkinin uzay ortamındaki niteliği bulunmaktadır.Bu tez öncelikle, bu yansımalardan en azından bazılarını tanımlamaya ve detaylandırmayıamaçlamaktadır.İlaveten tezin sonunda, gelecekle ilgili öngörüleri oluşturabilmeye olanak sağlamak ve bunları daha sağlam bir zemine yerleştirmek için, 15 ila 17. yüzyıllar arasındaki büyük deniz keşifleri dönemi ile koşullar ve sonuçlar üzerinden paralellikler kurulmaya çalışılacaktır.

Anahtar Kelimeler: uzay derin uzay, uzay madenciliği, uzay keşifleri, uzayın kolonizasyonu, uzay hukuku, uzay güvenliği, uluslararası ilişkiler, uluslararası güvenlik, bilim ve teknoloji çalışmaları, devlet dışı aktörler.

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LIST OF ABBREVIATIONS

CD: Conference on Disarmament

CO-ASAT: Co-Orbital Anti-Satellite Techniques

COPUOS: Committee on the Peaceful Uses of Outer Space

DEIC: Dutch East India Company

DSI: Deep Space Industries

EIC: East India Company

ESA: European Space Agency

EU: European Union

GEO: Geosynchronous Orbit

GGE: Group of Governmental Experts

HEO: High Earth Orbit

IGO: Intergovernmental Organization

IISL: International Institute of Air and Space Law

ISS: International Space Station

ITU: International Telecommunications Union

LEO: Low Earth Orbit

MEO: Medium Earth Orbit

MNC: Multinational Corporation

NASA: National Aeronautics and Space Administration

NATO: North Atlantic Treaty Organization

OST: Outer Space Treaty

PR: Planetary Resources

SSF: Strategic Support Force

UAE: United Arab Emirates

UN: United Nations

US: United States

USSR: Union of Soviet Socialist Republics

CHAPTER 1

INTRODUCTION

The human being, who lived in caves at the beginning, later on created cities, traded with each other, and founded states. As they progressed, their population hassoared continuously, reachingultimately the point where the resources of the planet Earth are close to becoming depleted. Hence human beings' search for alternatives, and thanks to scientific discoveries and technological progress in recent years, they are nowadays shifting their focus towards thecelestial bodies in space and the riches they contain. To accompany or perhaps revealing this shift, unscholarly and to a lesser extent scholarly agenda has been increasingly pre-occupied with debate and coverage of travel into deep space, founding of human settlements there, exploiting the material riches to be found in celestial bodies, positive and negative ramifications of such developments on global economy, international politics and so on.

From the perspective of international relations and the current nature of inter-state relations, human beings setting their sights on exploiting the riches of space give rise to a number of important questions and unknowns. When and if they begin exploiting space resources, or even creating settlements in outer space, would this be in conjunction

with states or independently of them? Space activity is on the agenda of many states and non-state actors and promises a great contribution to the world economy in the future. But would this contribution be divided fairly between states and nonstate actors, or further deepen current income and wealth divides among and between them? The literature in this field has just begun tackling with such questions, hence this being a relatively new topic, there are many gaps, not only in the literature, but also in the applicable norms and regulations of the international system. Consequently, on the subject of deep space, while preparations for activities continue in full spate, lack of a common ground to regulate them means that there could be problems in many areas, particularly with respect to political economy, legal and legislative framework and security. Another novelty is the fact that the number of non-state actors involved in space activity already surpasses the number of states; and this trend can be expected to continue unabated in the future. While there is little common ground and few established norms, even among states, the inclusion of private and/or multinational companies in the picture brings several new ambiguities and potential problems. These need to be addressed and resolved. In this respect, the lack of clear definition on the concept of property and ownership rights over celestial bodies and their resources may herald disagreements and disputes in the future.

Given the magnitude and complexity of ambiguities at stake, it may also be useful to investigate whether there has ever been a precedent in history and whether parallels could be drawn to present and future developments in deep space. For instance, could a parallel be established to the historical period when such large swaths of unexploited territories and resources came within reach of human beings? The age of great maritime explorations of the 16th and 17thcenturies and the ensuing colonization stand out as a readily visible example in history, during which states and corporations sometimes acted together, and sometimes in competition, to discover new continents and seize the resources on them. An obvious question becomes whether great maritime explorations hold similarities that could teach us lessons and enable forecasts relevant to the exploration and exploitation of deep space today.

1.1.Methodology

The *starting point* of this study has been this ever-accelerating pace of developments relating to human activity in deep space, and the ever-increasing pace of coverage and debate pertaining to this phenomenon. The researcher held certain ideas on the possible impact of this increased pace of activity in deep space on the relations between/amongst state and non-state actors, and its reflections on international security, international political economy and international relations on a wider and global scale. Yet, the need was evident for a more in-depth, systematic, empirical and analytical research to identify, analyze, compare and contrast various aspects and dimensions characterizing this phenomenon, so as to test, validate, refute or improve and expand those ideas, and to also generate empirically substantiated observations, predictions and conclusions on the subject matter. In this sense, a *theory-before-research* model was adopted, whereby some ideas and notions were already in place before the empirical phase, and the researcher has subsequently attempted to prove, disprove or improve them through empirical research and processes.[1]

Once this rough idea for the research study was in place, the researcher progressed with a first round of *literature review*so as to begin thinking and reading about this topical idea, and perhaps more importantly, to examine how others have already thought about and studied the same topic. This has consisted of a preliminary thorough review of the sources available in the library, supplemented by the material available through internet. This preliminary literature review enabled the researcher to identify and crystallize not only the research question, but also the subject topics related to the research question. Accordingly, starting from the rough question on the subject, the more clear*research problem statement* was refined and framed as "possible impacts on international relations of commercial activity in deep space". Accompanying this problem statement were a number of*sub-research questions* comprising:

[1]In structuring and implementing the methodology, the model and suggestions provided by the following was used: Bruce L. Berg, *Qualitative Research Methods For The Social Sciences* (Long Beach: California State University, 2001). Besides, relevant perspectives and content was drawn from the following: Janet Buttolph Johnson, H. T. Reynolds and Jason D. Mycoff, *Political Science Research Methods* (SAGE,2016).

(i) how imminent and likely is the commercialization of deep space?; (ii) which actors are likely to be at the forefront in deep space?; (iii) what shape the relations between state and non-state actors are likely to take in deep space?; (iv) whether the norms and legislative framework are in place to regulate activities and interactions in deep space?; and (v) whether history could be used as a reference to forecast the circumstances and consequences surrounding commercialization of deep space. In parallel, this stage also included the identification of key concepts to operationalize; which were identified as "deep space", implying space beyond Earth's orbit, and "commercial activity" used to refer to activities in deep space conducted for monetary gains. Whereas a variety of activities such as space tourism, transport, settlements and manufacturing in space are possible forms of commercial activity, the scope has been narrowed to focus on space mining as the most likely spearheading and large-scale commercial activity expected to take place in deep space.

The next step has been study design, identifying how the research study would be conducted and how the research question would be addressed, and its results would be produced and presented. Accordingly, *content analysis* to be undertaken on the basis of a second-round of much more comprehensive and meticulous *literature review* was selected as the method of choice for generating data; which was then to be collated, analyzed, reduced and presented in an organized, compressed assembly of readily understandable information permitting conclusions to be drawn analytically. Hence, the use of *qualitative* approach for deriving and handling the necessary data.

Following this has been data collection and organization phase built primarily on a second, more comprehensive literature review, which at its roots comprised the use of research already done by the others in order to generate new perspectives, conclusions, suggestions and predictions. Consequently, a fairly large number of scholarly printed and electronic/internet-based works have been reviewed. To the extent possible and feasible, state and organizational reports and documents were also accessed and reviewed. Since technological progress and their resulting economic, political and other ramifications pertaining to deep space are very recent, secondary and even third layers of sources comprising more real-time or near-real time newspaper stories, visual media

coverage, wire service reports, and on-line web page contents have been incorporated into the research so as to enhance the variety and timeliness of its dataset.

However, as the content analysis based on gathered documents and textual analysis progressed, the researcher identified certain gaps in the available literature, leaving certain aspects of the original research questions unaddressed. Likewise, the need has arisen to verify certain information gathered from the less reliable sources. The solution that was devised was to add expert interviews in the data collection process, whereby the knowledge, insights and opinions of experts active in the specific field of space systems were factored in and used to fill the gaps, to validate the data collated through literature review, and hopefully to also identify original perspectives and opinions which are not represented in the current literature. Put it differently, the decision was made to generate and incorporate actual data in what would otherwise be a pure literature review-based content analysis process. In identifying the interviewees, the method of *judgmental (purposive) sampling* was selected, along with which individuals displaying a specific attribute (in this case, comprehensive knowledge of and first-hand experience with deep space activities) were included. Bearing in mind logistical and practical limitations, four such expert interviewees residing in Turkey were identified. All four could be considered as precise experts, as they are all employed in senior positions by space-related industry, scientific research organizations with focus on space, or international consultancy companies specializing in aerospace. A *semi-structured* format was used during the interviews, whereby a number of predetermined questions were asked, but freedom to digress was allowed along with which the interviewees were permitted to probe beyond their answers to the predetermined questions. Afterwards, interviewees' opinions and contributions were transcribed and added as annexes to this written report; but more importantly their original points, remarks and contributions were incorporated in the data collection, analysis and reduction processes and subsequently incorporated in relevant segments of this study and its data presentation.

All the while, throughout the interview process, *ethical standards* and *measures* were applied to safeguard subject safety at adequate level. Accordingly, the consent of the equivalent of the institutional review board was obtained for both the method and the

questions of the interview. Moreover, the interviewees were made to read and sign consent forms leaving no ambiguity about the openness of intent, privacy, anonymity, confidentiality and their voluntary participation. Aligned with this, the interviewees and their opinions remained nameless and any elements that might compromise their identities were removed from the data presentation and display phases of the research.

Tough not contemplated at its outset, the addition of expert interviews may have pushed this research closer to what could be termed as the *triangulation* method – implying the use of slightly modified lines of action to generate and analyze varieties of data and methods, so as to obtain a more substantive picture of the reality.[2] In this sense, whereas the data generation drawing on literature review supplemented by expert interviews represented the first two such lines of action, in-depth comparison and contrasting of the circumstances surrounding two distinct time periods (3rd space age of the 21st century vs. maritime explorations of 16th century, which was incorporated in the literature review in order to address one of the research questions) could arguably be considered as a third line of action towards achieving triangulation. In this sense, an important feature and objective of this undertaking to compare the circumstances and the consequences of two distinct time periods has not been mere collation and combining of data, but it also entails an attempt at scrutinizing historical data in order to add predictive strength to the conclusions and forecasts pertaining to the future.

Lastly, data organization, analysis, presentation, and drawing conclusions stages were implemented, along with which collected and analyzed data was compressed and presented as an assembly of information that would readily permit the drawing of analytical conclusions.

1.2. Structure and Content

As for the structure and outline of the study, this first chapter provides a brief overview of the research question and the methodology to be used to scrutinize it. The second chapter will identify the scope of space and differentiate orbital from deep space. It will describe how space has so far been utilized, the beginnings and progressions of the various space ages, and the potential presented by deep space at the start of the third

[2]Berg, *Qualitative Research Methods For The Social Sciences*, 5-6.

space age. The third chapter focuses on technical infrastructure, cost considerations and the opportunities and obstacles for exploiting celestial bodies. The actors in this new realm will be the subject of the fourth chapter. State and non-state actors, and the contingencies affecting relations between them, will be explained. The existing legal ground and its inadequacies will constitute the focus of the fifth chapter. In addition, we shallcover existing agreements and legal arrangements up till the present day, current legal gaps, and the laws of different countries regarding deep space activities. At the same time, parallelswith deepsea legislation, whichhad a similar background and took place under comparable circumstances will be described here.Possible problems arising from lack of regulation will be discussed. In the sixth chapter our research will shift its focus to security in deep space; we will try to identify risks and threats to deep space activity, especially space mining, by both state and non-state actors. In the seventh chapter, a brief overview of the period of great maritime exploration, and its similarities to, and differences from ongoing and impending deep space activities will be identified. This will be followed by the final chapter, comprising the conclusion to the research. We will endeavour to suggest solutions to problems.

CHAPTER 2

USE OF SPACE

2.1. Physical Setting: Orbital Space vs. Deep Space

The space beyond Earth is divided into two layers: orbital space and deep space. The wide field of observation available from space makes it useful for many purposes. It may be used to monitor many parts of the Earth beneath it. Besides, it is of critical importance for a country to have free and unlimited movement in space. Because of having these characteristics, space activities first emerged during the time of the Cold War, and were used primarily to achieve military superiority. In addition to the military applications, satellites which were sent into orbital space have been used for communication, geolocation, and for the collection of scientific data, for example in meteorology. Besides satellites, manned space stations sent into space are also of great importance for scientific discoveries. Many facilities can be placed inside space stations and positioned in orbital space. Such manned laboratories have been established for research in astronomy and life sciences as well as for observing the Earth.Aspace station can also be a base for producing new materials for use on Earth, and it can be a

transportation hub for other spacecraft.[3] The best-known research facility in orbital space is the International Space Station (ISS), which was launched in 1998. It was a result of rare cooperation between states which had conflicts with each other politically: Europe, the US, Russia, Japan and Canada all collaborated.[4] The aims of the project were to improve the quality of life on Earth through scientific activity, and to prepare for future space travel.It has also helped scientists to understand the climate and structural characteristics of our planet, as well as features of the Sun, and it has contributed to research in astronomy and geology.[5]The Chinese Tiangong has also been designed and placed in orbit as a long-term, manned space station, similar to the ISS.[6]

Orbital space consists of four layers. The first 160km to 2.000 km from the surface of Earth is defined as Low Earth orbit (LEO). This is the layer in which satellites can go up and stay in orbit most easily.[7]So scientific research satellites generally stay in this low orbit. In the second layer, called Medium Earth orbit (MEO), navigation satellites are found, and also those which are used to monitor a specific area of the Earth's surface. They stay between 2.000 to 35.786 km from the Earth.[8] Beyond this height is the so-called Geosynchronous orbit (GEO).[9]Satellites in this orbit are used especially for communication, weather forecasting, and military early-warning.[10]They always rotate at the same speed as the Earth, so such a satellite is always at the same position above a specific point on the Earth's surface.[11]Finally there is the fourth layer, calledHigh Earth

[3] I. V. Franklin, "The Commercial Potential of Large Orbital Space Platforms," *Philosophical Transactions of the Royal Society of London. Series A, Mathematical and Physical Sciences* 312, no. 1519(1984): 133-140, accessed May 25, 2019, https://www.jstor.org/stable/37394.
[4] Tuna Emren, "Uluslararası Uzay İstasyonu," *Popular Science* 76 (August 2018): 42.
[5] Ibid:47.
[6]Elizabeth Howell, "Tiangong-1: China's First Space Station," *Space*, March 26, 2018, accessed April 18, 2019, https://www.space.com/27320-tiangong-1.html.
[7]David Hitt, "What is an orbit?," *NASA*,July 7, 2010, accessed January 22, 2019,https://www.nasa.gov/audience/forstudents/5-8/features/nasa-knows/what-is-orbit-58.html.
[8]Holli Riebek, "Catalog of Earth satellite orbits," *NASA*, September 4, 2009, accessed January 23, 2019,https://earthobservatory.nasa.gov/Features/OrbitsCatalog.
[9]Elizabeth Howell, "What Is a Geosynchronous Orbit?," *Space*, April 24, 2015, accessed March 1, 2019, https://www.space.com/29222-geosynchronous-orbit.html.
[10]Geosynchronous Satellites, *NASA*, accessed March 1, 2019, https://www.nasa.gov/audience/forstudents/5-8/features/geo_feature_5_8.html.
[11] Howell, "Geosynchronous Orbit."

orbit (HEO). It is the farthest away from the Earth and it is a useful location for weather and communication satellites, too.[12]

Beyond the confines of orbital space, there is deep space. The search for military superiority and scientific discoveries are among the uses of deep space, as well as hopes to obtain economic benefits, which are also a consideration in orbital space. Both states and private companies hope to use space for tourism as well as for scientific exploration.[13] Space tourism is just one small part of this developing sector, but the lion's share of upcoming economic activity relates to space mining. New opportunities in this field are a possible solution for the Earth's problems of dwindling mineral resources, and they carry the potential for making trillion-dollar contribution to the world economy.

States may cooperate with each other for shared, collective benefit, but more often they compete at one another's expense. As this process has unfolded up to the present day, it has led to many successful new discoveries because the desire to be first to discoversomething is so strong. Each new innovation has inspired the competing actors and accelerated the process. Major achievements, like reaching the Moon, result in shifts and variations in the balance and distribution of power among states in the international system.

2.2. The First and Second Space Ages

Each of the two Cold War superpowers – the US and the Union of Soviet Socialist Republics (USSR)- which were long in a state of conflict, aimed to be one step ahead of its rival in space. Thus, during the Cold War, space became a scene for superpower rivalry. They used space to serve their security agendas and interests, and sought to carry their military capabilities into theunconfined and unrestricted field of space, thus hoping to achieve supremacy in a domain where the other could not readily gain access or be able to intervene.

[12] Riebek, "Catalog of satellites."
[13] Gbenga Oduntan, "Who owns space? US Asteroid-Mining Act is dangerous and potentially illegal," *The Conversation*, November 25, 2015, accessed March 1, 2019, https://theconversation.com/who-owns-space-us-asteroid-mining-act-is-dangerous-and-potentially-illegal-51073.

The US and the USSR both tried to be first to launch an unmanned craft into orbit, and later a manned one. It was the USSR that sent the experimental satellite Sputnik into space in 1957, and it is therefore acknowledged to have started the so-called "first space age". The first man in space was also theirs, and the US did not readily accept being in the second place. However, the US launched many satellites and probes over the next threeyears,and alsoestablished a space agency.[14]After that Washington raised the ante and set its sights on a Moon landing, a mission they fulfilled in 1969. This success was the first attempt of humans to reach out intothe deep space.

This competition was primarily political, or even ideological; each of the two superpowers sought to prove it was superior, and that its system and ideology were better than the other's. They were also trying to impress and attract new allies as part of their rivalry to spread global influence. In addition, there were military and security considerations. Rockets used to take satellites into orbit were potentially useful as vehicles for carrying nuclear warheads across continents. Satellites placed in orbit excelled in reconnaissance and surveillance to monitor other countries' activities. They also proved their worth as excellent communication relay platforms, used first by the military, but later by commercial operators as well.In this way they have provided global communications and broadcast services.

Not all space-bound activity was limited to orbital space even during early times of the 1st space age. Spacecraft for scientific research were sent to various stellar objects, and probes were landed on nearby planets; those were hi-tech, hi-budget missions that only the two superpowers could afford. The most significant outreach beyond orbital space come in 1969 when the US landed on the Moon. This was the first, and for the time being, the last manned spacecraft which travelled beyond orbital space.

While the First Space Age was a competition between the USSR and the US, the Second Space Age was characterized by an increased number of actors and a greater spread of more accessible technology. In addition to the technological and commercial objectives of both state and non-state actors, states sought greater competence in military capability and defense.These considerations made it desirable for them to have a presence in

[14]Oduntan, "Who owns space?"

space.Whereas the so-called First Space Age ended with some activities already in deep space, during the Second Space Age, orbital space again gained prominence.As the number of satellitesincreased, competition revived. This phase of the space age started in the late-1990s, roughly after the collapse of the USSR. In the early 2000s, the US had dominance in orbital space, owning 90 percent of all military satellites and 60 percent of all commercial satellites.[15]However, as time passed, the proportions changed. At present, China, Japan, Europe and India have gained prominence regarding their numbers of launches and satellites.[16]The increase has not only been in the number of actors, but also in the variety and number of satellites. The proportion of commercial satellites, which was 4% in the First Space Age, has now increased to 36% in the Second Space Age.[17]

Although the US has tried to limit access to space, the technology needed has become accessible to many actors, which has made this Second Space Age more diverse. The US, which finished the First Space Age as leader in the field, has begun to perceive threats from many directions, and realized that it may not keep its predominance in space forever. While some countries try to increase and secure their use of space, they attempt to prevent others from doing the same.This has led to the development of technologies to damage, harm or interfere with the satellites of others. As we will be further elaborating in the sixth chapter, it is possible to create threats in space that could cause serious consequences. Cyber or electronic attacks, directed energy weapons such as lasers, anti-satellite missiles, militarized spacecraft, and even space mines have been developedand sometimes deployed.[18]For this reason, it is possible to consider the Second Space Age as more dangerous and potentially destructive than the previous one.

[15]Andy Oppenheimer, "Arms Race in Space," *Foreign Policy* 138 (2003): 81, accessed March 14, 2019, https://www.jstor.org/stable/3183664.
[16]Colin Clark, "CSIS On The Second Space Age: 'Diverse, Disruptive, Disordered And Dangerous,' *Breaking Defense*, October 4, 2017, accessed February 16, 2019, https://breakingdefense.com/2017/10/csis-on-the-second-space-age-diverse-disruptive-disordered-and-dangerous/.
[17]Todd Harrison et al., "Escalation & Deterrence in the Second Space Age," *CSIS* October (2017): 11, accessed March 3, 2019, doi: 10.13140/RG.2.2.15240.11525.
[18] Clark, "CSIS On The Second Space Age."

2.3. Deep Space: Third Space Age?

Today, deep space is more under the spotlight than it was in the First and Second Space Ages. There are new and promising commercial prospects shaping around deep space, like space tourism, asteroid mining, exploration of both the Moon and other celestial bodies and even the possibility of colonizing them. Although scientific research has not completely lost its importance, the necessary technology appears to be increasingly mature and available to enable the use of deep space for purposes other than pure research. This is the realm of economic benefits,andincludes exploitation of mineral and ores to be found on celestial objects.Among the object of interest, asteroids are important because they are mainly made up metals and rocky material.Comets, on the other hand, consist of ice, dust and rock. The human space adventure, which began with Sputnik, is acquiring a totally different dimension as experiences accumulate over the years and technology progresses.

Besides the US, which has had the technological lead, China has possibly the greatest ambition in these new areas. China is making preparations to set up a base on the Moon, with the collaboration of the European Space Agency (ESA).[19]It accomplished a landmark success recently by landing on the dark side of the Moon, something which no other space power has been able to do.[20] For a country aiming at exploiting economicresources in space, this is a critical step. Reaching the water which is known to exist under the poles of the Moon, and extracting hydrogen from it,could provide fuel to travel deeper into space. This could pave the way for a permanent settlement on the Moon, which is one of China's ambitions. Beyond that, China also aims to expand its presence and power deeper into space.[21]The cultural, sociological, political and

[19]Neil Connor, "China plans to build manned 'lunar palace' powered by the sun," *The Telegraph*, April 25, 2018, accessed March 23, 2019, https://www.telegraph.co.uk/news/2018/04/25/china-plans-build-manned-lunar-palace-powered-sun/.
[20]Namrata Goswami, "The new space race pits the U.S. against China. The U.S. is losing badly," *The Washington Post*, January 10, 2019, accessed January 20, 2019, https://www.washingtonpost.com/opinions/the-new-space-race-pits-the-us-against-china-the-us-is-losing-badly/2019/01/10/bcdcad10-14f9-11e9-b6ad-9cfd62dbb0a8_story.html?noredirect=on&utm_term=.198617642779.
[21] Namrata Goswami, "China in Space Ambitions and Possible Conflict," *Strategic Studies Quarterly* 12, no. 1 (2018): 85-87, accessed March 20, 2019, http://www.jstor.org/stable/26333878.

psychological characteristics of the Chinese,arising from theirpast history, provide motivation to make serious investments in order to become a leader in space.[22]

On the other hand, the US also wants to prove its dominance in this field. As we will discuss in the following chapters, the US has recently decided to rejuvenatea dedicated Space Force. Such a force was first suggested in 1982 by the US Congress[23]in order to sustain and safeguard satellites and other vehicles in space.[24]The US Congress is also enacting new laws to regulate commercial activityon celestial objects and deep space activities in general, all of which seem to indicategrowing US ambitionsin deep space. For example, SpaceX, a US company, has already started laying the groundwork for missions to land manned spacecraft on Mars and even to colonize it.[25]

The Space Age, which started with activitiessolelyinvolving state actors, has now assumed a different character.Increasingly it involves private companies, and sometimes both states and companies.[26]In the same way, when the continent of America was first discovered, it became attractive for peopleto settle there because of its untapped resources, and thus it became colonized. With the depletion of our own planetary resources on one hand, and the growing world population on the other, celestial bodies containing rich ores and minerals now lie open to exploration and exploitation. They are becoming the new focus of attention for human activity and possible settlement. We are facing a period in space that will be dominated by the expectation of accessing these resources and eventually colonizing celestial bodies.At the same time, a whole variety of new actors aim to benefit from these possibilities. One of the most prominent, new private actors, Elon Musk of SpaceX, says that he wants to see a new space race.[27] The

[22] John Hickman, "China is winning the space race," Foreign Policy, August 3, 2013, accessed April 20, 2019, https://foreignpolicy.com/2013/08/03/china-is-winning-the-space-race/.
[23]Justin Bachman and Travis Tritten, "Why Trump Wants a Space Force for the Final Frontier," *Bloomberg Businessweek*, August 6, 2018, accessed March 3, 2019, https://www.bloomberg.com/news/articles/2018-08-06/what-s-a-space-force-and-can-trump-really-start-one-quicktake.
[24]Jeremy Rehm, "What is the US Space Force?" *Space*, October 10, 2018, accessed March 3, 2019, https://www.space.com/42089-space-force.html.
[25]Elizabeth Howell, "Elon Musk: Private Space Entrepreneur," *Space*, August 8, 2018, accessed March 3, 2019, https://www.space.com/18849-elon-musk.html.
[26] Alan Yuhas, "The new space race: how billionaires launched the next era of exploration," *The Guardian*, February 9, 2018, accessed April 17, 2019, https://www.theguardian.com/science/2018/feb/09/new-space-race-billionaires-elon-musk-jeff-bezos.
[27]Ibid.

ambition and motivation for creating a Third Space Age focusing on deep space,clearly already exist at the present time. The tough question is whether the technology required to attain these goals is already available or not. This is what we shall look at next.

CHAPTER 3

COMMERCIALIZING DEEP SPACE: REQUISITES

A prime motivation and justification for travelling deep into space isspace mining. Another is colonization and human settlements. Ores contained in celestial bodies could in the future be removed and exploited by mining their surface. Space mining is currently still in its introductory and testing phase.Before it can be fully established, there are two categories of challenges that must be met. The first is the technological challenge and the second is the need for cost efficiency. On the technological side, obstacles that must be overcome include launching the spacecraft into space, refueling it for long journeys, locating and extracting ores, and processing them. Finally, the extracted materialswould have to be either used in space or brought back to Earth. However, even when necessary technology becomes available and is successfully implemented, it is still vitally important that the entire enterprise is economically justifiable. Otherwise, even if the technology is available, exploration and exploitation of deep space for commercial ends will not happen.

3.1. Technological & Cost Considerations

3.1.1. Getting into Deep Space

The first problem is how to reach the celestial bodies. It is already technologically possible to launch spacecraft into space and make them travel into deep space. However, it is extremely costly to lift spacecrafts offthe Earth and send them off into space. It takes approximately $10,000 to send out one kilogram of payload;[28] and 19 tons of propellant are needed to get one ton of payload away from Earth.[29]The cost is so huge because most of the weight of the spacecraftconsists of the propellant used for lift-off and the journey through space. In addition, re-usable rocket technology is already slashing back costs considerably. Another way to reduce this prohibitive expensewould be to eliminate the need to send spacecraft from the Earth each time. Great savings could be achieved by starting the journey from a position in space or even from other celestial bodies, such as the Moon. The energy required to escape from the Moon is much lower than that needed to escape from the Earth. Thus it may be more logical to send the spacecraft first to the Moon and then from there to other celestial bodies. Such spacecraft could even be eventually assembled on the Moon. Then, once established in space, they won't need to travel back to the Earth on each trip.By staying in space throughout their service life, they will eliminate a major portion of space launch expenses.

The components of water, hydrogen and oxygen, are essential both for supporting life and also as fuel for rockets. So, the first necessity for space travel is water. Water is present in the Moon; its poles are estimated to hold hundreds of millions tons of water in the form of ice.[30] Once the lunar ice is extracted, it can be melted and electrolyzed by solar-generated power, and its components separated.[31] Using hydrogen in space as

[28]Ross Pomeroy, "Will we ever stop using rockets to get to space?" *Space*, August 19, 2018, accessed May 23, 2019, https://www.space.com/41432-will-we-ever-stop-using-rockets-to-reach-space.html.
[29] Goswami, "The new space race pits the U.S. against China."
[30] Ibid.
[31]Robin McKie, "The lunar gateway: a shortcut to Mars?" *The Guardian*, September 22, 2018, accessed May 5, 2019, https://www.theguardian.com/science/2018/sep/22/the-lunary-gateway-the-future-is-closer-than-you-thought-nasa-esa-orion-jaxa-mars-mission.

rocket fuel is significantly cheaper than returning to Earth for refueling or taking fuel from Earth to space.[32] Once this is achieved, reusable rockets can be used; and they will not need to come back to Earth for fueling.[33] Thus longer and cheaper flights will be possible. The good news is that the technological feasibility of this has already been proven. In 2011, in the Robotic Refueling Mission managed by the National Aeronautics and Space Administration(NASA), a robot-actuated transfer of fuel was achieved on a platform on the ISS.[34]

However, the imperative to start deep space journeys from celestial bodies such as the Moon gives rise to another challenge: funding the initial cost of setting up facilities on the Moon or other celestial bodies such as asteroids, and rendering them sustainable. Such a station could then be used for starting, ending and/or refueling for journeys into deep space. Such facilities do not need to be manned, which makes the task easier. 3D printing and artificial intelligence technology, which means creating machines that learn from experience, would be available to build and sustain those facilities, and even repair or build spacecraft to travel from them.

NASAhas a mission in progress for autonomous base construction, mining and resource management for colonization of the Moon and Mars.[35] Likewise, China also has plans to create autonomous, unmanned bases on the surface of the Moon,to be built and operated using unmanned technology,[36] and artificial intelligence would be fully integrated into it.

The reader may have noticed all technical predictions so far have focused on unmanned missions and technologies. This is because they are preferable to manned missions which would bemuch more difficult; a possibility of failure of even1% probability may

[32]K. W., "Who owns what in outer space," *The Economist*, June 12, 2018, accessed February 20, 2019, https://www.economist.com/the-economist-explains/2018/06/12/who-owns-what-in-outer-space.
[33] Shura Collinson, "Asteroid mining: Russian experts call for action in the new space race," *Skolkovo*, October 20, 2017, accessed May 16, 2019, https://sk.ru/news/b/articles/archive/2017/10/20/asteroid-mining-russian-experts-call-for-action-in-the-new-space-race.aspx.
[34]Victor Tangermann, "A timeline for humanity's colonization of space," *Futurism*,October 30, 2017, accessed July 2, 2018, https://futurism.com/a-timeline-for-humanitys-colonization-of-space.
[35] Tristan Greene, "NASA is developing AI to give directions in space," *The Next Web*, August 2018, accessed April 22, 2019, https://thenextweb.com/artificial-intelligence/2018/08/22/nasa-is-developing-ai-to-give-directions-in-space/.
[36]Jean-Michel Valantin, "The Chinese-Russian robot and space strategic cooperation (1) – China," The Red Analysis Society, January 8, 2018, accessed March 19, 2019, https://www.redanalysis.org/2018/01/08/chinese-russian-robot-space-strategic-cooperation-1/.

not be acceptable due to the risk to human life. Besides, more equipment is needed in design of manned spacecraft and installations, and every item added for this purpose would mean extra cost. Existing manned vehicles and laboratories are all in orbital space, and it is comparatively easy to access them and intervene in the event of an emergency. "*However, rapid access to a manned spacecraft in deep space isimpossible* [due toenormous distances involved]".[37]Endangering human life is in any case not acceptable. When manned activity is excluded, the so-called time-delay problem makes the use of artificial intelligence imperative. Because of the extreme distances at stake, it will not be possible to provide real-time communication and command between Earth and outgoing vehicles and facilities. It takes 17 seconds for radio waves to reach a probe on Mars, and another 17 seconds for them to travel back – too long a delay for time-critical actions and processes."*For this reason,spacecraft in deep spacemust make decisions and implement those decisions on its own*", which could be achieved through the use of artificial intelligence.[38]

Besides artificial intelligence, 3D printing technology, which enablesmanufacturing of required hardware in space[39] is likely to play a critical role in this process.[40] In the upcoming years, robots will be the main operators of 3D printing, they will be able to manufacture the necessary product parts and assemble them.[41]In this way, the need tospend time and money for repairs or supplying new equipment from the Earth would be eliminated.

3.1.2. Extraction and Processing

Once celestial bodies are reached, extraction of their valuable content also necessitates adaptation of certain technologies to the space environment. But before even starting, it is necessary to identify the celestial object to be exploited from among approximately

[37] Interview with former director of a space institute, full text available in Appendix 2.
[38] Interview with senior executive of an aerospace consulting firm, full text available in Appendix 3.
[39]Tony Milligan, "Ethics for an 'off-world' economy," *Physics World* 29, no.8(2016): 17, accessed September 10, 2018, https://www.academia.edu/27492922/Ethics_for_an_Off-World_Economy_Physics_World_August_2016_p.17.
[40] Interview with senior executive of space programs of an electronics company, full text available in Appendix 1.
[41]Christopher Barnatt. The next big thing: From 3d printing to mining the moon. (CreateSpace Independent Publishing Platform, 2015): 6.

16,000 near-Earth objects.[42] For this purpose, satellites equipped with probes are already being sent to outer space in orderto measure the quantity and quality of water and minerals in celestial bodies. By using remote sensing technology, it may also be possible to determine what near-Earth asteroids or comets are made of while they are traveling close to Earth.[43]The next step is to dispatch vehicles to collect samples from such bodies, this will be necessary to guarantee profitable returns. NASA's Osiris-Rex and Japan's Hayabusa spacecrafts, which will be discussed in detail in the fourth chapter, are two ongoing projects intended exactly for this phase of deep space mining development.

After deciding which celestial body to target, the landing also needs to be carried out successfully. The spacecraft should be able to perform the necessary maneuvering to reach the appropriate location on the surface after leaving the celestial body's orbit.Since the area is smalland controlling the landing there is time-critical, it is necessary to take advantage of artificial intelligence to provide instant adjustmentwhen faced with unforeseencircumstances.

The stages of actual space mining are similar to those on Earth, involving various methods of drilling, blasting, cutting and crushing.[44]One method for extracting water from a celestial body is first to heat a part of thesurface with concentrated thermal energy from the Sun. Then the water will evaporate from the selected rocks and can be collected. Then it can be condensed or frozen again.[45] In order to remove ores in celestial objects, a scraping method would be used.[46] Since there is almost no gravity on the celestial bodies,a circumstance which makes the process easier, the necessary pieces of equipment must work by attaching themselves to the surface.

[42]Near-Earth Objects – NEO Segment, *ESA*, June 29, 2017, accessed March 5, 2019, http://www.esa.int/Our_Activities/Operations/Space_Situational_Awareness/Near-Earth_Objects_-_NEO_Segment.
[43]Caitlin O'Keefe, "How we choose our near-Earth asteroid targets," *Planetary Resources*, August 28, 2015, accessed March 5, 2019, https://www.planetaryresources.com/2015/08/how-we-choose-our-asteroid-targets/.
[44]Vide Hellgren, "Asteroid Mining-A review of methods and aspects" (Bachelor diss., Lund University, 2016: 14).
[45]Ibid: 17.
[46] Kevin Bonsor, "How asteroid mining will work," *How Stuff Works*, accessed March 6, 2019, https://science.howstuffworks.com/asteroid-mining2.htm.

The next stage is either transportation of extracts,or else processing them in space. For processing in space, the extracts may be collected by means of vehicles and brought to facilities built on the Moon or stationed in Earth's orbit. A planned robotic asteroid mining system, called Cornucopia, which has been developed by Kepler Energy and Space Engineering,is intended to carry 40 metric tons of asteroid material to LEO. The company believes this could be possible within a decade.[47]In such a facility, which would be constructed by robotic systems using artificial intelligence, processing of extracts would also be carried out by unmanned technology.

Many different elements can be found on asteroids. When they are processed,useful components can be manufactured out of them by 3D printing. Such components can be used in spacecraft, and also employed to build new facilities on celestial bodies.[48]This technique has already been tried and proven for iron-nickel alloys which may conveniently constitute the basis of future space structures.[49] Already, a company named Made in Space manufactures necessary devices and tools for 3D printing in space; they are currently intended for use on the ISS.[50]

As mentioned above, where there is water on celestial bodies, it can be used directly as fuel for spacecraft, without having to bring fuel from Earth. It is most likely that the first extracted mines, together with water, would be used to create a new manufacturing cycle in space.This could make it possible to construct new space settlements for people. A confined space economy of this sort may soon flourish.It would enable a supply-demand cycle for human settlements andspace tourism to be established, using the available resources processed in space. At the beginning, such resources would be used in the construction of robotic vehicles and bases, and after that for sustaining them.The final

[47]Deganit Paikowsky and Roey Tzezana, "The politics of space mining – An account of a simulation game," *Acta Astronautica*142, no. 1(2018): 11, accessed January 15, 2019, https://doi.org/10.1016/j.actaastro.2017.10.016.

[48] Rebecca Campbell, "Space mining is getting close to reality," *Mining Weekly*,December 15, 2017, accessed June 29, 2019, http://www.miningweekly.com/article/space-mining-is-getting-close-to-reality-2017-12-15-1/rep_id:3650.

[49] US Department of the Interior, US Geological Survey, *Feasibility Study for the Quantitative Assessment of Mineral Resources in Asteroids.*

[50]Joel Wooten, "A decade of commercial space travel – what's next?" *The Conversation*, September 27, 2018, accessed December 17, 2018, https://theconversation.com/a-decade-of-commercial-space-travel-whats-next-103405.

step would be development of human settlement. For such establishments, dependence on Earth may gradually decline and perhaps eventually cease altogether.

3.1.3. Bringing Back the Extracts

The problem of bringing valuable extracts back to Earth is an important issue that also creates challenges.It will be necessary for spacecraft to shuttle between the celestial objectwhich is being mined, and the terrestrial fuel station. To carry out the entire operation in space and to minimize such shuttle trips would make asteroid mining more feasible and profitable. Bringing the extracts to Earth is costly. But if they are needed on Earth, an asteroid which is suitable for mining might be moved to closer to Earth, for example into a lunar orbit or even into an Earth orbit. To achieve this, a powerful solar-electric propulsion system attached to the celestial objectcould be used.[51]Processing would take place in lunar or Earth orbit. The next challenge would be to land the extract on the Earth,a process complicated by entry into the atmosphere. The main obstacle is the extreme temperature created by such re-entry, caused by air friction. However, for solid extracts, unlikemanned spacecraft, this would not constitute a major problem because the extracts sent back to Earth would mostly be heat-resistant.[52] With the necessary steering apparatus attached to them, such transport could be achieved, and the costs would come down when the procedure became regularly used. Other approaches to lower costs are also possible. For example, Deep Space Industries is planning to develop a system for mining that allows many low-cost spacecrafts to move at the same time, collecting small amounts of substances from the near-Earth asteroids and moving them to a point which can be used as a depot between the Earth and the Moon.[53]

If things go as anticipated, Osiris-Rex of NASA will bring two kilos of asteroid resources to the Earth by 2023 and the mission will cost $1 billion. Deep Space Industries believes that it can accomplish the collectionof samples with its three Firefly

[51]Leonard David, "Is Asteroid Mining Possible? Study Says Yes, for $2.6 Billion," *Space*, April 24, 2012, accessed December 29, 2018, https://www.space.com/15405-asteroid-mining-feasibility-study.html.
[52]See Appendix 2.
[53] Zoë Corbyn, "The asteroid rush sending 21st-century prospectors into space," *The Guardian*, June 9, 2018. Accessed December 10, 2018. https://www.theguardian.com/science/2018/jun/09/asteroid-mining-space-prospectors-precious-resources-fuelling-future-among-stars.

vehicles for $20 million.[54] The Keck Institute for Space Studies states that moving an asteroid with a mass of 500.000 kilograms to a high lunar orbit will cost $2.6 billion.They are working to achieve this by 2025.[55]Such costs may be acceptablewhen the high economic returns on valuable minerals and rare Earth materials are considered in the future. An example is Helium-3, which is spread into space by solar winds but cannot reach the Earth due to the protection of its atmosphere. Itis abundant on the Moon because the Moon does not have any atmosphere.Helium-3 holds great potential for energy production on the Earth.[56]It can be used as fuel in nuclear power plants, it is environmentally friendly and produces little waste, and it is non-radioactive.[57]Overall, it is more efficient than the uranium and plutonium currently used for nuclear fission.[58]It is estimated that there may be millions of tons of Helium-3 on the Moon,[59]and every ton of it has a value of $1,3 billion.[60]In addition, according to NASA, the asteroids to be found in the belt between Mars and Jupiter may contain minerals worth 100 billion dollar for each individual on Earth.[61]Asteroids are rich in valuable elements which are rare on Earth,such as platinum, tantalum, rhodium or niobium.According to a calculation by the private company Planetary Resources, a single asteroid, the size of a football field, with platinum ore in it is worth between 25 and 50 billion dollars in today's market

[54] Rob Davies, "Asteroid mining could be space's new frontier: the problem is doing it legally" *The Guardian*,February 6, 2016, accessed December 1, 2018, https://www.theguardian.com/business/2016/feb/06/asteroid-mining-space-minerals-legal-issues.

[55]George D. Kyriakopoulos, "Legal challenges posed by the action of non-state actors in outer space," *Conflicts in Space and the Rule of Law*, June 2017: 284, accessed September 14, 2018, https://www.academia.edu/35855230/_Legal_Challenges_posed_by_the_Action_of_Non-State_Actors_in_Outer_Space_in_McGill_Centre_for_Research_in_Air_and_Space_Law_Maria_Manoli_and_Sandy_Belle_Habchi_eds._Monograph_Series_V_-_Conflicts_in_Space_and_the_Rule_of_Law_June_2017_p._273-290.

[56]Helium-3 Mining on the Lunar Surface, *ESA*, accessed March 21, 2019, https://www.esa.int/Our_Activities/Preparing_for_the_Future/Space_for_Earth/Energy/Helium-3_mining_on_the_lunar_surface.

[57] Ibid.

[58]Christopher Barnatt, "Helium-3 and Nuclear Fusion," *Explaining the Future*, accessed March 21, 2019, https://www.explainingthefuture.com/helium3.html.

[59]Randeep Ramesh, "India's unmanned moon mission may launch race for lunar landgrab," *The Guardian*, October 21, 2008, accessed March 21, 2019, https://www.theguardian.com/science/2008/oct/21/spaceexploration-india.

[60]Adrian Berry, "How China is sending man back to the Moon to mine safe nuclear power and become the world's energy giant," *The Telegraph*, February 29, 2016, accessed March 21, 2019, https://www.telegraph.co.uk/news/science/space/nightsky/12178122/night-sky-march-2016-china-space-mission.html.

[61] Andrew Wong, "Space mining could be a real thing – and it could be worth trillions," *CNBC*, May 15, 2018, accessed November 21, 2018, https://www.cnbc.com/2018/05/15/mining-asteroids-could-be-worth-trillions-of-dollars.html.

prices.[62]In the same way, some other minerals, such as gold, which are present on Earth but have the potential for depletion over time, may in the future be brought in from deep space.

3.2. Economically Viable or Not?

Our brief overview has revealed that all the technological prerequisites required for space mining areactually alreadyavailable. To illustrate this point, Japan has recently managed to send a spacecraft, called Hayabusa, to an asteroid, where it landed; moreover, it was able to collect samples and bring them back to Earth.[63]This Japanese undertaking was only for scientific purposes, and fullyfunded bythe state budget, so the main uncertainty associated with the cost of such an enterprise remains in question. Will such ventures ever be commercially viable and profitable? The rising prices of dwindling natural resources on Earth, and possibly the total depletion of certain critical ores, may render these costs bearable in the future. Another important factor is the nature and continuity of the costs at stake. The upfront investment required to develop the necessary technologies and designs, and create the necessary infrastructure, will be very high. Spacecraft, fuel stations, and the necessary hi-tech facilities, involving artificial intelligence and 3D printing are very expensive. But these costs only apply to the first stage; in other wordsthey are non-recurring. Once the upfront cost threshold is crossed, costs will drop dramatically and profits will start coming in. Once the cycle is in place and deep space activity becomes routine, its cost-efficiency will most likely improvea great deal. Besides contributing to the world economy, a new economic cycle could be created in space, using supply and demand generated within space itself. Thinking of asteroids as multi-billion or trillion-dollar resources, we should realistically expect such investment and development in the not too distant a future.

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[62] Andrew Zaleski, "Luxembourg leads the trillion-dollar race to become the Silicon Valley of asteroid mining," *South China Morning Post,* April 18, 2018, accessed July 5, 2018, https://www.scmp.com/news/world/europe/article/2142100/luxembourg-leads-trillion-dollar-race-become-silicon-valley.

[63]Jonathan Amos, "Japanese Hayabusa asteroid mission comes home," *BBC*, June 13, 2010, accessed December 11, 2018, https://www.bbc.com/news/10285973.

CHAPTER 4

DEEP SPACE: ACTORS

Attracted by the pull of space, besides states, we already observe a large number of non-state actors venturing out into deep space. In 2011, according to the report of Newspace Global, there were 125 companies operating in deep space industries; by 2015 this number had jumped to 900.[64] This huge increase is indicative of the perceived commercial potential of working in deep space. Companies,realizing the size of the profits at stake, are positioning themselves to get a share of the economic activity and upcoming market. There is a distinct similarity between this development and the discovery of new lands and continents which whetted the appetites of states and traders five centuries ago.Deep space is having similar effect on technologically advanced states as well as onnon-state actors today.

[64] Ebru Çolak, "Göktaşında Maden Aramak," *Derin Ekonomi,* May (2016): 76.

4.1. Old Players: States

It has already been explained that, during the Cold War, the US and the USSR were pioneers in space. Their competitionadvanced into deep space and was transformed after the collapse of the USSR, when other state actors also became involved.

The US has traditionally been the most important actor in space. However, its ambitions have variated according to which president was in office. During the presidency of George W. Bush Jr. (2001-2008), sending men to the Moon was on the US agenda; but President Obama (2009-2016) ignored this plan and concentrated instead on travelling to Mars and examining the asteroids. Now, during the Trump administration (from 2017 onwards),asteroids have fallen out of favor. Instead, reaching the Moon and establishing a spaceport on it has become important again. With this aim, the US has been cooperating with Russia, another important actor in the space race, to try to set up the first space station on the Moon.[65]In addition to this, a constant theme in the US, and a long-term goal of the NASA space program, is a journey to Mars.[66]They hope ultimately to create a human settlement there.[67]

The Parker Solar Probe, launched by NASA in August 2018, is the fastest-moving man-made object in history.[68]At first it flew towards Venus, but then began the journey towards its main destination, which is the Sun.[69] This project is important because it shows that it is possible for the US to travel into the depths of space. Another important project is currently being carried out on Mars; the lander called InSight has already deployed a probe which is digging the surface of the planet in order to measure

[65] Agence France-Presse, "Russia and US will cooperate to build moon's first space station," *The Guardian*, September 27, 2017, accessed February 21, 2019, https://www.theguardian.com/science/2017/sep/27/russia-and-us-will-cooperate-to-build-moon-first-space-station.
[66]Ibid.
[67]US Department of the Interior, US Geological Survey, *Feasibility Study for the Quantitative Assessment of Mineral Resources in Asteroids.*
[68] Jonathan Amos, "Parker Solar Probe: Nasa delays mission to unlock Sun's mysteries," *BBC*, August 11, 2018, accessed January 29, 2019, https://www.bbc.com/news/science-environment-45058911.
[69]Dwayne Brown et al., "NASA, ULA Launch Parker Solar Probe on Historic Journey to Touch Sun," *NASA*, August 12, 2018, accessed November 29, 2018, https://www.nasa.gov/press-release/nasa-ula-launch-parker-solar-probe-on-historic-journey-to-touch-sun.

temperatures.[70]Clearly, this kind of probe can also be used to collect material samples from the surfaces of celestial objects.

In addition to resurrecting the idea of creating the Space Force, the Trump administration has extended the scope of the US Departments of Commerce and Transportation to include space-oriented trade in conjunction with the ongoing space exploration.[71]It has also revived the National Space Council to preparethe ground for changes in space policy.[72] Modified US policies now includeencouraging the participation of private companies in deep space activities, and creating a favorable legal basis for state and private companies to acquire property ownership rights over the resources of celestial bodies.[73]

At the same time, the US is spending federal funds on a multiplicity deep space programs. Funded by the US federal budget, NASA managed to get a probe into orbit around a near-Earth asteroid in the year 2000, and to land the probe there in 2001.[74]NASA alsoestablished the presence of water on the Moon in 2009.[75] In a speech in January 2018 for NASA, it was stated that research on the Moon aims to explore sources of water and other minerals, and find out whether conditions might be suitable for life, production of fuel and other materials, and construction.[76] 50 years after people landed on the Moon, NASA is now planning to send a human being beyond it. As a first step towards this plan, aspacecraft will first travel unmanned to the Moon to determine if the spacecraft may besuitable for manned travel to distant planets.If so, the first manned test flight beyond the Moon may be carried out by NASA in 2021.[77]An international manned station on the Moon, named Gateway, will be set up with thecooperation of

[70]Andrew Good, "Mars InSight Lander's 'Mole' Pauses Digging," *NASA*, March 5, 2019, accessed March 7, 2019, https://mars.nasa.gov/news/8419/mars-insight-landers-mole-pauses-digging/?site=insight.
[71]Sean Kanuck and Alana Vogel, "The down of a new strategic era in outer space," *IISS*, September 24, 2018, accessed October 28, 2018, https://www.iiss.org/blogs/analysis/2018/09/iiss-observatory-24-sept.
[72]Rand Simberg, "The return of the space visionaries."*The New Atlantis*, no. 56(2018): 63, accessed October 20, 2018, https://www.jstor.org/stable/10.2307/26498244.
[73] Ibid.
[74]Matthew Shaer, "The asteroid miner's guide to the galaxy," *Foreign Policy*, April 28, 2016, accessed July 18, 2018, https://foreignpolicy.com/2016/04/28/the-asteroid-miners-guide-to-the-galaxy-space-race-mining-asteroids-planetary-research-deep-space-industries/.
[75]Barnatt. *The next big thing: From 3d printing to mining the moon*.
[76] Simberg, "The return of the space visionaries": 62.
[77] Tangermann, "Humanity's colonization of space."

Russia, Canada and Japan. It will enableastronauts to examine the surface of the Moon and develop new techniques for its exploration.[78]

Another current mission of NASA concernsthe Osiris-Rex spacecraft which was launched towardsan asteroid[79]in December 2018.[80]The asteroid isthought to be rich in water-bearing clay minerals, and also believed to hold$1 quadrillionworth of iron ore.[81] Osiris-Rex will collect samples and bring them back to Earth.[82] The actual landing on the asteroid's surface will be achieved in 2020. The probeshould return to the Earth in 2023 with almost 2 kg of dirt and rock samples, which would be the largest amount ever collected in deep space so far.[83]

NASA has also undertaken the world's first in-depth analysis of Jupiter, with its Juno probe, which entered the planet's orbit in 2016.[84]In addition to this, NASA sent a 3D printer into space in 2016 so that astronauts in the ISS can manufacture items they need while in space.[85]

Although many technological developments have been accomplished by the US; China and Russia have recently been making significant progress, too. Moreover, if the US does not increase its pace of progress, it may soon be left behind. The reason why the US may be losing its dominance is the decrease in the federal budget allocated to technology and science.[86]To reverse this trend, it is encouraging its private enterprises to

[78]McKie, "The lunar gateway."
[79]Nancy N. Jones, "Successful second deep space maneuver for Osiris-Rex confirmed," *NASA*, July 3, 2018, accessed October 21, 2018, https://www.nasa.gov/feature/goddard/2018/osiris-rex-executes-second-deep-space-maneuver.
[80]*NASA launches Osiris-Rex space probe to collect asteroid samples – video*, The Guardian, September 9, 2016, accessed August 5, 2018, https://www.theguardian.com/science/video/2016/sep/09/nasa-launches-osiris-rex-space-probe-asteroid-bennu-samples-video.
[81]Monique Scotti, "NASA plans mission to a metal-rich asteroid worth quadrillions," *Global News*, January 14, 2017, accessed September 3, 2018, https://globalnews.ca/news/3175097/nasa-plans-mission-to-a-metal-rich-asteroid-worth-quadrillions/.
[82] Corbyn, "21st-century prospectors into space."
[83]Doug Messier, "10 reasons why nasa is visiting asteroid Bennu," *Parabolic Arc*,August 18, 2018, accessed October 11, 2018, http://www.parabolicarc.com/2018/08/28/bennu-10-reasons/.
[84]*NASA scientists celebrate as Juno probe successfully enters orbit around Jupiter – video*, The Guardian, July 5, 2016, accessed September 21, 2018, https://www.theguardian.com/global/video/2016/jul/05/nasa-scientists-celebrate-as-juno-probe-successfully-enters-orbit-around-jupiter-video.
[85] Çolak, "Göktaşında Maden Aramak,": 76.
[86]John R. Allen and Amir Husain, "The next space race is artificial intelligence," *Foreign Policy*, November 3, 2018, accessed March 21, 2019, https://foreignpolicy.com/2017/11/03/the-next-space-race-is-artificial-intelligence-and-america-is-losing-to-china/#.

invest in deep space and related technologies. For example, Washingtonis now counting on a private enterprise, called SpaceX, with its re-usable launch vehicles, to send astronauts into space.[87]

Another US agency, the United States Geological Survey, focuses on space resources. It investigates the locations and the values of resources, especially on asteroids and on the Moon, and predicts what benefits might eventually be obtained from their exploitation.[88]

Besides US, another state actor vying for a major role in deep space is China. Since the 1990s, China has gained the leading position in the extraction of minerals on Earth – a title previously held by the US until the 1980s. Nowadays, 95% of the world's demand of rare minerals and ores (which are rare on Earth,but required for production of high-technology devices) is met by China. In fact, China confidently reducedits exports in this field in 2009,causing prices to rise and creating a silent crisis with the US.[89]

China is of the opinion of that, if it does not take action fast, it will be losingimportant, mineral-rich mining locations in space to the US, Japan and others.[90] Based on this conviction, it has made a major effort to accelerate the pace of its space activity. One of the major aims of Chinais to establish a manned space stationby 2020-2022, through which it will be able to develop technology and explore deep space.[91] In a 2015 report in which China's plans for a space transportation system were described, it was mentioned that nuclear-powered space shuttles would be developed.[92] This development would help with exploring deep space, and also enablelong-distance space travel and asteroid mining.[93]In a white paper of 2016, exploration of mineral resources on the Moon and asteroids were identified as a priority.[94] It was stated in the same paper -China's Space

[87] Hickman, "China is winning the space race."
[88] Leonard David, "The US geological survey is getting serious about space resources and mining," *Space*, September 4, 2018, accessed April 19, 2019, https://www.space.com/41707-space-mining-usgs-resource-survey.html.
[89] Ibid.
[90] Goswami, "China in Space,": 74.
[91] Ibid.
[92] Liang Jun, "China to Achieve 'Major Breakthrough' in Nuclear-powered Space Shuttle Around 2040: Report," *People's Daily Online,* November 17, 2017, accessed September 18, 2018, http://en.people.cn/n3/2017/1117/c90000-9293719.html.
[93]Tian He, "China sees 'breakthrough' in nuclear-powered space shuttles by 2040," *Global Times*,November 17, 2017, accessed October 20, 2018, http://www.globaltimes.cn/content/1075834.shtml.
[94] Goswami, "China in Space": 84.

Activities in 2016- that it intended to launch its first Mars probe by 2020, collect samples from Mars, and explore asteroids.[95]The estimated date for all this is sometime between 2020-2025.[96]In support of these plans, China already has a space lab and a cargo spacecraft with which in-orbit refueling can be carried out.[97]

Clearly, a competition is fast developing between the US and China in this domain, and China is already seen as NASA's major rival. China aims to double its budget for space exploration from the period 2011-2015 to that of 2026-2030. Although the goal is to catch up with NASA, this doubled investment barely bringsChina up to half of NASA's $5 billion annual spending.[98]However, the increase in China's spending has been phenomenal.10 yearsago China made no efforts and spent no money whatsoever in this field, and its investments,mostly in orbital space, weresolely for political or military purposes.[99]

Although China has tried to catch up with other countries in the field of space and has been making efforts in the race, until recently it has lagged behind in a number areas. For example; whereas the US, Japan and Europe allmanaged to take photos of an asteroid using unmanned spacecraft, China was only the fourth player to achieve this, and then only in 2015.[100]This trend, however,has being recently reversed and China is now taking the lead in certain fields. In January 2019, the Chinese spacecraft Chang'e 4 landed on the unexplored dark side of the Moon. This was a demanding technological feat that no other country had ever achieved. It signifies a big first step towards future missions, whereby China inches forward, ahead of all other actors, toward colonizing the Moon. Next in line for China is the task of sending robotic probes to the north and south poles of the Moon by 2030,probably again ahead of other space actors.[101]

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[95]The Information Office of the State Council, *China's Space Activities in 2016: III. Major Tasks for the Next Five Years.*
[96] Goswami, "China in Space": 85.
[97] Ibid: 76.
[98] Bloomberg News, "China's Secretive Space Program Threatens NASA'S Dominance," *Bloomberg*, November 28, 2016, accessed April 26, 2019, https://www.bloomberg.com/graphics/2016-asia-space-race/china.html.
[99] Ibid.
[100] Goswami, "China in Space": 85.
[101] Goswami, "The US against China."

The third of the principal state actors in space is Russia. The Soviet state and its successor, the Russian Federation,has worked and invested in deep space ever since the early Cold War years.[102] Most recently, in 2011, Russia has attempted to land a probe on Phobos, a satellite of Mars, to collect soil samples, but the mission ended in failure. After that, because of lack of funds, Russia has not been able to continue with new deep space programs.[103]

Like Trump of US, Putin of Russia wants to declare his country to be a superpower in space. To achieve that, Russia is planning to allocate approximately $40 million to explore mining on the Moon, a miniscule amount in comparison to US and Chinese spending.[104]Nonetheless, Russia maintains its ambitions to colonize the Moon, mine its resources, and become a superpower in space.[105]The main limitation for Russia in deep space exploration is economic. To overcome this hurdle, the Russian Aviation and Space Agency, Rosaviacosmos, is seeking international collaboration. It has already offered NASA collaboration in 2000, in which Russian rockets would be used in NASA's planetary missions in return for a fee.[106]However,this mission was canceled and Russia then turned toward Europe. ESA and Russia are currently working on projects for exploring and researching the Moon's resources.[107]

The worsening political climate between the US and Russia has also ledMoscow to explore cooperation with China. Those two countries made an agreement in 2017 to establish a mutual data center for deep space programs, and to research the Moon and deep space jointly for a four-year period.[108]

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[102] Anatoly Zak, "Unmanned missions to Mars," *Russian Space Web*,June 18, 2018, accessed November 5, 2018, http://www.russianspaceweb.com/spacecraft_planetary_mars.html.
[103] Ibid.
[104]Thomas Mackie, "Revealed: Putin's plan to mine on the moon as Russia plots to be superpower in space," *Express*,November 18, 2017, accessed April 21, 2019, https://www.express.co.uk/news/world/881102/putin-russia-mining-moon-astronauts-luna-space-moscow-soviet-union-fedor-planets.
[105] Ibid.
[106] Zak, "Unmanned missions."
[107]Leonard David, "Prospecting on the Moon: Russia, Europe to hunt for lunar ice," *Space*,August 29, 2018, accessed December 25, 2018, https://www.space.com/41653-moon-mining-europe-russia-prospect-project.html.
[108]Shubham Sharma, "Russia teaming up with China for moon and deep space exploration," *International Business Times*,June 9, 2018, accessed September 15, 2018, https://www.ibtimes.com/russia-teaming-china-moon-deep-space-exploration-2689060.

While Russia has been looking for partners, India has also asked for cooperation. India wants to achieve a manned space mission by 2022, with the help of Russia.If India reaches its goal it will be the fourth country to have launched a manned space mission, after Russia, the US and China.[109]

So far, India's first Moon mission has succeeded; the spacecraft Chandrayaan-1 entered the orbit of the Moon in 2008.[110]On the subject of water, the instruments on the spacecraft were able to detect surface and sub-terranean ice in the Moon.[111] India has also been fortunate in its endeavour concerning Mars; in its first attempt in 2013 it succeeded in placing a probe in the orbit of Mars.[112] An important difference between India and other space-faring nations involves costs. Its Mars mission has been hailed as a very cost-effective one."*India has been producing satellites at very low costs*, [and]*India could become a major player in the field of deep space in the medium to long terms.*"[113]

Besides India, Israel is yet another country that might become the 4th state to land on the surface of the Moon, following Russia, the US and China. AnIsraeli spacecraft lifted off in February 2019, intended to land on the surface of the Moon in April.[114]But the mission failed because of technical problems.[115]If this landing had been successful, the lander would haverecorded images and sent them back to Earth, and it would also have doneresearch on the Moon's magnetic field.[116] But there is a very important difference between Israel andthe other actors who have already reached the Moon: the Israeli Moon mission is run by a private organization,whereas all the previous landings by the other

[109]Jayanth Jacob, "India seeks Russia's help for Gaganyaan mission to put man in space by 2022," *Hindustan Times*,September 22, 2018, accessed October 25, 2018,https://www.hindustantimes.com/india-news/india-seeks-russia-s-help-for-gaganyaan-mission-to-put-man-in-space-by-2022/story-gWcaQbUQUNxCoTam9RmvaJ.html.
[110]Department of Space, *Space Science & Exploration.*
[111]Loren Grush, "Israeli spacecraft poised to become first privately funded lander on the Moon," *The Verge*, February 19, 2019, accessed March 19, 2019, https://www.theverge.com/2019/2/19/18228611/spaceil-israel-lunar-lander-beresheet-spacex-falcon-9-mission.
[112] Zak, "Unmanned missions."
[113]See Appendix 3.
[114]Kenneth Chang, "After SpaceX Launch, Israeli Spacecraft Begins Journey to the Moon," *The New York Times*, February 21, 2019, accessed March 21, 2019, https://www.nytimes.com/2019/02/21/science/spacex-launch-israel.html.
[115] Ari Rabinovitch, "Israeli spacecraft crashes onto moon after technical failures," *Reuters*, April 11, 2019, accessed April 22, 2019, https://www.reuters.com/article/us-israel-space/israeli-spacecraft-crashes-onto-moon-after-technical-failures-idUSKCN1RN1PY.
[116] Grush, "Israeli spacecraft-first privately funded lander."

three countries were funded and run by state institutions.[117]Israel's so-called SpaceIL is a non-profit organization which aims to encourage the next-generation of youngstersin Israel to study science, technology, engineering and mathematics.[118]

Japan, another actor in space, is the first and only country to have so far collected samples from an asteroid. In 2010, the Japanese spacecraft Hayabusa managed to bring back to Earth a symbolic 1 milligram sample from the asteroid Itokawa.[119] Another sample-return operation took place in December 2018, when the spacecraft Hayabusa-2 reached the asteroid Ryugu.[120]The return to Earth of the sample from there is scheduled for 2020.[121] These samples will be examined primarily to gain more information about the solar system's early days,[122]but the implications and possible future benefits, in terms of verifying Japan's ability to reach other celestial bodies and taking extracts back to Earth, are obvious. Meanwhile, Japan had plans for Mars that dated back to 1998; but its mission to enter the orbit of Mars failed in 2003.[123]

As China increases its domination in Asia, India and Japan are being pushed to cooperating more closely with each other in various realms, including space. Those two countries aim to jointly achieve the capacity to rival China, especially with respect to lunar missions.[124]

Luxembourg is yet another, if unlikely, state with a keen interest in deep space. But this interest is limited to economic and legal dimensions. Because it is a very wealthy countrywith a small population, Luxembourg watches for business opportunities related to deep space that it can invest in.[125]The mission of the Luxembourg Space Agency is to

[117]Stuart Winer and Shoshanna Solomon, "Israeli spacecraft aims for historic moon landing… within months," *The Times of Israel*, July 10, 2018, accessed March 21, 2019, https://www.timesofisrael.com/in-first-israeli-spacecraft-set-for-trip-to-the-moon/.
[118]The Mission, *SpaceIL*, accessed March 21, 2019, http://www.spaceil.com/mission/.
[119] Amos, "Japanese Hayabusa."
[120]Corbyn, "21st-century prospectors into space."
[121] Paikowsky and Tzezana, "The politics of space mining."
[122]Mike Wall, "Japanese probe drops tiny hopping robots toward big asteroid Ryugu," *Space*, September 21, 2018, accessed October 15, 2018, https://www.space.com/41898-hayabusa2-deploys-hopping-robots-asteroid-ryugu.html.
[123] Zak, "Unmanned missions."
[124]Rajeswari Pillai Rajagopalan, "The global space race, 2.0," *The Washington Post*, February 13, 2018, accessed November 17, 2018, https://www.washingtonpost.com/.
[125]Mariana Cid De Leon Ovalle,"Luxembourg sets sights on space mining with new law," *Boss Magazine*, accessed February 4, 2019, https://thebossmagazine.com/luxembourg-space-mining/.

identify these economic opportunities.To promote development in Luxembourg, the Agency supports the space industry, offers funding to companies, and tries to attract new enterprises.[126] In addition to passing a law about utilization of space resources, it also provides funds to private companies ready to register in Luxembourg, and become subject to itsnational law.[127] For example, the government of Luxembourg signed a Memorandum of Understanding in 2016 with a company called Deep Space Industries. The aim was to co-fund the development of a spacecraft that would be used, among other things, for the exploration and commercialization of resources onnear-Earth objects.[128]

A last category of important, and long-term players in space concerns European states - primarily France, Italy, Germany and the United Kingdom. They run quite a few space programs individually. European states also enter into bilateral agreements for specific space projects comprising two or more states. In several space programs, they take advantage their cooperation through and within the umbrella of the ESA, a Europe-based organization aimed at coordinating the financial and intellectual resources of member states so as to undertake programs in space going beyond the scope of any single European country. The ESA comprises 22 European member states, plus eight other European states and one non-European state (Canada) having signed cooperative agreements with the ESA.[129]The case of ESA would be touched upon once more under the subsequent section on non-state actors. But since it is acting more as a scientific and management umbrella bringing together the resources of individual states, and less an independent international actor with its own political and economic agenda, the most visible of its deep space programs involving active participation of European states would nonetheless be listed here.

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[126] Rich Phillips, "Space Frontier Foundation to Host NewSpace Europe 2018 Conference in Luxembourg Aimed at Identifying Barriers, Opportunities in the Global Space Economy," *Cision*, November 3, 2018, accessed November 8, 2018, https://www.prweb.com/releases/space_frontier_foundation_to_host_newspace_europe_2018_conference_in_luxembourg_aimed_at_identifying_barriers_opportunities_in_the_global_space_economy/prweb15809330.htm.

[127] K. W., "Who owns what in outer space."

[128] Kyriakopoulos, "Legal challenges."

[129] European Space Agency, *New Member States*, accessed May 4, 2019, https://www.esa.int/About_Us/Welcome_to_ESA/New_Member_States.

Accordingly, in 2014, aspacecraft called Philae, whichcame out of the space probe Rosetta of ESA, landed on a small comet.[130] This was a success in terms of both its scientific value and its contribution to future mining missions.[131] Another ESA mission, launched in 2016, to enter the orbit of Mars and land on the planet, is also in progress.[132] ESA is in collaboration with Canadian and Japanese space agencies to send a robotic mission to the Moonin order to collect, store and bring back samples. This is plannedto take place within the next decade.[133] So, at the scientific and technology development level, we see some deep space activity by a number of European governments, either individually or under the clout of the ESA. Those could and would normally generate technological and scientific benefits for commercial activity in deep space; but as we would see under the following subtitle, for Europe, such activity is more likely to remain on the side of non-state actors.

We see that several state actors are already active in deep space, and the numbers have increased in recent years. Not only the pace of scientific research missions, but also that of activities related to space mining and settlements,is increasing rapidly. Moreover, the increasing number of corporate actors vying for use of spaceis adding momentum to deep space activities. Cooperation between state organizations and private corporations also contributes.

4.2. Newcomers: Non-State Actors

The two most visible non-state actors with their sights on commercializing and colonizing deep space are an ever-increasing number of corporations, i.e. commercial entities aimed at generating economic and financial benefits. The two most prominent examples are both US-based, and they are called Deep Space Industries (DSI) and Planetary Resources (PR). As mentioned under the previous sub-title, DSIis also benefitting from investment in and from Luxembourg.[134] PR is the first company that is in the process of commercializing space missions.It is examining asteroids to find out

[130] Ibid.
[131]Çolak, "Göktaşında Maden Aramak,": 75.
[132] Zak, "Unmanned missions."
[133] McKie, "The lunar gateway."
[134] Corbyn, "21st-century prospectors into space."

whether they contain water.[135]By 2020, PR plans to place a large number of spacecrafts on a rocket, send them into space, and land them on predetermined asteroids for exploration. Among the selected asteroids, the one with the most water will be considered suitable for future mining.[136] DSI, the other corporate actor,envisionscreating small spacecrafts which can search for minerals and ice on celestial objects; and a larger spacecraft would carry and deploy small ones to collect and store materials.[137] The company has a contract with NASA to develop a method of decelerating spacecraft which carries asteroid minerals during atmospheric re-entry.The contract also covers the development and production of propellants from the substances extracted on asteroids.[138]

To analyze the content and makeup of the near-Earth asteroids, a Scottish company called Asteroid Mining Corporation plans to put a satellite in orbit in 2020[139]in order to detect platinum on asteroids.[140] This will be the first space mining mission for the United Kingdom.[141]

Commercial activity in space is not limited to mining. So-called space tourism has also been making strides in recent years. It seems that Blue Origin will be the company to initiate space tourism by sending tourists into space in the course of 2019.[142] Another space tourism scheme is that of SpaceX, a company owned by Elon Musk, whose intention is to send two humans to orbit of the Moon in the second half of 2019.[143] SpaceX has also been, since 2016 working on a plan for the colonization of Mars.[144]The corporation plans to initiate travel to Mars by 2022.[145] Afterwards, in 2024, the SpaceX contemplates colonizing Mars by actually sending people there.[146] The budget for these

[135]Abigail Beall, "The law of the worlds: how will outer space be regulated?," *The Guardian*, accessed September 3, 2018, https://www.theguardian.com/legal-horizons/2018/jul/09/the-law-of-the-worlds-how-will-outer-space-be-regulated.
[136]Campbell, "Space mining is getting close to reality."
[137] Davies, "Space's new frontier."
[138] Campbell, "Space mining is getting close to reality."
[139]Corbyn, "21st-century prospectors into space."
[140] "Scottish firm unveils plans for asteroid mining mission," *BBC*, July 30, 2018, accessed September 24, 2018, https://www.bbc.com/news/uk-scotland-scotland-business-45006938.
[141] Ibid.
[142] Tangermann, "Humanity's colonization of space."
[143]Mike Wall, "SpaceX Won't Launch Tourists Around the Moon This Year," *Space*, June 6, 2018, accessed March 9, 2019, https://www.space.com/40805-spacex-delays-tourist-trip-around-moon.html.
[144] Shaer, "The asteroid miner's guide."
[145] Tangermann, "Humanity's colonization of space."
[146] Ibid.

missions will be met by profits from mining the asteroids.[147] In addition, the SpaceX raises funds through its contract with NASA to transport cargo to the ISS with re-usable rockets.[148]

Another privately-owned business with its sights set in this field is Blue Origin. Its founder is the owner of Amazon.com, Jeff Bezos, who has stated that his long-term wish is to have millions of people living on other planets or in space.[149] He hopes that the Moon will become a manufacturing base within the next 100 years.[150] Virgin Galactic, yet another US company, this time owned by the eccentric billionaire Richard Branson, has got its first launch license for the SpaceShipTwo vehicle, so it will soon be testing manned suborbital spaceflight, with the aim of later extending its missions deeper intospace.[151]

Meanwhile, another company, Japan iSpace, has small vehicles that can be used for delivery of cargo into space. According to the director of the company, the Moon will be mined before asteroids, and iSpace rovers will be used to explore the Moon's surface.[152]

Kleos Space, which is a Luxembourg-based company, focuses on robotic technology for in-space productionof parts that could be used to manufacture and repair probes or spacecrafts. This breakthrough will help to avoid the high cost of transporting all such items from the Earth.[153]

Lastly, let's take a look atChina.There are several private companies there with their sights on deep space, too. The three leading ones are One Space, Expace and Land

[147] Shaer, "The asteroid miner's guide."
[148] Hickman, "China is winning the space race."
[149] Simberg, "The return of the space visionaries": 49.
[150]Chris Hadfield, "Lunacy? Far from it – you really could live on the moon," *The Guardian*, June 12, 2018, accessed January 25, 2019, https://www.theguardian.com/commentisfree/2018/jun/12/life-on-moon-chris-hadfield.
[151]Michael Huerta, "Democratization in Space," (Speech, Federal Aviation Administration Commercial Space Conference, Washington, DC, February 7, 2017).
[152]Chloe Cornich, "Interplanetary players: a who's who of space mining," *Financial Times*,October 19, 2017, accessed May 21, 2019, https://www.ft.com/content/fb420788-72d1-11e7-93ff-99f383b09ff9.
[153]Ibid.

Space.[154] The Chinese governmenthopes to stimulate both state-owned enterprises and private-owned initiatives to invest more in space.[155]

Significantly enough, the majority of commercial players investing or showing keen interest in deep space happen to be multinational corporations (MNCs), that is companies with activities and links that span multiple countries. Consequently, the role and involvement in deep space of non-state actors turn out to consist largely of MNCs and their activities. For decades, MNCs have been at the center stage of heated debate and deliberations concerning the impact of globalization on international relations, and more particularly on international political economy, in the sense of their negative and/or positive ramifications on state interests, inter-state relations and so on. For instance, by controlling greater resources and operating internationally with greater efficiency than most states, MNCs are already blamed for propping up national governments and tilting global economic cycles in their own favor, at the expense of others' and especially state actors' interests.[156]Given the anticipated preeminence of MNCs in the upcoming commercialization and colonization of deep space, their weight and dominance vis-à-vis state actors and within the international system could be further magnified. This would likely be the case not only in deep space, but back on Earth as well, because at least for a certain period of time MNCs will continue to operate out of their centers located on Earth. If nothing else, this could be expected to add more impetus to the further strengthening of MNCs – a process that has already been underway for decades as a result of globalization.[157] Such a progression could also be expected to add further impetus to the ongoing debate over the role, the contributions or else the drawdown of MNCs in the context of global economy, international relations, and relations between state and nonstate actors.

An overview of the likely roles and positions of nonstate actors of international relations in deep space will not be complete without paying due tribute to intergovernmental organizations (IGOs), which are generally accepted and treated as an important subset of

[154]Goswami, "China in Space": 77.
[155] Bloomberg News, "China's Secretive Space Program."
[156] Jon C. W. Pevehouse and Joshua S. Goldenstein, *International Relations* (Harlow: Pearson Education, 2017), 290-296.
[157] Ibid.

the category of nonstate actors as well. IGOs are those international organizations whose members are national governments, in other words state actors. They are formed to fulfill a variety of functions; yet over time may acquire identities and agendas of their own. By one count, there are more than 5,000 of them;[158] but only a handful of them which are directly relevant for the context of deep space will be briefly touched upon here.

The first and foremost among those is the United Nations (UN), the largest and the most visible of all IGOs. Since the very beginning of the first space age in late-1950s, the UN has been one of the important stakeholders in space activity, primarily with respect to regulatory and legislative aspects of the access to and use of both orbital and outer space. So, the UN as the leading IGO could hardly be considered as a newcomer in deep space.Several working groups and committees –among them the UN Office for Outer Space Affairs, Committee on the Peaceful uses of Outer Space (COPUOS), the Conference on Disarmament (CD), Group of Governmental Experts (GGE)-[159]have been formed under the UN umbrella over the years.The UN's main focus in all this has been to provide for the peaceful utilization and sustainable development in space for all states.[160]For instance, the UN Office for Outer Space Affairs wants everyone to benefit from the space equally, and through its "Access to Space for All" program and support of space-faring nations, it is trying to help especially non-space faring and emerging space-faring nations to benefit from space technologies.[161]The UNhas also taken solid steps to tackle with legal aspects of activities in outer space by inspiring the creation of OST and Moon Agreement within the context of the activities of COPUOS. Meanwhile, the CD created draft treaties in order to prevent arms races in outer space. The details and the impact of those will be addressed under the Chapter 5 on 'International Agreements'.But suffice it to observe here that the UN has not been a direct stakeholder in deep space, but rather attempted to fulfill a regulatory and intermediary role between various other actors. This is a profile likely to continue in the foreseeable future as several states and perhaps non-state actors are likely to preserve their hesitations in

[158] Ibid, 13.
[159] United Nations Office for Disarmament Affairs, *Outer Space*.
[160] United Nations Office for Outer Space Affairs, *UNOOSA Director, Simonetta Di Pippo*.
[161] United Nations Office for Outer Space Affairs, Access to Space for All.

accepting a multilateral approach of a major IGO like the UN. A most recent example was witnessed in conjunction with the use of cyber forces in space: the UN GGE's initial success in achieving a consensus on state behavior in space could not carried out after 2015. Afterwards, the rapid deterioration in the relation between the three leading space and cyber powers (US, Russia and China) broke the consensus in space and led to the questioning of the power of GGE, and in fact the overall international authority and prestige of the UN in this respect.[162]

On the other hand, a glimmer of hope for a multilateral and cooperative push in space may be apparent in the success story of another line of UN activity, namely the important multilateral and cooperative role played by the International Telecommunications Union (ITU). The origins of this specialized UN agency tasked with regulating the connectivity of international communication networks go back to 1865. All 193 states and over 800 other entities are members of ITU.[163] In the space domain, ITU has been tasked with allocating satellite orbital positions to all governments and commercial and other entities vying for precious orbital slots in which to place their satellites.[164]Over the decades, as a little known IGO, ITU has been successful in averting confrontations and frictions between its stakeholders. This offers a possible model and glimmer hope for similar UN-led arrangement in the future for assigning and regulating the access and use of celestial bodies such as asteroids and planets.

The EU is yet another internationalplayer with an interest and involvement in deep space. Having just cited the scientific and technological background provided by the ESA,under the previous subtitle, we can now focus on EU's interest and involvement in deep space at the level of institutional identity and its political agenda. In this regards, the EU makes arrangements aimed at ensuring that the member states and their various

[162] Paul Meyer, "UN GGE – Visions on the future of cyberspace clash at the UN," ICT4Peace, November 15, 2018, accessed July 6, 2019, https://ict4peace.org/activities/norms-of-responsible-state-behavior/visions-on-the-future-of-cyberspace-clash-at-the-un/.
[163]International Telecommunications Union, *List of Member States*, accessed July 10, 2019, https://www.itu.int/online/mm/scripts/gensel8. International Telecommunications Union, *List of Sector Members*, accessed July 10, 2019, https://www.itu.int/online/mm/scripts/gensel11.
[164] International Telecommunications Union, *Our Vision*, accessed July 8, 2019, https://www.itu.int/en/about/Pages/vision.aspx.

entities could work in a transparent environment; it also seeksto strengthen cooperation between member states by encouraging space studies.[165]EU allocates some funds to space projects, and it has also determined its objectives for a space policy program covering the period of 2021-2027,so as to provide high quality services in the space sector, increase welfare and job opportunities within the Union, and gain a strong role in space sector. In order to achieve these objectives, the EUaims adopting the existing legal framework of the EU to space policies and set up regulatory rules for space programs.[166]The EU has evenreleased a Draft Code of Conduct for Outer Space Activities document in 2008. EU's ambition was to use this document and initiative as a basis for an international Code of Conduct for deep space.[167] The code would be non-binding and voluntarily applied, emphasizing the importance of safety, security and sustainability of outer space activities, and creating a framework for a regime of transparency and confidence-building measures in space.However, this EU effort did not find acceptance by other states, most significantly by the US and Japan.[168]Those two leading spacefaring states said they accepted the general notions of the EU's draft, but they declared in 2012 that they preferred creating an International Code of Conduct with other partners. The creation of such International Code of Conduct was subsequently discussed under the umbrella of the UN. But despite several rounds of meetings, no consensus could be reached and EU's original Code is in a state of limbo.[169] To round it up, the weight of EU involvement in deep space has so far been somewhat similar to regulatory, legislative role assumed and played by the UN. Whether the EU would transform itself into an independent institutional player with a political and commercial deep space agenda of its own (as separate from those of its member states) remain to be seen.

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[165] Jaroslaw Adamowski, "EU could agree on new regulation for space program by May," Space News, January 14, 2019, accessed May 31, 2019, https://spacenews.com/eu-could-agree-on-new-regulation-for-space-program-by-may/.

[166] "EU shapes its future space policy programme," European Council, March 13, 2019, accessed May 31, 2019, https://www.consilium.europa.eu/en/press/press-releases/2019/03/13/eu-shapes-its-future-space-policy-programme/.

[167] Chris Johnson, "Draft International Code of Conduct for Outer Space Activities Fact Sheet," *Secure World Foundation*, February 2014, accessed July 6, 2019, https://swfound.org/media/166384/swf_draft_international_code_of_conduct_for_outer_space_activities_fact_sheet_february_2014.pdf.

[168] Ibid.

[169] Meyer, "UN GGE – Visions on the future of cyberspace clash at the UN."

The third intergovernmental non-state actor that deserves scrutinizing is NATO.In fact, the case of NATO is much easier to analyze:until very recently, NATO has not had an official space policy of its own, nor did it want to involve itself in that domain. The only unclassified reference to space was in NATO'sAllied Joint Doctrine for Air and Space Operations issued in 2016,stating very vaguely that the aim of NATO's operations in space would be to protect friendly space capabilities and to counterany attacks against them.[170]More recently though, the organization has been gradually recognizing the need to formulate a space policy because of the increased space activity and the fact that several of NATO member states' military capabilities have come to depend heavily on space. Albeit slowly, recognition and consensus has been emerging that NATO should develop capabilities in space in order to attain advantage in controlling what happens on Earth.[171]A first Alliance attempttowards creating a space policy was made in 2011-2012 period, but no consensus could be reached and that attempt resulted in failure.[172]The issue was taken up once more in June 2019, and this time NATO defense ministers agreed on a policy framework for space. If the process is not interrupted, in its December 2019 summit, NATO aims at rendering space a full operational domain (alongside land, sea, air and cyber), whereby NATO states would be able to start discussing threats in space and how to respond.[173] All indications are that initially the new policy will see NATO's continued use of space services provided by member states, and the alternative of track of NATO investing in its own capabilities is not currently contemplated.All the while, it is not clear as to whether NATO's collective defense provisions per Washington Treaty's Article 5 would be applicableto threats and contingencies involving space.[174]One thing is clear: NATO policy and actions towards orbital space are likely to take some years to materialize, and only afterwards could NATOperhaps be expected to start directing its attention to deep space. Given the time it

[170] Pawel Fleischer, "Above the Moon: NATO Space Policy," *Future NATO*, September 9, 2016, accessed June 1, 2019, http://futurenato.org/articles/above-the-moon-nato-space-policy/.
[171] Robin Emmott, "Exclusive: NATO aims to make space new frontier in defense," *Reuters*, June 21, 2019, accessed July 7, 2019, https://www.reuters.com/article/us-nato-space-exclusive/exclusive-nato-aims-to-make-space-new-frontier-in-defense-idUSKCN1TM1AD.
[172] "Countdown to NATO space strategy," *France24*, June 25, 2019, accessed July 7, 2019, https://www.france24.com/en/20190625-countdown-nato-space-strategy.
[173]Ibid.
[174] Emmott, "Exclusive: NATO aims to make space new frontier in defense."NATO, *Collective Defense – Article 5.*

took for NATO to tackle with developments in orbital space, this next step is rather unlikely to happen in the near future.

A last category of nonstate actors involves nongovernmental organizations (NGOs). Those are private organization with political, humanitarian, economic or technical agendas with a capacity to build transnational advocacy networks to exert pressure on state and other non-state actors.[175] So far, their interest and involvement in the upcoming human activity in deep space has been miniscule.[176] Naturally, with the start of mining and other forms of exploitation and settlement on and around celestial bodies, it would be realistic to anticipate increased awareness and consequent concerns over the integrity of those bodies and perhaps even over yet-to-be-discovered alien life forms in space. This would imply an extension into deep space of the Earthly notions and movements of environmental protectionism. Whether and how soon such a stage would be reached is hard to predict; nonetheless, NGOs deserve being considered as probable if not primary actors in deep space in the future. Yet, given the absence of direct impact on individuals' daily lives, their strength vis-à-vis states and MNCs may be expected to be much limited than counterparts on Earth.

4.3. New Realm of Undefined Interactions

"*Space is the internet of tomorrow. Countries that do not have access to it will be left behind*" said Simonetta Di Pippo,the astrophysicist and director of the UN Office of Outer Space Affairs.[177]

Since the more extensive legal and security analyses have, so far, focused on orbital space, using the conflicts experienced there as the baseline, we can make some predictions about the struggle for dominance.We can also make predictions about the complex set of relationships between the numerous state and non-state actors computing for roles in deep space. Those states already investing in technology for space activities will have a head start. As the two important state actors in space, the US and the

[175] Pevehouse and Goldenstein, *International Relations*, 13.
[176]Secure World Foundation, https://swfound.org/about-us/who-we-are/. The Planetary Society, http://www.planetary.org/about/.
[177] Beall, "The law of the worlds."

rapidlyrising China will certainly have a struggle for dominance reaching into deep space. In fact, it is already beginning.

China is the first country to have created a space-oriented Strategic Support Force (SSF). It happened in 2015,and is a branch of the People's Liberation Army. Among the tasks of the SSF's are enhancing space capabilities and supporting cyber and electronic warfare capabilities.It is seen as the bulwark of China's intentions to weaponize space.[178] As a response to Chinese military progress in space, the US, under the Trump administration, has recently taken a more aggressive stand. It has been pushing for an independent US Space Force, as a sixth branch of thearmed forces.[179]With this step, the US, which wants to carry its positionas a superpower into orbital space and beyond,and does not hide its intentions to declare hegemony in space. This ambition may be dangerous and may result in the erosionof international legal norms.[180] The fact is that space may become a new domain for military confrontation and conflict.[181]The US aspires to dominatethat domain,[182]and this is indicative of ever-increasing competition and potential for hostilities in space. It is also possible that deep space activities,being run primarilyby the private sector in the US, may constitute a disadvantage and weakness,as they may undermine the direct control of the state over space activity. This may in turn become an advantage for China and may lead to faster progress there.[183]

It would seem from world politics that China uses its dominance when it feels superior (not unlike the US); but it tries to cooperate and find peaceful solutions in situations where it is not influential and its power may not be sufficient.[184] After the US decided to

[178] Kanuck and Vogel, "The down of a new strategic era."
[179] Ibid.
[180]Ann Deslandes, "The Bold Future of the Outer Space Treaty," *Jstor Daily*, August 1, 2018, accessed January 19, 2019, https://daily.jstor.org/the-bold-future-of-the-outer-space-treaty/.
[181] Stewart Patrick and Kyly L. Evanoff, "The Right Way to Achieve Security in Space," *Foreign Affairs*, September 17, 2018, accessed September 21, 2018, https://www.foreignaffairs.com/articles/space/2018-09-17/right-way-achieve-security-space.
[182] Chelsea Gohd, "Trump wants a Space Force – But we have an Air Force Space Command," *Space*, August 10, 2018, accessed February 27, 2019, https://www.space.com/41452-space-force-air-force-space-command.html.
[183] Goswami, "The US against China."
[184] Goswami, "China in Space": 90.

create the Space Force; China proposed a structure to prevent and restrain an arms race in space, and demanded the US should changeits Cold War attitude.[185]

As for the US, with the establishment of the Space Force, the already low budget allocated to NASA may be further reduced and this amount transferred to the Space Force.[186] If this happens, the US space activities will move away from science, andassume a more military nature. This may also be the basis of possible violations of the Outer Space Treaty (OST), the one and only legal arrangement in place to regulate legal and security aspects of space activity. We shall come back to legal and security aspects and give more detailsin subsequent chapters.

Overall, there are many indications that rivalry between state actors on Earth will be carried into deep space, especially with respect to major powers with significant capabilities and investment there. This meansnot only US and China, but also the Russian Federation, Europe, India and Japan, who are all primary state actors in space.

Luxembourg may also be able to gain a place in the international arena, not because of technological infrastructure or missions achieved, but because it can attract space companies with promising investments schemes. Luxembourg, which doesn't even have a full-fledged military, could come to the fore with its economic power in colonization of space or in space mining. A parallel may be drawn with the similarly novel field of cyber security, where the competition is already rife and intense. For example, it was the Netherlands to have revealed that the Russian governmentused cyber tools to interfere in and manipulate the 2016 US presidential elections. Among all the traditional great powers, a comparatively small player like the Netherlands was able tosucceeded in making a difference by capitalizing on its fledging cyber warfare talents.[187] Likewise,

[185]Sam Stevenson, "China calls for space arms race control in bid to curb Trump's 'space force' ambitions," *Express,*August 29, 2018, accessed October 11, 2018, https://www.express.co.uk/news/world/1009872/space-force-space-arms-race-control-china-USA-Donald-Trump-Mike-Pence-outer-space-military.

[186] Wendy Whitman Cobb, "Would a space force mean the end of NASA?" *The Conversation*, October 18, 2018, accessed May 17, 2019, https://theconversation.com/would-a-space-force-mean-the-end-of-nasa-102472.

[187]Rick Noack, "The Dutch were a secret U.S. ally in war against Russian hackers, local media reveal," *The Washington Post,*January 26, 2018, accessed September 15, 2018, https://www.washingtonpost.com/news/worldviews/wp/2018/01/26/dutch-media-reveal-country-to-be-secret-u-s-ally-in-war-against-russian-hackers/?noredirect=on&utm_term=.5ce22889fb91.

Estonia as asmaller member of the EU and NATO, managed to field cyber capabilities to challenge Russia. It was able to do this by investingselectively in cyber security and warfare. This country, which has militaryforces of only 6,000 personnel,[188] isin this respect 150 times smaller than Russia. Yetitfields a 300-member cyber team and hosts NATO's main center for high level cyber defense.[189]Considering such examples in the cyber domain, countries that attract space investment and talent,such as Luxembourg may have a bigger say in deep space than their mere size and influence would suggest, and they may also become leading players "*in the trade ofspace minerals",* among other commodities.[190]

However, in a more general framework, it would be realistic to anticipate a deep inequality between those countries able to carry out activities in deep space and those which are unable to do so. Thewealth and income gap, between technologicallyadvanced countries and technologically undeveloped or developing countries, which is already large, is likely to widen further. A few rich states willexploit the resources of deep space; the majority of others will become comparatively weaker and poorer. This is hardly a harbinger of a harmonious and stable international order for the future.

In times to come, when space mining turns into commercial activity, some experts anticipate a scenario, in which countries without access to deep space willboycott the mines and merchandise originating there, thuslimiting theirprofitability.[191]According to another scenario,"*states may not intervene directly in each other's activities in deep space, but, back in Earth, they may resort to economic tools and sanctions tohampereach other's deep-space initiatives*."[192] What is certain is that, with a multiplicity of possible developments, there will be an increase in unpredictability and fluidity in inter-state relations.

There is also another dimension to consider.How willthe relationships between state and non-state actors be affected,re-shaped and perhaps redefined?Legal and economic

[188]Estonian Defence Forces, *Estonian National Defence Policy.*
[189] Ott Ummelas, "Russia's tiny neighbor prepares its cyber revenge," *Bloomberg*, June 31, 2018, accessed January 11, 2019, https://www.bloomberg.com/news/articles/2018-10-31/treasury-lifts-long-term-debt-sales-for-fourth-straight-quarter.
[190]See Appendix 3.
[191]See Appendix 2.
[192]Interview with current senior researcher of a space institute, full text available in Appendix 4.

relations between the state and non-state actorsare interrelated. There are different opinions about this issue among the experts in the field. Some argue that states will be the main actors in the future,because companies cannot make progress without the support of the states under which they operate.[193]However, others believe that strong states like "*the US will encourage private companies by providing direct and indirect support to ensure that their country stays ahead*."[194] A third line of contention is that,"*once states eliminate the risks of deep space missions and they put the necessary infrastructure in place, they will then step aside in favor of private enterprises*."[195] This last possibility is not very different fromdevelopments observed in the past in such domains as telecommunications or orbital space.

What we currently observe is that private companies can exert influence on states, or even defy them. The founder of SpaceDev, Jim Benson, has stated that his company will not accept any funding from governments, because he thinks that establishing rights of private ownership in space is important.[196] Companies that invest and spend billions of dollars want to make sure that their endeavor will not be wasted or compromised. Although there is no agreed legal framework, and there are no existing treaties, corporations are understandably trying to base their business on solid legal ground. In this context, they are pressuring their respective states to take initiatives to create legal protection. For instance, DSI and PR have both sought a legal framework to ensure their future rights in space. PR hired a lobbying firm for this purpose. It negotiated with the US government, cited the opportunities (more jobs and new technology) that the sector would generate, and contended that if a legal framework could be created, it would also be a good example for other countries.[197] As a result of this bargaining, a special law providing ownership rights and promoting private exploration in space was enacted by the US Congress in 2015.[198]

[193]See Appendix 1.
[194]See Appendix 3.
[195] See Appendix 4.
[196] Shaer, "The asteroid miner's guide."
[197] Ibid.
[198] Jeff Foust, "House passes commercial space bill," *Space News*, November 16, 2015, accessed January 22, 2019, https://spacenews.com/house-passes-commercial-space-bill/.

The number of private space companies has increased in recent years, and, even thoughactive space mining has not yet started, there is every reason to expect this number to continue to rise. Besides their broader financial opportunities, decision-making processes are faster in private corporations, and it is easier for them to take action.[199]For this reason, they can make faster progress. This will mean that private, commercial actors, who have the necessary infrastructure to start space mining,will begin making profits and occupy the most lucrative domains, while others are still contemplating whether they should participate or not. In addition, a cycle may start in which companies are more effective and dominant in international relations than states are. We may witness an environment where oversight and control by states, especially the weaker ones, is much reduced, and private companies become more visible and decisive.

Overall, all this implies big uncertainties and ambiguities regarding relations between state-state and state-nonstate actors. The need for established norms and legal principles is more urgent than ever. Whether such norms and legal framework can be created will be our next topic.

[199] Hadfield, "Lunacy? Far from it."

CHAPTER 5

LEGAL ASPECT: LEGISLATION (UN)REGULATING DEEP SPACE

Colonization of space and exploitation of its resources has not happened yet. However, given the pace of technological progress and the magnitude of investment going into it, they may be imminent. There are many indications that space activities,including commercial space stations, asteroid mining and space tourism, are all looming on the horizon.[200]Because of this, establishing norms, regulations and a legal framework in deep space is becoming critical.

5.1. Existing Legal Framework

5.1.1. International Agreements

In 1958, shortly after the first satellite was placed in orbit, an international committee was formed by the UN General Assembly.It was called the Committee on the Peaceful

[200] Huerta, "Democratization in Space."

Uses of Outer Space (COPOUS).[201] Space and space activities and their legal and technical dimensions were debated in this committee.[202] The committee first drew up a document entitled Declaration of Legal Principles Governing the Activities of States in the Exploration and Use of Outer Space, in 1963, and it also inspired the creation of the Outer Space Treaty (OST).[203]

The OST, which took the Antarctic Treaty as an example,[204] is the most comprehensive legal arrangement which exists so far, for space. It came into force in 1967, and ruled that space is a common field for all to use. According to this treaty, nobody and no state can claim any rights to the bodies in space, and space is thus identified as the 'province of all mankind'. At the same time, the OST declares space to be a domain open to all for exploration. Significantly, it also prohibits the deployment of weapons of mass destruction on celestial bodies, but allows the use of space for military and security purposes.[205]

Many argue that the treaty is not appropriate for today, because it was drawn up according to the conditions of the Cold War period. For instance, it is state-centred and does not have any rules to regulate the commercial activities of companies. Besides, whether theterm "celestial bodies"implies just planets, or all space objects, is not clear.[206]Nor is the treaty completely clear about the legal status of resources in space.[207] Understandably, it onlyconstituted a general framework because it could not precisely forecast the upcoming technological progress in space.[208]

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[201]David Tan, "Towards a New Regime for the Protection of Outer Space as the 'Province of All Mankind'," *Yale Journal of International Law* 25, no. 1(2000): 156, accessed July 26, 2018, https://digitalcommons.law.yale.edu/yjil/vol25/iss1/4/

[202]Merve Erdem, "Dünya Uzay Haftasının Ardından Uzay Faaliyetlerinin Hukuki Rejimine İlişkin Düşünceler," *Academia*,2017, accessed January 26, 2019, https://www.academia.edu/36745567/D%C3%BCnya_Uzay_Haftas%C4%B1n%C4%B1n_Ard%C4%B1ndan_Uzay_Faaliyetlerinin_Hukuki_Rejimine_%C4%B0li%C5%9Fkin_D%C3%BC%C5%9F%C3%BCnceler.

[203] Tan, "Towards a New Regime."

[204] Simberg, "The return of the space visionaries": 61

[205]Ben Rusek, "The Outer Space Treaty at a glance," *Arms Control Association*, August 1, 2017, accessed September 18, 2018, https://www.armscontrol.org/factsheets/outerspace.

[206]Hamza Hameed, "The Legality and Ethics of Mining an Asteroid," *Space Law Resource*,February 25, 2017, accessed January 16, 2019, https://www.academia.edu/31736455/The_Legality_and_Ethics_of_Mining_an_Asteroid.

[207] K. W., "Who owns what in outer space."

[208] Erdem, "Dünya Uzay Haftasının Ardından."

On the one hand, the treaty ruled out state sovereignty and declared space to be the property of all human kind. On the other hand, though, there are scholars who think that the treaty allows implicitly for commercial activities in space, because there are no specific provisions ruling them out. Most recently, in 2017, at the Global Space Congress which was set up by the International Astronautical Federation, the OST was discussed from legal, political, economic and social perspectives. Space mining was also an issue that was considered. The view that predominated was that the treaty did not specifically prohibit space mining, and that therefore it allowed for such activity.[209]

Unlike questions of commercial activities and ownership, there are loopholes regarding the weaponization of space. For example, applying military technology for defensive purposes does not violate the treaty.[210]However, every defensive weapon does have the potential to be used for offensive purposes as well. The OST evidently tried to prevent space from becoming a domain for war. Because, from early-60s onwards, both superpowers developed and deployed military capabilities in space in order to obstruct each other's unhindered use of it. And what we witness today is a US President openly declaring that his country must dominate space.[211] The rejuvenation of the US Space Force, which was created in the 1980s and incorporated in the US Air Force in 2002,[212] has apparently become a political priority and a necessity for the Trump administration. This government has set its eyes on the Moon, Mars and beyond; hencethey feel the need for military force to protect US interests in space. One obvious justification for the revival of the Space Force by the Trump administration is the US perception of threatsfrom Russia and Chinathat might jeopardizeits dominance in space.This raises the possibility of military conflicts spilling over there.[213] Russia's orbital satellite forceis

[209] Ibid.
[210]Bob McDonald, "Trump's 'dominance' in space is playing with international space treaty," *CBC*, June 22, 2018, accessed January 1, 2019, https://www.cbc.ca/radio/quirks/blog/trump-s-dominance-in-space-is-playing-with-international-space-treaty-1.4718058.
[211]Gbenga Oduntan, "Donald Trump's space force: the dangerous militarization of outer space," *The Conversation*, June 25, 2018, accessed January 2, 2019, https://theconversation.com/donald-trumps-space-force-the-dangerous-militarisation-of-outer-space-98588.
[212]James Hasik, "The U.S. Needs a Space Force (To Win the Wars of the Future)," *The National Interest*, February 14, 2017, accessed March 11, 2019, https://nationalinterest.org/blog/the-buzz/the-us-needs-space-force-win-the-wars-the-future-19432.
[213]Mike Wall, "Space weapon? US calls out Russian satellite's 'very abnormal behavior'," *Space*, August 15, 2018, accessed January 4, 2019, https://www.space.com/41503-russian-satellite-possible-space-weapon.html.

mostly for military purposes[214] and the country does not deny that it is developing anti-satellite capabilities which could be used with the intention of destroying others' space assets.[215]

The OST's shortcomings and unfairness have encouraged attempts to challenge and improve it. For example, the Bogota Declaration of 1976 came as an agreement to balance the OST. It was signed by equatorial nations above whose territory hung the geostationary satellites of others, and the declaration pointed out thattechnologically-advanced countries had claimed and occupied slots in space without allowing similar possibilitiesfor other nations. The Bogota Declaration is not about exploitation of space's resources per se. But it reflectsthe desire of developing countries for regulation and fair-sharing of the benefits offered by space.[216]

In order to resolve the ambiguities of the OST and to provide a more comprehensive legal basis, the Moon Agreement was negotiated in 1979 by the Legal Subcommittee of COPUOS. Only 18 states signed it, whereas the OST was ratified by 107 countries. The Moon Agreement borrowed Article 1 from the OST, stating that the Moon and its natural resources are the common heritage of all mankind[217] and should only be used for peaceful purposes. Besides that, the ill-fated Moon Treaty foresaw the creation of an international committee to regulate the use of lunar resources. The treaty also suggested that all states or companies should inform the UNabout the purposes and locations of any facilities they establish on the Moon.[218]

What could be the reasons for the Moon Agreement attracting only so few signatories? Asmentioned above, the OST is more ambiguous and open to interpretation by various

[214]Philip Yiannopoulos, "Inside the epic debate on rethinking our 50-year-old Outer Space Treaty," *Fast Company*, September 24, 2018, accessed January 2, 2019, https://www.fastcompany.com/90240304/inside-the-epic-debate-on-rethinking-our-50-year-old-outer-space-treaty.
[215] Wall, "Space weapon?"
[216]Haris Durani, "Property, Power and Law in 'The New Dimension'," *Academia, a*ccessed February 19, 2019, https://www.academia.edu/34080847/Property_Power_and_Law_in_the_New_Dimension_.
[217] "Space Lawyer Frans von der Dunk: A Less Strict Form of the Law of the Sea Might Be the Way to Go for Asteroid Mining," *Lawless*, September 20, 2018, accessed October 7, 2018, https://lawless.tech/space-lawyer-frans-von-der-dunk-a-less-strict-form-of-the-law-of-the-sea-might-be-the-way-to-go-for-asteroid-mining/.
[218]United Nations Office for Outer Space Affairs, *Agreement Governing the Activities of States on the Moon and Other Celestial Bodies.*

actors. Since it does not have clear rules, it allows for divergent opinions and even disagreements amongst the signatories. In contrast, the Moon Agreement comprises strictly binding articles and contains clear regulations. Its language is unambiguous and does not leave room for varied interpretations. The countries which donot sign the Moon Agreement already have programs and activities in space, or else they have the capacity to start them.[219]The only possible conclusion is that stakeholders in space do not want to make any commitmentsthat might restrain their activities. Among the 18 countries to have signed the agreement, Australia is the only space-faring nation.[220]It seems that other space-faring states do not want anymulti-lateral, international control or limit imposed on their activities.

Additionally, if states become parties to the Moon Agreement, thiswill also havean impact on their respective companies, possibly causing them to refrain from investing in the field when faced with limiting conditions. Taking into consideration the lobbying power of some of those commercial entities, failure to accede to the agreement may be seen as an interest-oriented attitude that involves not only states themselves, but their companies and commercial activities as well.

From the perspective of signatories of the Moon Treaty, all of them are states which have notinvested in commercial space activities (such as plans for mining)and arenot in possession of the technology or economic strength to do so,at least not in 1970s. They include such countries as Turkey, Saudi Arabia, Uruguay and Pakistan. The reason they have become signatories to the agreement could be that they wanted to regulate the use of space and keep it under international and collective control. Otherwise, in the absence of supervision, these countries may feel concerned that development of space activity will be damaging to their economies and risk eroding their international standing. Some states mayalso be worried that economic gains and strategic benefits from the use of space risk dramatically altering theexisting economic balance among states and further increasing inequalities. Indeed, a few years ago when the US and Luxembourg enacted national laws extending their sovereignty into space, Armenia and Venezuela promptly

[219]United Nations Treaty Collection, *Chapter XXIV Outer Space.*
[220] Dunk, "A Less Strict Form of the Law."

ratified the Moon Agreement as a reaction to this move.[221] In retrospect, unless some or all space-faring states sign up, or at least agree to abide by the Moon Agreement, the actions of the others in signing up will remain merely symbolic.

We should also identify a number of UN initiatives supplementing the legal dimension of deep space activities. As mentioned elsewhere, one of the prime objectives of the OST has been to prevent an arms race in the outer space. To achieve this goal, the UN General Assembly holds a meeting every year in order to maintain and stress its position opposing the weaponization of space.[222]In addition, using the UN context, Russia and China proposed treaties such as *'Prevention of the Placement of Weapons in Outer Space, the Threat or Use of Force against Outer Space Objects'* in 2008; and *'Further Practical Measures for the Prevention of An Arms Race In Outer Space'* in 2017.[223]But some states, and especially the US,opposed to this[224] because of the desire to preserve its technological edge, and also to avoid any effects the treaty might have on its existing missile defense programs.[225]Bearing in mind the increasing capabilities of several states, the UN, in 2013, also worked to createconfidence-building and transparency-enhancing rules in outer space. Measures to encourage information exchange and cooperation in risk-reduction were suggested.[226]However, in keeping with its traditional determination to avoid binding agreements in this field, the US has not agreed to anything.As the proposed measures were not supported by the main space actor, they could not be implemented.[227]

Some experts believe that it would not be possible to establish an agreement under the leadership of the UN,because "*the credibility and the sanctioning power of these kinds of multinational organizations have been much eroded"* in recent years.[228]

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[221] Lorenzo Gradoni, "What on Earth is happening to space law?," *EJIL: Talk*, July 31, 2018, accessed December 16, 2018, https://www.ejiltalk.org/what-on-earth-is-happening-to-space-law-a-new-space-law-for-a-new-space-race/.
[222] Paul Meyer, "Failure to launch," *Open Canada*, February 28, 2013, accessed September 24, 2018, https://www.opencanada.org/features/failure-to-launch/.
[223] Ibid.
[224] Kanuck and Vogel, "The down of a new strategic era."
[225] The Nuclear Threat Initiative, *Proposed Prevention of an Arms Race in Space (Paros) Treaty*.
[226] Meyer, "Failure to launch."
[227] Ibid.
[228]See Appendix 3.

5.1.2. National legislations

Instead of signing international agreements and/or treaties and adopting them to their national legislation, certain states have begun establishing their own national laws in space. Although China was generally expected to become the first country, thanks to its rising power status in space, that would change the law,[229] the first concrete step was actually taken by the US Congress, which passed an act in 2015 to legalize mining in outer space. This act included the following statement:

'A U.S. citizen engaged in commercial recovery of an asteroid resource or a space resource shall be entitled to any asteroid resource or space resource obtained, including to possess, own, transport, use, and sell it according to applicable law, including U.S. international obligations.'[230]

Although section 403 of the act contends that the US does not claim sovereignty over, or ownership of any celestial body; the ownership right given to US citizens by the act cannot be reconciled with Article 2 of the OST, which prohibits both the sovereign rights of states, and appropriations by any individual or entity, in space.[231]

By enacting such a law, the US encourages trade and hence the buying and selling of space products. However, one has to have ownership, or at least control, over the aforementioned source to be able to trade its extracts. Although the OST strictly forbids the claim of ownership on the Moon and other celestial bodies, regardless by any person or state getting there and planting their flag,[232] the US government has, by enacting such legislation, entitled not itself but its citizens to do so.[233]

As if this was not a bold enough step, the US Congress passed one more act in 2017, bringing all commercial space applications under the control of the Office of Space Commerce.[234] By reinterpreting the OST, the new act regulates space activities and enhances the control of the state over private entities. Since the OST holds states to

[229] Hickman, "China is winning the space race,"
[230] 114th Congress, "H.R.2262 - U.S. Commercial Space Launch Competitiveness Act: Sec. 402."
[231] Kyriakopoulos, "Legal challenges."
[232] Davies, "Space's new frontier."
[233] Kyriakopoulos, "Legal challenges."
[234] Jeff Foust, "House passes commercial space regulatory bill," Space News, April 25, 2018, accessed January 25, 2019. https://spacenews.com/house-passes-commercial-space-regulatory-bill/.

account for their space activities,[235] the new act takes its authority arising from this responsibility, and forces companies willing to undertake activity in space to get a certificate from the US Secretary of Commerce within one year after the act comes into force.[236] But according to an article in the act, space is not a global commons.[237] The statement contradictsthe OST and gives rise to a situation in which commercial corporations may start working in space according to national legislation, not according to international rules.[238]

Some critics, particularly Russia, are opposed to these decisions.They allege that the US cannot decide by itself who will have what rights in outer space; the national laws are only valid in intra-state activities and cannot be enforced internationally unless recognized by other countries.[239] Similarly, the International Institute of Air and Space Law (IISL) contends that the US does not have any right or superiority over international law. At the same time, IISLalso contends that in the absence of clear prohibition, space resources can be exploited; hence US legislation can also be seen as an interpretation of the OST.[240]

New laws contravening the framework of the OST are not enacted purely as an initiative of state governments. Some private companies also push for them and have an influence over their governments' decisions. In this context, in addition to PR,[241] a new British company named Asteroid Mining Corporation, which was established in 2016, is lobbying the UK government for new space mining legislation.[242]

Luxembourg has followed the US with regard to the importance given to national space legislation. As already mentioned in previous chapters, it has made fundsavailable for companies willing to invest in space mining.[243]To supplement this step, the deputy

[235]Hao Liu and Fabio Tronchetti, "The American Space Commerce Free Enterprise Act of 2017: The latest step in regulating the space resources utilization industry or something more?," *Space Policy* (2018):1, accessed November 14, 2018, https://doi.org/10.1016/j.spacepol.2018.02.004.
[236] Ibid:2.
[237]American Space Commerce Free Enterprise Act of 2017, Chapter 803, Global commons.
[238] Liu and Tronchetti, "The American Space Commerce Free Enterprise Act of 2017."
[239] K. W., "Who owns what in outer space."
[240]Kyriakopoulos, "Legal challenges."
[241]Ibid.
[242] Paikowsky and Tzezana, "The politics of space mining."
[243] K. W., "Who owns what in outer space."

prime minister and the minister for economy of Luxembourg attempted to create a legal framework in 2017, to regulate the property of space resources and asteroids. Initially, this attempt was opposed by the Council of State, noting that private ownership in space or over celestial bodies is not legal, and therefore not enforceable.[244] Yet, shortly afterwards, the Parliament of Luxembourg adopted a draft law, which came into force in August 2017, whereby Luxembourg became the first European country with a legal framework for the utilization of space resources.[245] According to this law, if a spacecraft which is owned by a company registered in Luxembourg extracts any resources from a celestial body, such as water, gold or other valuable materials, then such material would legitimately belong to that company.[246]

Luxembourg hopes to gain advantage in the competition in a different way, by offering attractive environment to space companies, which includes favorable tax regulations. Companies may prefer to do business in such an environment, in which the state does not get involved or interfere much. Besides, Luxembourg aims to create other conveniences, such as easy arrangements of meetings with politicians, helpful finance mechanisms, good care to business, and minimal bureaucracy.[247]

Reports abound that the United Arab Emirates (UAE) is preparing similar legislation.[248]The UAE established a Space Agency Working Group on Space Policy and Law in 2015, so as to make appropriate arrangements relating to the space sector, and it has been preparing laws to cover both manned exploration missions and commercial activities in deep space.[249]

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[244] Martine Huberty, "Doubts over space mining legal status," *Delano*, April 13, 2017, accessed September 20, 2018, http://delano.lu/d/detail/news/doubts-over-space-mining-legal-status/142567.
[245]The Government of the Grand Duchy of Luxembourg, *Draft Law on the Exploration and Use of Space Resources.*
[246] Atossa Araxia Abrahamian, "How a tax haven is leading the race to privatise space," *The Guardian*, September 15, 2017, accessed January 26, 2019, https://www.theguardian.com/news/2017/sep/15/luxembourg-tax-haven-privatise-space.
[247] Ibid.,
[248] Campbell, "Space mining is getting close to reality."
[249] Lucy Barnard, "UAE to finalise space laws soon," *The national*, March 7, 2016, accessed May 11, 2019, https://www.thenational.ae/business/uae-to-finalise-space-laws-soon-1.219966.

5.2. Extending Deep Sea Legislation into Deep Space

As new fields of discovery emerge, the international system seeks new regulations. In this sense, the developments of deep space exploration and mining may be compared to the developments and challenges of deepsea mining during 1960's. Whereas territorial waters are defined as the region out of 19 km from the coastline of the state, the term "deepsea" refers to a territory which is outside of the Exclusive Economic Zone -beyond 322 km from the coast-,[250] and 200meters below the surface of the ocean.[251] As is the case with deep space now, there were not anyappropriate international bodies to rule over deepsea mining until four decades ago. Due to the absence of legal regulations, many companies were unable to expand their research and lay claim tostretches of ocean floor containing minerals.

Apart from the absence of legal ground, another similarity between these two important areas of exploration (deep sea and deep space) is that the label 'the common heritage of mankind' has been given to both.In 1970, the UN declared the resources of the ocean to fall under this definition.[252]But, as a result of many years of effort and pressure by private organizations and states, an international agreement, that had been under consideration since the conferences of the Law of the Sea in 1958 and 1960, was finally established in 1994 and is still valid today. According to the legal framework, the exploration and exploitation of the deep seabed minerals is allowed andregulated.[253]

Deepsea mining policy has been largely agreed upon, but other marine resources such as wrecks remain problematic; the ownership rights to wrecks and other remains in deepsea areas are not clear. The case of the Titanic illustrates the complexities at stake. The cruise liner Titanic sank in 1912, and when the wreck was discovered in 1985, deep on the bottom of the ocean, ownership rights to the wreck and valuable objects it held became a subject of legal controversy. While some argued that the company which owned the ship originally should be entitled to salvage its treasures, the insurance

[250] John P. Rafferty, "Are There Laws on the High Seas?" *Britannica*, accessed March 12, 2019, https://www.britannica.com/story/are-there-laws-on-the-high-seas.
[251]"The Deep Ocean,"*Ocean Today*, accessed March 12, 2019, https://oceantoday.noaa.gov/deepocean/.
[252] United Nations General Assembly, *2749 (XXV). Declaration of Principles Governing the Sea-Bed and the Ocean Floor, and the Subsoil Thereof, beyond the Limits of National Jurisdiction*.
[253]Caitlyn Antrim, "The International Seabed Authority turns twenty," Georgetown Journal of International Affairs 16, no. 1 (2015): 190, https://www.jstor.org/stable/43773680.

companies which had paid compensation to the survivors of the accident,and torelatives of those who perished, claimed that they owned all the rights tothe wreck.[254] Finally, it was recognized, through an international agreement, that the wreck was an international monument and it was necessary to protect it.[255]Hence all claimants were prevented from exploiting its spoils. If there are still legal gaps and controversies over a realm like world's oceans, which have been used by humans for millennia, we may as well ask how long it will take toinstitute a legal framework in deep space.

5.3. Deep Space: Legal Abyss?

Given the absence of an agreed upon international arrangement to regulate space mining and colonization, commercialactivity could have serious consequences.Unfair economic distribution could be one result, but, beyond that, a permanent perception of being threatened may arise among the different states active in space.When national interests are stake, adoption of a legal framework and its implementation tend to be delayed or simply overlooked. For example, before the rise of deepsea mining, there was no comprehensive agreement. But, when the countries and companies began to develop their technology and invest in the field, the US took the lead to establish a new agreement andto create regulations. In contrast, what we witness today in space is a US that does not want to be party to an international agreement. On the contrary, it is introducing its own laws on space mining. One possible explanation is as follows: when there was a rival as strong as itself (in this case, the USSR), the US had to resort to international law to make arrangements to protect its interests and powerful position. However, today the US perceives itself as the only remaining superpower andsees its strong position in space as assured.Consequently it is not willing to seek multilateral cooperation or the assurances of international law.Hence the US is not signing any agreements that are recommended by the UN.

Although the political and security interests of states are significant influences that shape their behavior and attitudes, another factor which determines their behavior in the

[254]Chris McGreal, "US court aims to establish ownership of over $100m in Titanic artefacts," *The Guardian*, October 26, 2009, accessed December 8, 2018, https://www.theguardian.com/world/2009/oct/26/titanic-artefact-case.
[255]Gavin Murphy, "RMS Titanic: A Legal Update 1," *Encyclopedia Titanica*, August 28, 2003, accessed December 8, 2018, https://www.encyclopedia-titanica.org/titanic-legal-update-1.html.

international arena is their commercial interests. States that possess the technologies to undertake space mining may not be willing to be bound by international rules, because the desire to shape and maintaina monopoly in space is stronger than the urge to develop cooperation with others. In other words,lucrative commercial benefits and strictly-defined self-interestsare likely to determine policy. In this context, another view is, that as long as there are only a few states that are able totravelinto deep space and exploit its riches, they will negotiate and share the cake;hence there will not be any problem in the short term.[256] If any problem arises, such a small club of states will negotiate among themselves to solve it. With the passage of time and more actors arriving, and through bilateral agreements between some pairs of actors, a wider international legal framework on common ground could well be established. But unless new actors enter the scene and a multi-polar environment is created in space, such agreements would not be ideal. Instead, they would be directed towards protectingthe narrowly-defined self-interests of a small number of actors.[257]

It will be difficult to create an international concurrence because of the different interests of each state.[258]Though international agreements are seen asthe best possible solution for regulating space activities, states do not easily accede to them. The passage of time may not render the task any easier, either. Over time, all states involved in space activity will begin creating their own laws, and de-conflicting those national laws with wide-ranging international arrangement will not be easy.[259]

The OST does not have specific articles on commercial activities in space, because no one had thought about those at the time the agreement was written. Space mining and colonization were still in the realm of science fiction. But now, both states and private corporations are on the verge of exploiting resources in deep space, and yet there are no accompanying norms, laws, rules and regulations. How, then,can they be regulated? As was explained in the chapter on 'Actors', while a lot of actors may at present bebehaving in accordance with the existing international agreements, it isunrealistic to expect them to adapt to the rules which have yet to be created and agreed upon.

[256]See Appendix 1.
[257]See Appendix 2.
[258] Paikowsky and Tzezana, "The politics of space mining."
[259] Davies, "Space's new frontier."

In addition to the lack of legal grounds to prepare the ground before space mining takes off; it will be impossible to guarantee that international laws and regulations on deep space activity, prepared in retrospect (i.e. after deep space activity has started taking place), would be just and fair for all, and that such rules would be recognized and observed universally. Developing countries, which are not yet at the same level astechnologically-advanced countries, may well be left in an unfair position because of the implementation of a 'first come first served'approach.

Clearly, the absence of established norms and regulations can result in an environment of uncertainty for both non-state and state actors, and may ultimately hamper, if not totally prevent, the full development of this novel sector and its associated industry. The legal system also is necessary to determine the purpose and scope of such advanced technology as the actors develop.And while the US, Russia and China are already competing in the military use of orbital space,[260] how can one expect them to show restraint and maturity when operating in a completelyunrestrained and lawless environment like deep space?

There appears to be an acute lack of international norms, rules and regulations to prevent, curtail or contain misunderstandings between various actors. The future effect of this will be that misunderstandings risk rapidly spiraling towards conflicts involving the use of force, especially military force, in deep space. To complete the picture, in the next chapter we shall identify the military instruments, both offensive and defensive, which are already available to the actors,particularly in deep space. On this basis, we will reflect on the magnitude and urgency of the danger ofactual confrontation and conflict in deep space.

[260]Agence France-Presse, "Lift-off for China-US rivalry over space's new frontiers," *South China Morning Post*, January 6, 2019, accessed January 20, 2019, https://www.scmp.com/news/china/diplomacy/article/2180883/lift-china-us-rivalry-over-spaces-new-frontiers.

CHAPTER 6

SECURITY AND INSECURITY IN DEEP SPACE

6.1. Need for Security

Besides all the technical pre-requisites needed to initiate and sustain activity in space, an additional dimension concerns the security of space activities and the entire range of assets and infrastructure associated with it. One of the most important aspects of this is the protectionof spacecraft, refueling stations and other space facilities from possible attack. We have already pointed out the gaps in the legal framework of currentlegislation, andmentioned the fact that established rules and regulations are absent in space. Non-state actors' commercial interests, and both the commercial and national interests of space actors may be in conflict with those of others. For instance, the US aspires at dominance in space, but China is getting stronger and wants to exert its power, too. The outcome of this strict pursuit of self-interest, coupled withthe legal void, could easily transform space into a domain for conflict and warfare. During the years of the First Space Age, when the US landed on the Moon and access to deep space was achieved for the first time, some international agreements were formed and the two Cold

War rivals, the US and the USSR,also interacted with each other to create a *modus vivendi*in space, whereby the use of weapons in space wascontrolled and averted. The two superpowers did not deploy weapons in space; yet they continued to develop such capabilities. 50 years later, there are still no legal curbs on weaponization of space and its use for military purposes. Furthermore, there are more non-state and state actors gaining access to space, and that will surely render the situation even more complicated. Different commercial and economic interests in this new space agewill create more uncertainty and volatility.

The term "security" as used in this context is different from safety. What we understand from security is protection from others' activities and making sure that their intentions do not become damaging when implemented. "Safety", on the other hand, is associatedwith being safe and sound from hazards and dangers which are not necessarily associated with actions and intentions of other actors in space. Along with this understanding, absence of security in space would imply hindrance, interference, coercion, and ultimately the use of force and destruction. Such threats,originating from the capabilities and intentions of other actors, may come to pose a serious problem for deep space activities. As such,confrontation or conflict is most likely to start in the phases of surveying and/or extraction of resources, andmay likely spillover into the phases of transit and transport to deep space destinations, as well as the return journeys.Ultimately, it could extend to supporting functions, such as refueling and manufacturing,and even to human settlements in space.

6.2. Cyber, Electronic and Other Forms of Attacks

The first category of attacks on space assets could be initiated from the Earth. For instance, through cyberattacks, critical data could be stolen or distorted. Space assets and their extensions on Earth are vulnerable to cyber intervention and manipulation. Communications between the Earth and space assets could be cut. When command systems or software are compromised, the assets in space could be hacked, diverted or permanently damaged. Besides the US, China and Russia are the two states to have made the biggest investments in this field. China, for instance, is known to have

attempted to interfere with US satellites several times in the past.[261] The fact that unmanned activity in deep space will inevitably rely on AI means that the threat to software on spacecraft and their facilities will be magnified. In other words, because most activity in space would depend on software, any attempts at interfering with it would have far-reaching consequences.

Likewise, as a result of electronic attacks entailing outcomes, if not techniques,similar to cyberattacks, control of spacecraft or space assets could be hampered, their activities interrupted, and flows of information could be intercepted. Iran was accused of jamming the satellite signals of several Western broadcasters in 2009 and 2010. Such Iranian interference to a number of international satellite transmission, both in the US and Europe, presents a good example of electronic attacks, and what might be carried out against any targets in space.[262]

Another aspect to be stressed in this category is what is called industrial security. The threat in this case arises from some agent deliberately interfering with the supply chainsof space-bound systems in order to insert malicious hardware and/or software. Defective items thus produced could cause irreparable damage when sent into space as part of future missions. Suppose, for example, that there is aspacecraft approaching an asteroid. When and if a spacecraft collides with an asteroid as a result of interference or malfunction, this would result in huge losses: not only monetary, but also in terms of lost time and tainted prestige. Cyber, electronic, and supply chain interference, or a multiplicity of other causes may be blamed, but given the huge distances at stake, precise attribution would be extremely difficult and time-consuming. So, the actor losing its spacecraft may never even figure out what happened exactly, and why.

In addition to this type of threat, autonomous robotic systems also are possible sources of conflict, in spite of all the benefits they provide. "*While a human being can re-*

[261]Kathryn Waldron, "Space: The last frontier for cybersecurity," *The Hill*, June 28, 2018, accessed January 26, 2019, https://thehill.com/opinion/cybersecurity/399224-space-the-last-frontier-for-cybersecurity.

[262]"Iran Jams Satellites to Block Transmissions by VOA, BBC," *Voa News*, December 30, 2009, accessed March 15, 2019, https://www.voanews.com/a/iran-jams-satellites-to-block-transmissions-by-voa-bbc--80352412/416809.html. , Stephanie Nebehay, "U.N. tells Iran to end Eutelsat satellite jamming," *Reuters*, March 26, 2010, accessed March 15, 2019, https://www.reuters.com/article/us-iran-jamming-itu/u-n-tells-iran-to-end-eutelsat-satellite-jamming-idUSTRE62P21G20100326.

evaluate policy when an unpredictable situation arises",anautonomous systems would not have such judgment and they would follow pre-determined software tracks and formats.[263] For example, it may use its offense capability when it encounters a vehicle belonging to another state on an asteroid or a planet.It may hit a vehicle that it did not expect to find in the area; or it may cause a damage within a territory in which it did not move cautiously enough. All this points out to the existence of dangerous encounters and occurrences in deep space.

6.3. Precedent and Building Blocks: Co-orbitalASAT

Concerning threats directed at satellites in orbit, there is a rapidly growing literature supported by actual and proven cases in the field. In other words, the sort of scenarios which may be expected to happen in deep space are already happening in orbital space, thus magnifying concerns about the security of missions in deep space. A prime category of weapons directed against space assets is theDirect-Ascent Anti-satellite (DA-ASAT) missile, which may be launched from the Earth into space.[264] Russia, the US,China and India are all reported to be working on such technologies.[265]They all have proven capabilities, but their activity has been mostly confined to satellites in LEO. More recently, tough, China, for one, is thought to be developing missiles that would be effective against GEO satellites – 36.000 km away from Earth, and already touching the confines of deep space.[266]

A more readily relevant and promising category of destructive technology for deep space isreferred to as Co-Orbital Anti-Satellite Techniques (CO-ASAT). In this

[263]See Appendix 2.
[264]Gosnold, "Contested space I: Threats: Direct ascent ASAT," *Satellite Observation*, February 26, 2018, accessed May 30, 2019, https://satelliteobservation.net/2018/02/26/contested-space-i-threats/.
[265] "Russia's ASAT development takes aim at LEO assets," *Jane's*, accessed December 30, 2018, https://www.janes.com/images/assets/591/81591/Russias_ASAT_development_takes_aim_at_LEO_assets_v2.pdf. Harsh Vasani, "How China is weaponizing outer space," *The Diplomat*, January, 19, 2017, accessed December 30, 2018, https://thediplomat.com/2017/01/how-china-is-weaponizing-outer-space/. Laura Grego, "A history of anti-satellite programs," *Union of Concerned Scientists*, January, 2012, accessed December 30, 2018, https://www.ucsusa.org/nuclear-weapons/space-security/a-history-of-anti-satellite-programs. Brian Weeden and Victoria Samson, "Op-ed | India's ASAT test is wake-up call for norms of behavior in space," *Space News*, April 8, 2019, accessed May 31, 2019, https://spacenews.com/op-ed-indias-asat-test-is-wake-up-call-for-norms-of-behavior-in-space/.
[266]Sandra Erwin, "Analysts: Space weapons proliferating, there is more congestion and competition," *Space News*, April 11, 2018, accessed December 30, 2018, https://spacenews.com/analysts-space-weapons-proliferating-there-is-more-congestion-and-competition/.

technique, inflicting damage on a spacecraft, or causing interruption to its progress in deep space, may not even require a dedicated, purpose-built weapon. A rival's spacecraft may be disabled or disorientedsimply by a close encounter. It suffices for the saboteur vehicle to just come near enough to its target in space. Interferingwith the target spacecraft usinga robotic arm, casting a net over it, firing small projectiles, damaging it with laser beams or high-power microwaves are all possible.[267]Suchcapabilityhas already been built and deployed in orbital space by the leading space powers, and there is no reason why it will not be modified for use in deep space as well. For instance, China is already known to be developing co-orbital systems in order to reduce the functionality of satellites, especially those of the US.[268] Russia has launched so-called inspector satellites for close-up observation of other objects in orbit.Once such a vehicle got close enough to a rival's space assets, it could interfere with them and even destroy them.[269] In fact, if a country claims that it is deploying such objects to control its own spacecraft, there are no simple restrictions or checks that could be applied. Although the US does not have an officially recognized CO-ASAT program, since the beginning of the Cold War it has carried out experiments and studied the technology.The claim has always been that those tests are conducted to improve defensive capability.[270]In the absence of international treaties or arms control arrangements, defensive capabilities could be readily applied to offensive ends,if and when required.

Working in space may thus entail many threats and dangers for the vehicles operating in it. Such threats may be directed not only tothe spacecraft, but also to its

[267]Brian G. Chow, "Worker-bee satellites will weaponize space – and help us keep the peace," *Defense One*, June 5, 2018, accessed December 30, 2018, https://www.defenseone.com/ideas/2018/06/worker-bee-satellites-will-weaponize-space-we-can-still-keep-peace/148746/. Sydney J. Freedberg Jr. "Detect nukes in flight with electron beam technology," *Breaking Defense*, August 8, 2018, accessed December 30, 2018, https://breakingdefense.com/2018/08/detect-nukes-in-flight-with-electron-beam-technology/.
[268]Davis Florick, "Beijing's Anti-Satellite and Missile Defense Systems: A Threat to Its Neighbors," *Real Clear Defense*, March 26, 2018, accessed December 30, 2018, https://www.realcleardefense.com/articles/2018/03/26/beijings_anti-satellite_and_missile_defense_systems_a_threat_to_its_neighbors_113245.html.
[269]"Russia develops co-orbital anti-satellite capability," *Jane's*, accessed December 30, 2018, https://www.janes.com/images/assets/463/83463/Russia_develops_co-orbital_anti-satellite_capability.pdf.
[270]Brian Weeden & Victoria Samson, "Global Counterspace Capabilities: An Open Source Assessment," Secure World Foundation, April 2018, accessed December 29, 2018, https://swfound.org/media/206118/swf_global_counterspace_april2018.pdf.

communication.[271]Hence defensive systems and measures are needed to counter such threats to deep space activities. It is, of course, unthinkable that a trade in which billions of dollars are being invested will be left unprotected and vulnerable. Non-state actors as well as states will want to develop their own defensive as well as offensive capabilities. Hence, we cannot rule out the possibility of a competitive, conflict-prone and tense environment in deep space. Suspicions will make their pressure felt, and each actor will be closely monitoring the other's activities. The effects of problems in space can also be expected to have effects on relations between those back on Earth. As a result of rivalries, tensions and potential conflicts in space, relations on Earthwill certainly be adversely affected. Negative ramifications are possible, not only in international politics, but also in the realms of economics, trade and commerce. All told, we can confidently state that, given the absence of established norms, regulations and legal framework in space, together with the existence of technologies that allow offensive and disruptive operations there, there is every reason to expect the transition into the 3rd space age, to lead to deterioration rather than improvement in inter-state relations. An obvious question to ask here is whether there have been any historical precedents of such a transition in inter-state relations, and whether lessons could be drawn from it. This will be considered in the nextchapter.

[271]Charles Q. Choi, "Can we prevent war in space? These guidelines may help," *Space*, May 2, 2018, accessed January 25, 2019, https://www.space.com/40462-space-war-woomera-manual.html.

CHAPTER 7

HISTORICAL PRECEDENT: AGE OF MARITIMEEXPLORATION AND COLONIALISM

Although human access to deep space is a new development which has just begunin this century, history may in some sense be repeating itself. Indeed, history has in the past witnessed exploration and colonization of new lands, andexperienced a complex set of new relations as a result. While some actors are now again playing the role of explorers and/or colonists, this time the exploited medium is outside the Earth, not a territory in the world. The attraction of wealth and untapped resources, the desire to own more, and to journey into the unknown, all have their parallels and precedents in the Age of Great Maritime Explorations of the 15^{th}-17^{th} centuries, and in the wave of colonialism that took place in parallel with it.

7.1. Historical Frontier: Undiscovered Continents

The motivation behind the Age of Explorations, besides discovering new lands to use their resources, was to find new routes for the spice and silk trades, and to also obtain valuable metals such as silver and gold. In the process of pursuing this goal, the technological enablers were the improvedmethods of navigation, mapping and shipping.

Motivated by asearch for precious goods, China had already travelled to East Africa, North Australia and the coast of North America during the period 1405-1433.[272]However, thosecontacts could not be sustained, mainly due to China's internal struggles and rivalries. On the Europeans side, the keenest and most determined maritime explorerswere the Portuguese.They discovered the islands in the Atlantic Ocean during the first two decades of the 1400s, and then travelled south along the African coast.[273]They pushed incrementally along the coastline of the African continent overthe years, and finally reached the Cape of Good Hope by 1490.[274]The next target was a maritime route to India to create a new route for the spice trade.After much effort and many attempts, the Portuguese finallyreached India in 1498.[275]Thus, by the timethe next European power(the Spanish) were preparing to set sail to distant continents, the Portuguese had already acquired a near monopoly over the trade routes to West Africa and India.The next major discoveriesby the Portuguese were to be Brazil in 1500 and Japan in 1543.[276]Yet, before those two discoveries took place, another ground-breaking success was achieved by the rival Spanish state. The crews of three Spanish ships sailing from a Spanish port in 1492discovered the islands off the coast of North American continent. However, they mistook their discovery for India,[277]and finally it was up to the

[272] Murat Hanilçe, "Coğrafi Keşiflerin Nedenlerine Yeniden Bakmak," *Tarih Okulu* 7 (2010): 51-52, accessed March 16, 2019, http://dergipark.ulakbim.gov.tr/usakjhs/article/view/5000039765.
[273] Briney, "A Brief History."
[274] Ibid.
[275] Shane Winser, "Vasco de Gama: The search for trade routes," *BBC*, February 17, 2011, accessed March 20, 2019, http://www.bbc.co.uk/history/british/tudors/vasco_da_gama_01.shtml.
[276]Amber Pariona, "What Was The Age Of Exploration Or The Age Of Discovery?" *WorldAtlas*, April 25, 2017, accessed March 16, 2019, https://www.worldatlas.com/articles/what-was-the-age-of-exploration-or-the-age-of-discovery.html."
[277]Christopher Columbus: Voyages, *The Mariners' Museum and Park*, accessed March 22, 2019, https://exploration.marinersmuseum.org/subject/christopher-columbus/.

Portuguese to figure out that what their Spanish rivals had discovered was a new continent. From that time on, it was known as America.[278]

As a newly discovered continent, America attracted the attention of many European states, as well as their people and entrepreneurs. The wealth brought to Spain from the territories of the 'New World' was the main reason for this interest. Britain landed in North America in 1497,[279] and over time colonized the territory.[280]France, on the other hand, could not get there before 1524.[281]The first comers,Portugal and Spain,soon quarreled over the sharing of South America's spoils, but they managed to sign an agreement delineating a dividing line between their spheres of influence there.[282] According to this agreement, the eastern half of South America was left to the Portuguese, while the rest of the continent was accepted as Spain's.[283] Increasing its wealth and power in the New World, the Spanish Empire established an army consisting of bothSpanish and native Americans, and pushed their way into the lands of the Aztec civilization – a region rich in gold and other minerals.[284] The Spanish Empire boosted their economy through gold-mining in the New World, but once the deposits were depleted, they had to search for new territories rich in ores.[285] Similarly, the Portuguese flourished through mining and trading;their colonies were in what is today's Brazil.

[278]Michael Marshall, "Columbus and the Age of Exploration," *The World & I* 13 (1998): 11, accessed March 27, 2019, http://web.a.ebscohost.com/ehost/detail/detail?vid=0&sid=f8f6fba4-8622-4e56-9601-d61c7146329e%40sessionmgr4007&bdata=JnNpdGU9ZWhvc3QtbGl2ZQ%3d%3d#AN=1217911&db=f6h.
[279]Rob Waugh, "Did an English expedition BEAT Columbus to the Americas? Record of bank loan to sailor who found North America in 1497 hints that others may have been there first," *Daily Mail*, May 4, 2012, accessed March 26, 2019, https://www.dailymail.co.uk/sciencetech/article-2139486/Did-English-expedition-BEAT-Columbus-Americas-Record-bank-loan-sailor-North-America-1497-hints-first.html.
[280]The First Europeans, American History From Revolution to Reconstruction and beyond, accessed January 8, 2018, http://www.let.rug.nl/usa/outlines/history-1994/early-america/the-first-europeans.php.
[281]"New France," *Britannica*, accessed March 27, 2019, https://www.britannica.com/place/New-France.
[282]"Exploration of North America," *History*, August 21, 2018, accessed January 8, 2019, https://www.history.com/topics/exploration/exploration-of-north-america.
[283]"Latin America: The colonial era,"*Time Maps*, accessed January 8, 2019, https://www.timemaps.com/civilizations/latin-america-the-colonial-era/.
[284] Exploration of North America.
[285] Latin America: The colonial era.

Once those deposits were exhausted, the Portuguese switched their attentions to South Africa.[286]

The Portuguese was also the first European power to reach Indonesia by sea, and began to dominate the spice trade there. Following them, the Spanish, Dutch and British soon afterwards arrived in South - East Asia in search of wealth and new trading opportunities.[287]

Britain could not find what it hoped for in its North American colonies, because of strong competition from the French and the Spanish, so it then moved towards India.[288] The Dutch and Portuguese were also interested in this huge, populous territory, which was difficult to control.[289] Althoughthe Portuguese first colonized parts of India,[290]ultimately it was Britain that became the primary colonial and commercial power in this part of the world.[291] All those territories, colonies and the associated webs of trading and economic relations were retained by the European powers for over four hundred years, lasting well into the 20th century.

7.2. States and Powerful Non-State Actors

In addition to states with empires, non-state actors were also involved and took an important part in this early history of colonialism. Two readily visible and better-known examples competed with each other throughout the 17th and 18th centuries. One was the East India Company (EIC) of the British, and the other the Dutch East India Company (DEIC) of the Netherlands. Interestingly, those two enterprises had a lot in common with the pioneering deep space companies of today.They both made big investments and

[286]Oxford Analytica, "Diamond mining resurges in Latin America," *Forbes*, September 24, 2008, accessed January 27, 2019, https://www.forbes.com/2008/09/23/brazil-diamonds-paraguay-biz-cx_0924oxford.html#5df0b4a82f8d.
[287]"Portuguese Arrival,"*Lonely Planet*, accessed February 1, 2019, https://www.lonelyplanet.com/indonesia/history#pageTitle.
[288]Ruby Daily, "Living in British Colonial India, 1750-1850," *The Newberry*, accessed January 27, 2019, https://dcc.newberry.org/collections/living-in-british-colonial-india.
[289]"Colonization and the East India Company,"*Bristol and Transatlantic Slavery*, accessed February 1, 2019, http://www.discoveringbristol.org.uk/slavery/routes/places-involved/east-indies/colonisation/.
[290]Shakeel Anwar, "Arrival of the British & Establishment of British East India Company," *Jagran Josh*, September 22, 2015, accessed January 27, 2019, https://www.jagranjosh.com/general-knowledge/arrival-of-the-british-establishment-of-british-east-india-company-1442914649-1.
[291]P. J. Cain and A. G. Hopkins. *British Imperialism: Innovation and Expansion 1688-1914*. (New York: Longman, 1993), 91.

tookmajor risks by venturing into unchartered waters.Today, companies visit deep space and celestial objects. EIC was first established in 1600 by 80 merchants from London,in order to exploit and colonize the new lands.India possessed several kinds valuable and exportable goods, and this wealth had attracted the attention of Western powers from the outset. The EIC was given a Royal Charter by the British Queen, enabling it to establish a monopoly over Britain's trade with Asia and control the import of spices, tea, silk, and other exotic items to Europe, for a long time.[292] The company became a symbol of colonialism for the majority of Indians.[293] It still has a sinister reputation for conducting what is remembered as corporate violence in India.One of the words that came into the English language from Hindi was 'loot', which is a slang expression for plunder.[294] The word, which was frequently used by Indians to refer to actions of the British, became a common term in Britain as well.

The corporation became powerful in a short time, thanks to the power and privilege it acquired in India under the British Empire. It quickly seized the control of undiscovered territories to the North and took the lion's share of India's trade with Britain. In the 18th century, this one company controlled almost 50% of the world's total trading volume, all by itself.[295]

However, colonial rivalry resulted in a war between the French and the British that lasted for seven years.[296] Despite its devastating effects,the power of the EIC in India was increased by the British state. Its commercial and administrative activities were defined through a number of acts, and it was given the power to rule the region

[292] Vidhi Doshi, "How the East India Company became a weapon to challenge UK's colonial past," *The Guardian*, May 7, 2017, accessed November 2, 2018, https://www.theguardian.com/world/2017/may/06/east-india-company-british-businessman.
[293]Amar Farooqui, "Governance, Corporate Interest and Colonialism: The Case of the East India Company," *Social Scientist* 35, no. 9/10(2007): 46, accessed December 2, 2018, https://www.jstor.org/stable/27644239.
[294]William Dalrymple, "The East India Company: The original corporate raiders," *The Guardian*, March 4, 2015, accessed December 3, 2018, https://www.theguardian.com/world/2015/mar/04/east-india-company-original-corporate-raiders.
[295] Peter Stone, "The East India Company," *The History of London*, accessed October 11, 2018, http://www.thehistoryoflondon.co.uk/the-east-india-company/.
[296]Office of the Historian, *Treaty of Paris, 1763*.

legally.[297]The company was rendered as strong as any state, and its rule lasted for a very long period of time. Important decisions were taken by a committee which was directly in touch with the British government. In theory, India was ruled by the British government from London. But in reality, theEIC had puppet administrators appointed according to its wishes and itselfpulled the strings in India.[298]

With such a significant authority and power at its disposal, the EIC had to defend itself. Therefore, it also created its own private security force, comprising 260,000 soldiers, the majority of which were local Indians. At that time, the whole British army itself could only field half that number of soldiers. The large size of this private army underlined the importance of expansionism, oppression and forceful control. In 1803, the EIC captured India's capital, Delhi. A director of the company described it as an empire within an empire. Meanwhile, in order to sustain and protect its privileges and interests, it provided lucrative investments and distributed tangible benefits in its home country. For this purpose, it was financially assisted by the administration and civil service of the British Empire.[299]

Over the course of centuries, the British Empire was forced to adapt to the changing world to preserve its reputation, not to lose the support of its own people, and to avoid negative reactions from other countries. Hence, after IEC's monopoly for well over two hundred years, anddue to pressure to liberalizethe trade, the British government took that privilege away from the EIC in 1859.[300] Several other companies quickly stepped into trade with India and connect it with the rest of the world. From that point on, the EIC ruled India as an agent of the British Parliament, so its profits were much reduced.

In 1857, the Great Indian Mutinycontributed to the EIC losing its power. The security forces of the EIC revolted against their own employer, and the revolt was supported by civilian Indians employed by the EIC.[301]The company sought to suppressthe rebellion by

[297]Barun De, "Arguments of the East India Company in favour of decentralisaton in India – At the time of the passage of pitts India act, June-July 1784," *Proceedings of the Indian History Congress* 24(1961): 271-272, accessed August 2, 2018, https://www.jstor.org/stable/44140763.
[298] Stone, "The East India Company."
[299] Dalrymple, "The East India Company."
[300] Ibid.
[301] Peter Marshall, "British India and the 'Great Rebellion'," *BBC*, February 17, 2011, accessed December 11, 2018, http://www.bbc.co.uk/history/british/victorians/indian_rebellion_01.shtml.

hanging and murdering tens of thousands of rebels.[302] Following this failure of governance, in 1858 the British government took over the EIC's administrative powers and dissolved its armed force. Thesoldiers were re-organized under the newly-establishedBritish Indian Army.[303] Until its closure two decades later, the EICcontinued to trade in tea and coffee on a small scale.[304] Finally, it was totally shut downin 1874.[305]

The second example from the age of colonizationis the Dutch East India Company (DEIC), which was established in 1602, just after the founding of the British EIC. The aim was to ensure expansion of Dutch trading and influence in East Asia – a process that was to last for almost two hundred years. The DEIC became one of the most important symbols of global trade in the 17th and 18th centuries and no other Dutch company was given permission to trade with Asia.[306]

Like the EIC, the DEIC also had the privilege of making treaties with native rulers and deploying armed forces in the East Indies – today's Indonesia.[307]In addition, since the regions it was trading in were not always safe, its ships carried weapons and the DEIC deployed its own navy, too. Hundreds of soldiers were first brought from the Netherlands to protect the area, and in time, as the conquered territories expanded, the number increased up to ten thousand.[308] Through regular courts the company provided judicial functions, and printed money in the territories it ruled. In this way, it had absolute sovereignty over the overseas territories of the Dutch state. All this was managed by a board comprising 17 members who were selected from among the directors of the company.[309]

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[302] Dalrymple, "The East India Company."
[303] Stone, "The East India Company."
[304] Doshi, "The East India Company."
[305]"East India Company Timeline,"*Brick Lane Circle*, accessed December 2, 2018, http://www.bricklanecircle.org/east-india-company-timeline.html.
[306]Femme S. Gaastra, "The Dutch East India Company," *The Great Circle* 19, no. 2(1997): 109, accessed August 2, 2018, https://www.jstor.org/stable/41555332.
[307]"Dutch East India Company," *Britannica*, accessed February 2, 2019, https://www.britannica.com/topic/Dutch-East-India-Company.
[308]Tristan Mostert, "Chain of Command: The wars of the company," (Master's diss., University of Leiden, 2007).
[309] Raimondo Luraghi. *Sömürgecilik Tarihi*. (E Yayınları, 1975), 141.

The profit that company acquired over 180 years was 36 times as much as its initial capital.[310] But as the 18th century advanced, the situation began to change for the DEIC as well. Year by year the profits declined. After 1780, the state withdrew its financial support from the company.[311]The main reason for this decline was that global trade and shipping were growing fast and the company was losing its monopoly, so competition reduced its profits. The DEIC went bankrupt and was expropriated in 1799.[312] Its functions and privileges were taken over by the Dutch state.

7.3. State-Corporate Interactions: Similarities with Deep Space

Our historical overview reveals several common points between the discovery of new continents on the one hand, and today's deep space exploration and exploitation of its resources on the other. First of all, state actors are rivals in both cases. In maritime explorations, armed conflict followed soon after new lands were discovered. This is a sinister omen for the future of increased human activity in deep space.

Besides states, the involvement and competition of non-state actors is readily visible in both cases. During the age of colonization, some companies had more power than states, used violence, and acted brutally. Whether this will be the case in deep space remains to be seen. What is certain is that conflicts in deep space are likely to turn more complex because of the involvement of a multiplicity of non-state actors.

An important issue here is competition under unequal conditions. Powerful colonial entities had the power to deactivate or push aside other actors – a process clearly visible in the examples of the past. Those excluded could be states ornon-state actors. When theconflict is between companies, formulating and standardizing rules that both states and non-state actors could setup, might become ameans of regulation. But when it comes to states versus non-state actors, the question that arises in this case is how a nation-state could safeguard its interests when pitted against a powerful corporation. In this kind of situation,only international norms and agreements can provide solutions.

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[310] Ibid: 142.
[311] Ibid: 112
[312]Caner Kuşbabalı, "Baharatın sırtında yükselen dev; Hollanda Doğu Hindistan Şirketi," *Gazete Bilkent,* April 14, 2015, accessed March 5, 2019, http://www.gazetebilkent.com/2015/04/14/bir-devin-cokusu-hollanda-dogu-hindistan-sirketi/. comm

Another similarity between the parallel developments we have considered is that the main motivation in both periods is commercial interests. The idea of becoming economically superior by getting hold ofresources before others fuels competition. When we look at the progress of the two most prominent non-state actors in the history of colonialism, it is very clear that they accumulated great wealth when they had monopolies over certain regions and categories of trade. Yet, in the absence of overriding international law orrules, there were deep ambiguities over the ownership rights and sharing of new resources.Those uncertainties,whichrestricted the activities of both companies and states,have not been totally resolved up to the present day.It took up to 500 years to create a legal system like the Law of the Sea. Similarly, there is a lack of legal ground today and the OST, created to address this deficiency in 1967,containsseveral ambiguities and unaddressed issues. We can expectdozens, if not hundreds, of companies to get involved in space-mining activities in the coming decades. It is important in this context to know which legislation, rules and regulations will be applied to activities in space. Since companies can be expectedto be predominant,compared to their respective states, company-company and company-state arrangements will be of critical importance.However, inter-state agreements should not be overlooked either.

In the field of deep space, what is important is the realization that steps should be taken as soon as possible to avoid future problems. Presumably, it will be much easier and comparatively straight forward to prepare the legal groundwork before state and corporate interests become imminent and tangible. Once they take shape and real vested interests are at stake, the process of agreeing on a common framework will likely become much more elusive and difficult. The experience presented by the Age of Great Maritime Explorations validates this point. More than 500 years have elapsed since the first explorations of the late-15th century, but some aspects of maritime and other international law continue to be a subject of dispute. The human racestill has a chance to avoid the same fate in deep space, provided that steps are taken inthe brief interval that is still available beforethe arrival of extensive activity in deep space.

CHAPTER 8

HUMAN ACTIVITIES IN DEEP SPACE: CONCLUDING REMARKS AND SUGGESTIONS

Discoveries that began on Earth have continued up into the sky, into orbital space, and now extend further beyond that intothe deep space. Although activities there are still in an early stage of scientific exploration, considering the maturity of the required technologies that we have identified, we can expect rapid developments in the not-too-distant future. This conclusion is supported by both the interviews we had with field experts and professionals, and the widely-held views of researchers revealed through our literature review. Even though the biggest remaining obstacle seems to be the cost efficiency of venturing into space for commercial goals, there is every reason to anticipate that the technology will eventually advance sufficiently to overcome this hurdle, too. Traveling into deep space, extracting and processing valuable substances there, creating space stations, as well as manned and unmanned settlements on celestial bodies, appear to be already within reach technologically. When associated costs of these activities could be lowered, then profitability would be attained and the pace of

commercializationincrease rapidly and dramatically. The fact that several actors in the field are already competing with each otherspeeds up technological progress, suggesting the prospective feasibility of attempts to open up to deep space materializing pretty soon, perhaps within a decade or so. This provides an answer to our first research question, whereby commercial activity in deep space has come to constitute not a possibility, but a matter of certainty. The only remaining element of uncertainty in the equation is whether such commercialization is imminent or more likely to take place in adistant future. Again, our compiled data and expert opinions indicate that such commercialization may be imminent, quite likely to take place within perhaps a decade or two.

With respect to our second research question, namely the likely actors to be at the forefront of space activity, available data suggest that continued role and eminence of state actors may come under pressure from non-state actors, primarily private corporations and investors which are already harboring big ambitions and schemes for ripping the riches of celestial bodies. There are already several hundred private corporations vying to take a front seat in this respect, and they may indeed be poised to outpace state actors by virtue of their technological and entrepreneurial agility. Among those corporations are some of the leading MNCs of the current global economy like the Amazon, Microsoft and Virgin groups. Thence, extension of the clout and influence of MNCs into the deep space appears certain, and tilting of the balance in space in favor of MNCs (at the expense of state actors) is possible. In fact, our analysis of the consequences of the comparable circumstances during the age of Great Maritime Explorations is indicative of increased clout of private corporations over national governments when such conditions prevail. Conversely, given the currently observed unwillingness of leading spacefaring nations to accept multilateral controls and restraints over their respective space activity, the role of the other main category of non-state actors, namely intergovernmental organizations, is not expected to fare heavily in deep space. For sure, intergovernmental bodies such the UN and the EU could carry on with their regulatory and/or legislative functions; but the prospects for reaching beyond that is dim. At least for opening phases of deep space activity, the same appears to be applicable to the case of another category of non-state actors, namely NGOs.

All the while, the complex set of interactions between state actors on the one hand, and state actors and non-state actors on the other hand should be expected to continue unabated in deep space as well. What appears to be critical in determining the nature and outcomes of those complex interplays should be handled together with the findings of our fourth research question, namely the state of norms and legislative framework to regulate activities and interactions in deep space. In this respect, the prospects are not encouraging, because all these developments are taking place against a background devoid of satisfactory legal basis and framework. The laws of states which normally regulate their internal affairs are not necessarily, and certainly not readily, applicable to deep space. Even if they were, there are no guarantees that they would find acceptance and legitimacy in space. In the absence of internationally-binding agreements, this pointsout to the possibility of an unregulated, chaotic, self-help situation in deep space in the coming years. The OST, which was put together very early-on in the space age, is the only comprehensive agreement in the field, yet it is clearly not up to the task, especially for deep space endeavors. The Moon Treaty which was created after the OST, failed to attract space-faring nations. A main reason could be their distrust of the schemes shaped under the umbrella of UN, hence an unwillingness to accept multilateral restraints and obligations. Over 50 years have passed since the inauguration of OST, yet leading spacefaring states are reluctant to adopt a new regulatory framework andcorresponding treaties and agreements. This situation will not only magnify ambiguities, but it will also create future problems. These will affect not only the current space-faring nations, but also others likely to travel in space in the future.

The lessons of historical precedent in conjunction with our fifth research question do not provide much relief either. As our examination of the case ofthe Great Maritime Explorations illustrated, during a period when there were no legal boundaries a handful of private companies became representatives of their respective states. In the process, they came to dominate all trade and economic activity in and out of the newly-discovered territories, and in the process they even created their private armies and navies. There were no viable restrictions on their arming and use of force. They have shaped and influenced their respective governments' policies and decisions, which has precipitated the emergence of violence at both domestic and interstate levels. Legal

norms in this respect began to emerge only with the liberalization of trade, and afterwardsa comparatively fair order could becreated.

This is in fact presenting the context for an interesting line of deliberations and debate with respect to the interplay between mercantilism and liberalism as the two competing paradigms of international political economy. Mercantilism in this sense could be taken as the international trade equivalent of the Realist world view of international relations, whereas economic liberalism would have more in common with liberal internationalism and its belief in cooperation to realize common gains.[313] In a mercantilist order, each state is expected to protect its own interest at the expense of others. There could be no mutual gains, therefore states and their respective traders struggle for relative gains, hence relative power vis-à-vis others. Some of the implications of such mercantilist international setting would be; first, no room for international organizations; and second, an intrinsic and mutually-reinforcing link between military power on the one hand and wealth, economic exploitation and trade on the other. Increased economic wealth would generate increased military power, and vice versa. Conversely, in an international system shaped by economic liberal norms and principles, states can mutually benefit from economic exchanges, wealth could increase in absolute terms, and international institutions play an important role by building structures and norms for increased cooperation.

The era and series of events we have analyzed under Chapter 7 on Great Maritime Explorations is a typical example of international political economy shaped by mercantilism, which was eventually supersededby economic liberalism. During this mercantilist period, as we have already identified, there was not a comprehensive legal framework regulating international trade or interstate relations, nor were there any IGOsto restrain or mediate in between the seafaring, colonizing states and their overseas corporations (which could in fact be deemed as the forerunners of modern MNCs). State governments have shown no or little intention to cooperate with other states, and opted instead to act unilaterally.Cooperation drawing on shared and mutual interests was confined to the one between the states and their own corporations. In such collaboration,

[313]Pevehouse and Goldenstein, *International Relations*, 241.

corporations had significant clout and influence over their respective governments, displaying similarities to the circumstances of certain powerful, modern day corporations vying to take part in the commercialization of space today, and the influence such corporations have already started exerting on their respective governments and legislative bodies on decisions relating to deep space.

All this points out to a noteworthy similarity with the characteristics observed during the age of Great Maritime Explorations. Combined with the failure so far to develop and implement universally-accepted multilateral restraints, norms and regulations on activities in deep space, this could even be taken as a possible harbinger of the reemergence of an order reminiscent of mercantilist era in deep space. With the backing of the respective states, private corporations may be poised to establish their control, perhaps even their hegemony over the exploitationand trading of space resources. Paying tribute to the characteristics of the mercantilist order that prevailed during the age of Great Maritime Explorations, it may even not be farfetched to anticipate some of those strong private actors shaping and influencing the policies and orientations of their respective governments. Consequently, negative ramifications in the sense of increased propensity for more violent relations both in deep space and back on Earth could not be ruled out.

Asthe two powers (US and China) already leading in relevant space technologies and also encompassing strong economic bases back on the Earth, theyare likely to have a head start in space mining, travel and settlements, and the ensuing commercialization of deep space. Japan and India are likely to follow on their footsteps. Also, European states either through bilateral cooperative arrangements or under the umbrella of the EU could follow the suit. Besides those main actors, there could also be some unexpected new players by virtue of legislative, financial or technological breakthroughs achieved by their private entities and MNC.

All the while, it is highly probable that a reconciliatory and regulatory role being played by the UN and perhaps the EU as well. NATO and other IGOs are not expected to play a direct and decisive role in all this. Even for the UN, the foot-dragging by leading spacefaring nations, and especially by the US is most likely to constitute a major

stumbling block on the way to increased multilateralism, cooperation, and regulatory framework in deep space, and this being the expectation at least in the near and medium terms.

All told, if lessons are to be taken from history and applied to the future, it is obvious that the lack of international regulation applicable to deep space risks creating similar circumstances and outcomes of the 16th to 18th centuries. It is true that a comparatively liberal trade order prevails today. Yet, since only a small number of countries have the necessary means to venture into deep space, there will be huge financial losses for other countries without such means. Therefore, the need for progress is readily apparent. There are two aspects to such progress. First, there is a need for legal arrangements and binding regulations, which also should include laws on arms control, as well as promoting transparency and confidence-building in space. Second, mechanisms should be put in place to safeguard the stakes and interests of developing and underdeveloped states, too. Obviously, such goals are easier said than done. Nonetheless, if ways could not be found to make progress in that direction in an environment in which powerful players predominate over weaker ones, the lack of rules will exacerbate unfair conditions, and risks leading to confrontations and conflicts which would be detrimental to the interests of all parties. Therefore, although it may not always seem to be in the interest ofleading space powers, creating and sustaining a legal framework in space appears to be imperative. The priority must be to getmore advanced space powers to agree to such arrangements. This might be possible with the help of someinternational institutions. Currently, the absence of such a mechanism makes such undertaking and practice unlikely. Another alternative of course is for theleading space powerstaking such regulatory measures voluntarily, which couldperhaps be expected to take place through mutual agreementswhen the competition between them gets tougher and more damaging. If the history teaches us any lessons, such a coursecould come to be implemented not from the beginning, but onlyafter activities in deep space reach and cross a certain threshold.The likelihood of such course, how soon or late it could take place, and its probable effectiveness, are open to debate.

With respect tothe second objective, namelythe need to protect underdeveloped countries against a ruthless "winner takes it all" system in deep space, is very important, too. Bypromoting cooperation and alliances of the willing, some progress in that direction could perhaps be achieved. On the positive side, developing countries and their people may have easier access to the required technologies thank to the democratization of knowledge, and also easier access to such information in parallel with the maturation and wider dissemination of space-related technologies. This could in fact provide for an advantage forprogressing in space mining, space manufacturing and similar activities at fasterpace than the initial group of pioneering space powers. Consequently, the gap could eventually be closing and over time it could perhaps even be reversing. The crux of the matter is that we already have the negative lessons of a historical example in front of us, whereby exploitation and competition in the absence of norms, regulations and legal framework resulted in major problems and suffering, some of which have persisted up until modern days. And without learning from the past and taking the necessary steps in a timely manner, we may be faced with the recurrence of the same.

A very last remark concerns thepeople who settled on the newly-discovered continents five centuries ago, and themeventually seeking their independence from homelands and creating their own states.When and if human settlements and colonization begin in space, the original nationalities of individuals residing in them, and state sovereignty over such settlements may eventually lose relevance. Humanity could then even create a new political order and civilization in deep space. This may sound like science fiction at the moment, but it may already a possibility in the making,given the breathtaking pace at which technology is developing and how many individuals are keen to travel and settle in space. With the inclusion of deep space element, and its people and settlements, a transformation ofwhat we call today "world affairs"may not be far-fetched. In this sense, developmentsinvolving and triggered by deep space may give rise to unprecedented shifts in globaleconomy, politics and security. Therefore, it is of utmost importance that some preparations, cooperative initiatives and at a minimum creative debate better be launchedahead of time as compared to the alternative course of ignoring the fact that ground shaking developments around deep space iscertain to happen and a only matter of time.Otherwise, if each and every dominant actor carries on with "business as usual",

and feels bound only by its own laws and refuses to accept the yoke of restrictive international rules and cooperative schemes, on the basis of current as well as historical evidence, there is every reason to anticipate a period of uncertainties and volatility that could last for decades or even centuries. At the very least, this is the lesson that the developments of five centuries ago under somewhat similar circumstances appear to be teaching us.

REFERENCES

114th Congress, "H.R.2262 - U.S. Commercial Space Launch Competitiveness Act: Sec. 402."

Abrahamian, Atossa Araxia. "How a tax haven is leading the race to privatise space." The Guardian. September 15, 2017. Accessed January 26, 2019. https://www.theguardian.com/news/2017/sep/15/luxembourg-tax-haven-privatise-space.

Adamowski, Jaroslaw. "EU could agree on new regulation for space program by May." Space News. January 14, 2019.Accessed May 31, 2019.https://spacenews.com/eu-could-agree-on-new-regulation-for-space-program-by-may/.

Agence France-Presse, "Lift-off for China-US rivalry over space's new frontiers." South China Morning Post. January 6, 2019. Accessed January 20, 2019. https://www.scmp.com/news/china/diplomacy/article/2180883/lift-china-us-rivalry-over-spaces-new-frontiers.

Agence France-Presse. "Russia and US will cooperate to build moon's first space station." The Guardian. September 27, 2017. Accessed February 21, 2019. https://www.theguardian.com/science/2017/sep/27/russia-and-us-will-cooperate-to-build-moon-first-space-station.

Allen, John R. and Amir Husain. "The next space race is artificial intelligence." Foreign Policy. November 3, 2018. Accessed March 21, 2019. https://foreignpolicy.com/2017/11/03/the-next-space-race-is-artificial-intelligence-and-america-is-losing-to-china/#.

American Space Commerce Free Enterprise Act of 2017, Chapter 803, Global commons.

Amos, Jonathan. "Japanese Hayabusa asteroid mission comes home." BBC. June 13, 2010. Accessed December 11, 2018. https://www.bbc.com/news/10285973.

Amos, Jonathan. "Parker Solar Probe: Nasa delays mission to unlock Sun's mysteries." BBC. August 11, 2018. Accessed January 29, 2019. https://www.bbc.com/news/science-environment-45058911.

Antrim, Caitlyn. "The International Seabed Authority turns twenty." *Georgetown Journal of International Affairs* 16, no. 1 (2015): 190. https://www.jstor.org/stable/43773680.

Anwar, Shakeel. "Arrival of the British & Establishment of British East India Company." Jagran Josh. September 22, 2015. Accessed January 27, 2019. https://www.jagranjosh.com/general-knowledge/arrival-of-the-british-establishment-of-british-east-india-company-1442914649-1.

Bachman, Justin and Travis Tritten. "Why Trump Wants a Space Force for the Final Frontier." Bloomberg Businessweek. August 6, 2018. Accessed March 3, 2019. https://www.bloomberg.com/news/articles/2018-08-06/what-s-a-space-force-and-can-trump-really-start-one-quicktake.

Barnard, Lucy. "UAE to finalise space laws soon." The National, March 7, 2016. Accessed May 11, 2019. https://www.thenational.ae/business/uae-to-finalise-space-laws-soon-1.219966.

Barnatt, Christopher. “Helium-3 and Nuclear Fusion.” Explaining the Future. Accessed March 21, 2019. https://www.explainingthefuture.com/helium3.html.

Barnatt, Christopher. *The next big thing: From 3d printing to mining the moon*. CreateSpace Independent Publishing Platform, 2015.

Beall, Abigail. “The law of the worlds: how will outer space be regulated?.” The Guardian. Accessed September 3, 2018. https://www.theguardian.com/legal-horizons/2018/jul/09/the-law-of-the-worlds-how-will-outer-space-be-regulated.

Berg, Bruce L. *Qualitative Research Methods For The Social Sciences*.Long Beach: California State University, 2001.

Berry, Adrian. “How China is sending man back to the Moon to mine safe nuclear power and become the world's energy giant.” The Telegraph. February 29, 2016. Accessed March 21, 2019. https://www.telegraph.co.uk/news/science/space/nightsky/12178122/night-sky-march-2016-china-space-mission.html.

Bloomberg News. “China’s Secretive Space Program Threatens NASA’S Dominance.” Bloomberg. November 28, 2016. Accessed April 26, 2019. https://www.bloomberg.com/graphics/2016-asia-space-race/china.html.

Bonsor, Kevin. “How asteroid mining will work.” How Stuff Works. Accessed March 6, 2019. https://science.howstuffworks.com/asteroid-mining2.htm.

Brown, Dwayne et al. “NASA, ULA Launch Parker Solar Probe on Historic Journey to Touch Sun.” NASA. August 12, 2018. Accessed November 29, 2018. https://www.nasa.gov/press-release/nasa-ula-launch-parker-solar-probe-on-historic-journey-to-touch-sun.

Cain, P. J. and A. G. Hopkins. *British Imperialism: Innovation and Expansion 1688-1914*. New York: Longman, 1993.

Campbell, Rebecca. "Space mining is getting close to reality." Mining Weekly. December 15, 2017. Accessed June 29, 2019. http://www.miningweekly.com/article/space-mining-is-getting-close-to-reality-2017-12-15-1/rep_id:3650.

Chang, Kenneth. "After SpaceX Launch, Israeli Spacecraft Begins Journey to the Moon." The New York Times. February 21, 2019. Accessed March 21, 2019. https://www.nytimes.com/2019/02/21/science/spacex-launch-israel.html.

Choi, Charles Q. "Can we prevent war in space? These guidelines may help." Space. May 2, 2018. Accessed January 25, 2019. https://www.space.com/40462-space-war-woomera-manual.html.

Chow, Brian G. "Worker-bee satellites will weaponize space – and help us keep the peace." Defense One. June 5, 2018. Accessed December 30, 2018. https://www.defenseone.com/ideas/2018/06/worker-bee-satellites-will-weaponize-space-we-can-still-keep-peace/148746/.

Christopher Columbus: Voyages. The Mariners' Museum and Park. Accessed March 22, 2019. https://exploration.marinersmuseum.org/subject/christopher-columbus/.

Cid De Leon Ovalle, Mariana. "Luxembourg sets sights on space mining with new law." Boss Magazine. Accessed February 4, 2019. https://thebossmagazine.com/luxembourg-space-mining/.

Clark, Colin. "CSIS On The Second Space Age: 'Diverse, Disruptive, Disordered And Dangerous.' Breaking Defense. October 4, 2017. Accessed February 16, 2019. https://breakingdefense.com/2017/10/csis-on-the-second-space-age-diverse-disruptive-disordered-and-dangerous/.

Cobb, Wendy Whitman. "Would a space force mean the end of NASA?" The Conversation. October 18, 2018. Accessed May 17, 2019. https://theconversation.com/would-a-space-force-mean-the-end-of-nasa-102472.

Collinson, Shura. “Asteroid mining: Russian experts call for action in the new space race.” *Skolkovo*. October 20, 2017. Accessed May 16, 2019. https://sk.ru/news/b/articles/archive/2017/10/20/asteroid-mining-russian-experts-call-for-action-in-the-new-space-race.aspx.

“Colonization and the East India Company.” Bristol and Transatlantic Slavery. Accessed February 1, 2019. http://www.discoveringbristol.org.uk/slavery/routes/places-involved/east-indies/colonisation/.

Connor, Neil. “China plans to build manned ‘lunar palace’ powered by the sun.” The Telegraph. April 25, 2018 Accessed March 23, 2019. https://www.telegraph.co.uk/news/2018/04/25/china-plans-build-manned-lunar-palace-powered-sun/.

Corbyn, Zoë. “The asteroid rush sending 21st-century prospectors into space.” The Guardian. June 9, 2018. Accessed December 10, 2018. https://www.theguardian.com/science/2018/jun/09/asteroid-mining-space-prospectors-precious-resources-fuelling-future-among-stars.

Cornich, Chloe. “Interplanetary players: a who’s who of space mining.” Financial Times. October 19, 2017. Accessed May 21, 2019. https://www.ft.com/content/fb420788-72d1-11e7-93ff-99f383b09ff9.

“Countdown to NATO space strategy.” France24. June 25, 2019.Accessed July 7, 2019.https://www.france24.com/en/20190625-countdown-nato-space-strategy.

Çolak, Ebru. "Göktaşında Maden Aramak." *Derin Ekonomi*, May (2016): 75-76.

Daily, Ruby. “Living in British Colonial India, 1750-1850.” The Newberry. Accessed January 27, 2019. https://dcc.newberry.org/collections/living-in-british-colonial-india.

Dalrymple, William. “The East India Company: The original corporate raiders.” The Guardian. March 4, 2015. Accessed December 3, 2018.

https://www.theguardian.com/world/2015/mar/04/east-india-company-original-corporate-raiders.

David, Leonard. "Is Asteroid Mining Possible? Study Says Yes, for $2.6 Billion." Space. April 24, 2012. Accessed December 29, 2018. https://www.space.com/15405-asteroid-mining-feasibility-study.html.

David, Leonard. "Prospecting on the Moon: Russia, Europe to hunt for lunar ice" Space. August 29, 2018. Accessed December 25, 2018. https://www.space.com/41653-moon-mining-europe-russia-prospect-project.html.

David, Leonard. "The US geological survey is getting serious about space resources and mining." Space. September 4, 2018. Accessed April 19, 2019. https://www.space.com/41707-space-mining-usgs-resource-survey.html.

Davies, Rob. "Asteroid mining could be space's new frontier: the problem is doing it legally." The Guardian. February 6, 2016. Accessed December 1, 2018. https://www.theguardian.com/business/2016/feb/06/asteroid-mining-space-minerals-legal-issues.

De, Barun. "Arguments of the East India Company in favour of decentralisaton in India – At the time of the passage of pitts India act, June-July 1784." *Proceedings of the Indian History Congress* 24(1961): 271-272. Accessed August 2, 2018. https://www.jstor.org/stable/44140763.

Department of Space. *Space Science & Exploration.*

Deslandes Ann. "The Bold Future of the Outer Space Treaty." Jstor Daily. August 1, 2018. Accessed January 19, 2019. https://daily.jstor.org/the-bold-future-of-the-outer-space-treaty/.

Doshi, Vidhi. "How the East India Company became a weapon to challenge UK's colonial past." The Guardian. May 7, 2017. Accessed November 2, 2018.

https://www.theguardian.com/world/2017/may/06/east-india-company-british-businessman.

Durani, Haris. "Property, Power and Law in 'The New Dimension'." Academia. Accessed February 19, 2019. https://www.academia.edu/34080847/Property_Power_and_Law_in_the_New_Dimension_.

"Dutch East India Company." Britannica. Accessed February 2, 2019. https://www.britannica.com/topic/Dutch-East-India-Company.

"East India Company Timeline." Brick Lane Circle. Accessed December 2, 2018. http://www.bricklanecircle.org/east-india-company-timeline.html.

Emmott, Robin. "Exclusive: NATO aims to make space new frontier in defense." Reuters. June 21, 2019. Accessed July 7, 2019.https://www.reuters.com/article/us-nato-space-exclusive/exclusive-nato-aims-to-make-space-new-frontier-in-defense-idUSKCN1TM1AD.

Erdem, Merve. "Dünya Uzay Haftasının Ardından Uzay Faaliyetlerinin Hukuki Rejimine İlişkin Düşünceler." Academia. 2017. Accessed January 26, 2019. https://www.academia.edu/36745567/D%C3%BCnya_Uzay_Haftas%C4%B1n%C4%B1n_Ard%C4%B1ndan_Uzay_Faaliyetlerinin_Hukuki_Rejimine_%C4%B0li%C5%9Fkin_D%C3%BC%C5%9F%C3%BCnceler.

Erwin, Sandra "Analysts: Space weapons proliferating, there is more congestion and competition." Space News. April 11, 2018. Accessed December 30, 2018. https://spacenews.com/analysts-space-weapons-proliferating-there-is-more-congestion-and-competition/.

Estonian Defence Forces. *Estonian National Defence Policy.*

"EU shapes its future space policy programme." European Council. March 13, 2019.Accessed May 31, 2019.https://www.consilium.europa.eu/en/press/press-releases/2019/03/13/eu-shapes-its-future-space-policy-programme/.

European Space Agency. *New Member States.* Accessed May4, 2019. https://www.esa.int/About_Us/Welcome_to_ESA/New_Member_States.

"Exploration of North America."History. August 21, 2018. Accessed January 8, 2019. https://www.history.com/topics/exploration/exploration-of-north-america.

Farooqui, Amar. "Governance, Corporate Interest and Colonialism: The Case of the East India Company." *Social Scientist* 35, no. 9/10(2007): 44-51. Accessed December 2, 2018. https://www.jstor.org/stable/27644239.

Fleischer,Pawel. "Above the Moon: NATO Space Policy." Future NATO. September 9, 2016.Accessed June 1, 2019.http://futurenato.org/articles/above-the-moon-nato-space-policy/.

Florick, Davis. "Beijing's Anti-Satellite and Missile Defense Systems: A Threat to Its Neighbors." Real Clear Defense. March 26, 2018. Accessed December 30, 2018. https://www.realcleardefense.com/articles/2018/03/26/beijings_anti-satellite_and_missile_defense_systems_a_threat_to_its_neighbors_113245.html.

Foust, Jeff. "House passes commercial space bill." Space News. November 16, 2015. Accessed January 22, 2019. https://spacenews.com/house-passes-commercial-space-bill/.

Foust, Jeff. "House passes commercial space regulatory bill." *Space News*. April 25, 2018. Accessed January25, 2019. https://spacenews.com/house-passes-commercial-space-regulatory-bill/.

Franklin, I. V. "The Commercial Potential of Large Orbital Space Platforms." *Philosophical Transactions of the Royal Society of London. Series A, Mathematical*

and Physical Sciences 312, no. 1519(1984): 133-140. Accessed May 25, 2019. https://www.jstor.org/stable/37394.

Freedberg Jr., Sydney J. "Detect nukes in flight with electron beam technology." Breaking Defense. August 8, 2018. Accessed December 30, 2018. https://breakingdefense.com/2018/08/detect-nukes-in-flight-with-electron-beam-technology/.

Gaastra, Femme S. "The Dutch East India Company." *The Great Circle* 19, no. 2(1997): 109-123. Accessed August 2, 2018. https://www.jstor.org/stable/41555332.

Geosynchronous Satellites. NASA. Accessed March 1, 2019. https://www.nasa.gov/audience/forstudents/5-8/features/geo_feature_5_8.html.

Gohd, Chelsea. "Trump wants a Space Force – But we have an Air Force Space Command." Space.August 10, 2018. Accessed February 27, 2019. https://www.space.com/41452-space-force-air-force-space-command.html.

Good, Andrew. "Mars InSight Lander's 'Mole' Pauses Digging." NASA. March 5, 2019. Accessed March 7, 2019. https://mars.nasa.gov/news/8419/mars-insight-landers-mole-pauses-digging/?site=insight.

Gosnold, "Contested space I: Threats: Direct ascent ASAT." Satellite Observation. February 26, 2018. Accessed May 30, 2019. https://satelliteobservation.net/2018/02/26/contested-space-i-threats/.

Goswami, Namrata. "China in Space Ambitions and Possible Conflict." *Strategic Studies Quarterly* 12, no. 1 (2018): 74-97. Accessed March 20, 2019. http://www.jstor.org/stable/26333878.

Goswami, Namrata. "The new space race pits the U.S. against China. The U.S. is losing badly." The Washington Post. January 10, 2019. Accessed January 20, 2019. https://www.washingtonpost.com/opinions/the-new-space-race-pits-the-us-against-

china-the-us-is-losing-badly/2019/01/10/bcdcad10-14f9-11e9-b6ad-9cfd62dbb0a8_story.html?noredirect=on&utm_term=.198617642779.

Gradoni, Lorenzo. "What on Earth is happening to space law?." EJIL: Talk. July 31, 2018. Accessed December 16, 2018. https://www.ejiltalk.org/what-on-earth-is-happening-to-space-law-a-new-space-law-for-a-new-space-race/.

Greene, Tristan. "NASA is developing AI to give directions in space." The Next Web. August 2018. Accessed April 22, 2019. https://thenextweb.com/artificial-intelligence/2018/08/22/nasa-is-developing-ai-to-give-directions-in-space/.

Grego, Laura. "A history of anti-satellite programs." Union of Concerned Scientists.January, 2012.Accessed December 30, 2018.https://www.ucsusa.org/nuclear-weapons/space-security/a-history-of-anti-satellite-programs.

Grush, Loren. "Israeli spacecraft poised to become first privately funded lander on the Moon." The Verge. February 19, 2019. Accessed March 19, 2019. https://www.theverge.com/2019/2/19/18228611/spaceil-israel-lunar-lander-beresheet-spacex-falcon-9-mission.

Hadfield, Chris. "Lunacy? Far from it – you really could live on the moon." The Guardian. June 12, 2018. Accessed January 25, 2019. https://www.theguardian.com/commentisfree/2018/jun/12/life-on-moon-chris-hadfield.

Hameed, Hamza. "The Legality and Ethics of Mining an Asteroid." Space Law Resource. February 25, 2017. Accessed January 16, 2019. https://www.academia.edu/31736455/The_Legality_and_Ethics_of_Mining_an_Asteroid.

Hanilçe, Murat. "Coğrafi Keşiflerin Nedenlerine Yeniden Bakmak." *Tarih Okulu* 7 (2010): 51-52. Accessed March 16, 2019. http://dergipark.ulakbim.gov.tr/usakjhs/article/view/5000039765.

Harrison, Todd et al. “Escalation & Deterrence in the Second Space Age.” CSIS October (2017): 11. Accessed March 3, 2019. Doi: 10.13140/RG.2.2.15240.11525.

Hasik, James. “The U.S. Needs a Space Force (To Win the Wars of the Future).” The National Interest. February 14, 2017. Accessed March 11, 2019. https://nationalinterest.org/blog/the-buzz/the-us-needs-space-force-win-the-wars-the-future-19432.

He, Tian. “China sees ‘breakthrough’ in nuclear-powered space shuttles by 2040.” Global Times. November 17, 2017. Accessed October 20, 2018. http://www.globaltimes.cn/content/1075834.shtml.

Helium-3 Mining on the Lunar Surface. ESA. Accessed March 21, 2019. https://www.esa.int/Our_Activities/Preparing_for_the_Future/Space_for_Earth/Energy/Helium-3_mining_on_the_lunar_surface.

Hellgren, Vide. “Asteroid Mining-A review of methods and aspects” (Bachelor diss., Lund University, 2016).

Hickman, John. “China is winning the space race.” Foreign Policy. August 3, 2013. Accessed April 20, 2019. https://foreignpolicy.com/2013/08/03/china-is-winning-the-space-race/.

Hitt, David. “What is an orbit?.” NASA. July 7, 2010. Accessed January 22, 2019. https://www.nasa.gov/audience/forstudents/5-8/features/nasa-knows/what-is-orbit-58.html.

Howell, Elizabeth. “Elon Musk: Private Space Entrepreneur.” Space. August 8, 2018. Accessed March 3, 2019. https://www.space.com/18849-elon-musk.html.

Howell, Elizabeth. “Tiangong-1: China's First Space Station.” Space. March 26, 2018. Accessed April 18, 2019. https://www.space.com/27320-tiangong-1.html.

Howell, Elizabeth. “What Is a Geosynchronous Orbit?” Space. April 24, 2015. Accessed March 1, 2019. https://www.space.com/29222-geosynchronous-orbit.html.

Huberty, Martine. “Doubts over space mining legal status.” Delano. April 13, 2017. Accessed September 20, 2018. http://delano.lu/d/detail/news/doubts-over-space-mining-legal-status/142567.

Huerta, Michael. “Democratization in Space.” Speech presented at Federal Aviation Administration Commercial Space Conference, Washington, DC, February 7, 2017. Accessed September 21, 2018.

International Telecommunications Union.*List of Member States.*Accessed July 10, 2019.https://www.itu.int/online/mm/scripts/gensel8.

International Telecommunications Union.*List of Sector Members*.Accessed July 10, 2019.https://www.itu.int/online/mm/scripts/gensel11.

International Telecommunications Union.*Our Vision*. Accessed July 8, 2019.https://www.itu.int/en/about/Pages/vision.aspx.

“Iran Jams Satellites to Block Transmissions by VOA, BBC.” Voa News. December 30, 2009. Accessed March 15, 2019. https://www.voanews.com/a/iran-jams-satellites-to-block-transmissions-by-voa-bbc--80352412/416809.html.

Jacob, Jayanth. “India seeks Russia’s help for Gaganyaan mission to put man in space by 2022.” Hindustan Times. September 22, 2018. Accessed October 25, 2018. https://www.hindustantimes.com/india-news/india-seeks-russia-s-help-for-gaganyaan-mission-to-put-man-in-space-by-2022/story-gWcaQbUQUNxCoTam9RmvaJ.html.

Johnson, Chris. “Draft International Code of Conduct for Outer Space Activities Fact Sheet.” Secure World Foundation. February 2014. Accessed July 6, 2019. https://swfound.org/media/166384/swf_draft_international_code_of_conduct_for_outer_space_activities_fact_sheet_february_2014.pdf.

Johnson, Reynolds and Jason D. Mycoff.*Political Science Research Methods.* SAGE,2016.

Jones, N. Nancy. "Successful second deep space maneuver for Osiris-Rex confirmed." NASA. July 3, 2018. Accessed October 21, 2018. https://www.nasa.gov/feature/goddard/2018/osiris-rex-executes-second-deep-space-maneuver.

Jun, Liang. "China to Achieve 'Major Breakthrough' in Nuclear-powered Space Shuttle Around 2040: Report." People's Daily Online. November 17, 2017. Accessed September 18, 2018. http://en.people.cn/n3/2017/1117/c90000-9293719.html.

Kanuck, Sean and Alana Vogel, "The down of a new strategic era in outer space." IISS. September 24, 2018. Accessed October 28, 2018. https://www.iiss.org/blogs/analysis/2018/09/iiss-observatory-24-sept.

Kuşbabalı, Caner. "Baharatın sırtında yükselen dev; Hollanda Doğu Hindistan Şirketi." Gazete Bilkent. April 14, 2015. Accessed March 5, 2019. http://www.gazetebilkent.com/2015/04/14/bir-devin-cokusu-hollanda-dogu-hindistan-sirketi/.

Kyriakopoulos, George. "Legal challenges posed by the action of non-state actors in outer space," *Conflicts in Space and the Rule of Law*, June 2017: 273-290. Accessed September 14, 2018. https://www.academia.edu/35855230/_Legal_Challenges_posed_by_the_Action_of_Non-State_Actors_in_Outer_Space_in_McGill_Centre_for_Research_in_Air_and_Space_Law_Maria_Manoli_and_Sandy_Belle_Habchi_eds._Monograph_Series_V_-_Conflicts_in_Space_and_the_Rule_of_Law_June_2017_p._273-290.

"Latin America: The colonial era." Time Maps. Accessed January 8, 2019. https://www.timemaps.com/civilizations/latin-america-the-colonial-era/.

Liu, Hao and Fabio Tronchetti. “The American Space Commerce Free Enterprise Act of 2017: The latest step in regulating the space resources utilization industry or something more?.” *Space Policy* (2018):1-6. Accessed November 14, 2018. https://doi.org/10.1016/j.spacepol.2018.02.004.

Luraghi, Raimondo. *Sömürgecilik Tarihi.* E Yayınları, 1975.

Mackie, Thomas. “Revealed: Putin’s plan to mine on the moon as Russia plots to be superpower in space.” Express. November 18, 2017. Accessed April 21, 2019. https://www.express.co.uk/news/world/881102/putin-russia-mining-moon-astronauts-luna-space-moscow-soviet-union-fedor-planets.

Marshall, Michael. “Columbus and the Age of Exploration.” *The World & I* 13 (1998). Accessed March 27, 2019. http://web.a.ebscohost.com/ehost/detail/detail?vid=0&sid=f8f6fba4-8622-4e56-9601-d61c7146329e%40sessionmgr4007&bdata=JnNpdGU9ZWhvc3QtbGl2ZQ%3d%3d#AN=1217911&db=f6h.

Marshall, Peter. “British India and the ‘Great Rebellion’.” BBC. February 17, 2011. Accessed December 11, 2018. http://www.bbc.co.uk/history/british/victorians/indian_rebellion_01.shtml.

McDonald, Bob. “Trump's 'dominance' in space is playing with international space treaty.” CBC. June 22, 2018. Accessed January 1, 2019. https://www.cbc.ca/radio/quirks/blog/trump-s-dominance-in-space-is-playing-with-international-space-treaty-1.4718058.

McGreal, Chris. “US court aims to establish ownership of over $100m in Titanic artefacts.” The Guardian. October 26, 2009. Accessed December 8, 2018. https://www.theguardian.com/world/2009/oct/26/titanic-artefact-case.

McKie, Robin. “The lunar gateway: a shortcut to Mars?” The Guardian. September 22, 2018. Accessed May 5, 2019. https://www.theguardian.com/science/2018/sep/22/the-lunary-gateway-the-future-is-closer-than-you-thought-nasa-esa-orion-jaxa-mars-mission.

Messier, Doug. “10 reasons why nasa is visiting asteroid Bennu.” Parabolic Arc. August 18, 2018. Accessed October 11, 2018. http://www.parabolicarc.com/2018/08/28/bennu-10-reasons/.

Meyer, Paul. “Failure to launch.” Open Canada. February 28, 2013. Accessed September 24, 2018. https://www.opencanada.org/features/failure-to-launch/.

Meyer, Paul. “UN GGE – Visions on the future of cyberspace clash at the UN.” ICT4Peace. November 15, 2018.Accessed July 6, 2019.https://ict4peace.org/activities/norms-of-responsible-state-behavior/visions-on-the-future-of-cyberspace-clash-at-the-un/.

Milligan, Tony. “Ethics for an ‘off-world’ economy.” *Physics World* 29, no.8(2016): 17. Accessed September 10, 2018. https://www.academia.edu/27492922/Ethics_for_an_Off-World_Economy_Physics_World_August_2016_p.17.

Mostert, Tristan. “Chain of Command: The wars of the company.” (Master’s diss., University of Leiden, 2007).

Murphy, Gavin. “RMS Titanic: A Legal Update 1.” Encyclopedia Titanica. August 28, 2003. Accessed December 8, 2018. https://www.encyclopedia-titanica.org/titanic-legal-update-1.html.

NASA launches Osiris-Rex space probe to collect asteroid samples – video. The Guardian. September 9, 2016. Accessed August 5, 2018. https://www.theguardian.com/science/video/2016/sep/09/nasa-launches-osiris-rex-space-probe-asteroid-bennu-samples-video.

NASA scientists celebrate as Juno probe successfully enters orbit around Jupiter – video. The Guardian. July 5, 2016. Accessed September 21, 2018. https://www.theguardian.com/global/video/2016/jul/05/nasa-scientists-celebrate-as-juno-probe-successfully-enters-orbit-around-jupiter-video.

NATO.*Collective Defense – Article 5.*

Near-Earth Objects – NEO Segment. ESA. June 29, 2017. Accessed March 5, 2019. http://www.esa.int/Our_Activities/Operations/Space_Situational_Awareness/Near-Earth_Objects_-_NEO_Segment.

Nebehay, Stephanie. "U.N. tells Iran to end Eutelsat satellite jamming." Reuters. March 26, 2010. Accessed March 15, 2019. https://www.reuters.com/article/us-iran-jamming-itu/u-n-tells-iran-to-end-eutelsat-satellite-jamming-idUSTRE62P21G20100326.

"New France." *Britannica*. Accessed March 27, 2019. https://www.britannica.com/place/New-France.

Noack, Rick. "The Dutch were a secret U.S. ally in war against Russian hackers, local media reveal." The Washington Post. January 26, 2018. Accessed September 15, 2018. https://www.washingtonpost.com/news/worldviews/wp/2018/01/26/dutch-media-reveal-country-to-be-secret-u-s-ally-in-war-against-russian-hackers/?noredirect=on&utm_term=.5ce22889fb91.

Oduntan, Gbenga. "Donald Trump's space force: the dangerous militarization of outer space." The Conversation. June 25, 2018. Accessed January 2, 2019. https://theconversation.com/donald-trumps-space-force-the-dangerous-militarisation-of-outer-space-98588.

Oduntan, Gbenga. "Who owns space? US Asteroid-Mining Act is dangerous and potentially illegal." Iflscience. Accessed March 1, 2019. https://www.iflscience.com/space/who-owns-space-us-asteroid-mining-act-dangerous-and-potentially-illegal/.

Office of the Historian. *Treaty of Paris, 1763.*

O'Keefe, Caitlin. "How we choose our near-Earth asteroid targets." Planetary Resources. August 28, 2015. Accessed March 5, 2019. https://www.planetaryresources.com/2015/08/how-we-choose-our-asteroid-targets/.

Oppenheimer, Andy. "Arms Race in Space." *Foreign Policy* 138 (2003): 81-82. Accessed March 14, 2019. https://www.jstor.org/stable/3183664.

Oxford Analytica. "Diamond mining resurges in Latin America." Forbes. September 24, 2008. Accessed January 27, 2019. https://www.forbes.com/2008/09/23/brazil-diamonds-paraguay-biz-cx_0924oxford.html#5df0b4a82f8d.

Paikowsky, Deganit and Roey Tzezana. "The politics of space mining – An account of a simulation game." *Acta Astronautica*142, no. 1(2018): 12. Accessed January 15, 2019. https://doi.org/10.1016/j.actaastro.2017.10.016.

Pariona, Amber. "What Was The Age Of Exploration Or The Age Of Discovery?" WorldAtlas. April 25, 2017. Accessed March 16, 2019. https://www.worldatlas.com/articles/what-was-the-age-of-exploration-or-the-age-of-discovery.html."

Patrick, Stewart and Kyly L. Evanoff. "The Right Way to Achieve Security in Space." Foreign Affairs. September 17, 2018. Accessed September 21, 2018. https://www.foreignaffairs.com/articles/space/2018-09-17/right-way-achieve-security-space.

Pevehouse, Jon C. W. and Joshua S. Goldenstein.*International Relations.*Harlow: Pearson Education, 2017.

Phillips, Rich. "Space Frontier Foundation to Host NewSpace Europe 2018 Conference in Luxembourg Aimed at Identifying Barriers, Opportunities in the Global Space Economy." Cision. November 3, 2018. Accessed November 8, 2018. https://www.prweb.com/releases/space_frontier_foundation_to_host_newspace_europe_2018_conference_in_luxembourg_aimed_at_identifying_barriers_opportunities_in_the_global_space_economy/prweb15809330.htm.

Pomeroy, Ross. "Will we ever stop using rockets to get to space?" Space. August 19, 2018. Accessed May 23, 2019. https://www.space.com/41432-will-we-ever-stop-using-rockets-to-reach-space.html.

"Portuguese Arrival." Lonely Planet. Accessed February 1, 2019. https://www.lonelyplanet.com/indonesia/history#pageTitle.

Rabinovitch, Ari. "Israeli spacecraft crashes onto moon after technical failures."Reuters. April 11, 2019.Accessed April 22, 2019.https://www.reuters.com/article/us-israel-space/israeli-spacecraft-crashes-onto-moon-after-technical-failures-idUSKCN1RN1PY.

Rafferty, John P. "Are There Laws on the High Seas?" Britannica. Accessed March 12, 2019. https://www.britannica.com/story/are-there-laws-on-the-high-seas.

Rajagopalan, Rajeswari Pillai. "The global space race, 2.0." The Washington Post. February 13, 2018. Accessed November 17, 2018. https://www.washingtonpost.com/.

Ramesh, Randeep. "India's unmanned moon mission may launch race for lunar landgrab." The Guardian. October 21, 2008. Accessed March 21, 2019. https://www.theguardian.com/science/2008/oct/21/spaceexploration-india.

Rehm, Jeremy. "What is the US Space Force?" Space. October 10, 2018. Accessed March 3, 2019. https://www.space.com/42089-space-force.html.

Riebek, Holli. "Catalog of Earth satellite orbits." NASA. September 4, 2009. Accessed January 23, 2019.https://earthobservatory.nasa.gov/Features/OrbitsCatalog.

Rusek, Ben. "The Outer Space Treaty at a glance." Arms Control Association. August 1, 2017. Accessed September 18, 2018. https://www.armscontrol.org/factsheets/outerspace.

"Russia develops co-orbital anti-satellite capability." Jane's. Accessed December 30, 2018. https://www.janes.com/images/assets/463/83463/Russia_develops_co-orbital_anti-satellite_capability.pdf.

"Russia's ASAT development takes aim at LEO assets." Jane's.Accessed December 30, 2018. https://www.janes.com/images/assets/591/81591/Russias_ASAT_development_takes_aim_at_LEO_assets_v2.pdf.

Scotti, Monique. “NASA plans mission to a metal-rich asteroid worth quadrillions.” Global News. January 14, 2017. Accessed September 3, 2018. https://globalnews.ca/news/3175097/nasa-plans-mission-to-a-metal-rich-asteroid-worth-quadrillions/.

“Scottish firm unveils plans for asteroid mining mission.” BBC. July 30, 2018. Accessed September 24, 2018. https://www.bbc.com/news/uk-scotland-scotland-business-45006938.

Shaer, Matthew. “The asteroid miner’s guide to the galaxy.” Foreign Policy. April 28, 2016. Accessed July 18, 2018. https://foreignpolicy.com/2016/04/28/the-asteroid-miners-guide-to-the-galaxy-space-race-mining-asteroids-planetary-research-deep-space-industries/.

Sharma, Shubham. “Russia teaming up with China for moon and deep space exploration.” International Business Times. June 9, 2018. Accessed September 15, 2018. https://www.ibtimes.com/russia-teaming-china-moon-deep-space-exploration-2689060.

Simberg, Rand. “The return of the space visionaries.” *The New Atlantis*, no. 56(2018): 48-68. Accessed October 20, 2018. https://www.jstor.org/stable/10.2307/26498244.

“Space Lawyer Frans von der Dunk: A Less Strict Form of the Law of the Sea Might Be the Way to Go for Asteroid Mining.” Lawless. September 20, 2018. Accessed October 7, 2018. https://lawless.tech/space-lawyer-frans-von-der-dunk-a-less-strict-form-of-the-law-of-the-sea-might-be-the-way-to-go-for-asteroid-mining/.

Stevenson, Sam. “China calls for space arms race control in bid to curb Trump’s ‘space force’ ambitions.” Express. August 29, 2018. Accessed October 11, 2018. https://www.express.co.uk/news/world/1009872/space-force-space-arms-race-control-china-USA-Donald-Trump-Mike-Pence-outer-space-military.

Stone, Peter. “The East India Company.” The History of London. Accessed October 11, 2018. http://www.thehistoryoflondon.co.uk/the-east-india-company/.

Tan, David. "Towards a New Regime for the Protection of Outer Space as the 'Province of All Mankind'." *Yale Journal of International Law* 25, no. 1(2000): 145-194. Accessed August 11, 2018. https://digitalcommons.law.yale.edu/yjil/vol25/iss1/4/.

Tangermann, Victor. "A timeline for humanity's colonization of space." Futurism. October 30, 2017. Accessed July 2, 2018. https://futurism.com/a-timeline-for-humanitys-colonization-of-space.

"The Deep Ocean." Ocean Today. Accessed March 12, 2019. https://oceantoday.noaa.gov/deepocean/.

"The First Europeans." American History From Revolution to Reconstruction and Beyond. Accessed January 8, 2018. http://www.let.rug.nl/usa/outlines/history-1994/early-america/the-first-europeans.php.

The Government of the Grand Duchy of Luxembourg. *Draft Law on the Exploration and Use of Space Resources.*

The Information Office of the State Council. *China's Space Activities in 2016: III. Major Tasks for the Next Five Years.*

The Nuclear Threat Initiative. *Proposed Prevention of an Arms Race in Space (Paros) Treaty: Background.*

The Mission. SpaceIL. Accessed March 21, 2019. http://www.spaceil.com/mission/.

Ummelas, Ott. "Russia's tiny neighbor prepares its cyber revenge." Bloomberg. June 31, 2018. Accessed January 11, 2019.https://www.bloomberg.com/news/articles/2018-10-31/treasury-lifts-long-term-debt-sales-for-fourth-straight-quarter.

United Nations General Assembly. *2749 (XXV). Declaration of Principles Governing the Sea-Bed and the Ocean Floor, and the Subsoil Thereof, beyond the Limits of National Jurisdiction.*

United Nations Office for Outer Space Affairs.*Access to Space for All.*

United Nations Office for Outer Space Affairs. *Agreement Governing the Activities of States on the Moon and Other Celestial Bodies.*

United Nations Office for Outer Space Affairs.*UNOOSA Director, Simonetta Di Pippo.*

United Nations Treaty Collection. *Chapter XXIV Outer Space.*

US Department of the Interior, US Geological Survey. *Feasibility Study for the Quantitative Assessment of Mineral Resources in Asteroids.*

Valantin, Jean-Michel. "The Chinese-Russian robot and space strategic cooperation (1) – China." The Red Analysis Society. January 8, 2018. Accessed March 19, 2019. https://www.redanalysis.org/2018/01/08/chinese-russian-robot-space-strategic-cooperation-1/.

Vasani, Harsh."How China is weaponizing outer space." The Diplomat.January, 19, 2017. Accessed December 30, 2018.https://thediplomat.com/2017/01/how-china-is-weaponizing-outer-space/.

W. K. "Who owns what in outer space." The Economist. June 12, 2018. Accessed February 20, 2019. https://www.economist.com/the-economist-explains/2018/06/12/who-owns-what-in-outer-space.

Waldron, Kathryn. "Space: The last frontier for cybersecurity." The Hill. June 28, 2018. Accessed January 26, 2019. https://thehill.com/opinion/cybersecurity/399224-space-the-last-frontier-for-cybersecurity.

Wall, Mike. "Japanese probe drops tiny hopping robots toward big asteroid Ryugu." Space. September 21, 2018. Accessed October 15, 2018. https://www.space.com/41898-hayabusa2-deploys-hopping-robots-asteroid-ryugu.html.

Wall, Mike. “Space weapon? US calls out Russian satellite’s ‘very abnormal behavior’.” Space. August 15, 2018. Accessed January 4, 2019. https://www.space.com/41503-russian-satellite-possible-space-weapon.html.

Wall, Mike. “SpaceX Won't Launch Tourists Around the Moon This Year.” Space. June 6, 2018. Accessed March 9, 2019. https://www.space.com/40805-spacex-delays-tourist-trip-around-moon.html.

Waugh, Rob. “Did an English expedition BEAT Columbus to the Americas? Record of bank loan to sailor who found North America in 1497 hints that others may have been there first.” Daily Mail. May 4, 2012. Accessed March 26, 2019. https://www.dailymail.co.uk/sciencetech/article-2139486/Did-English-expedition-BEAT-Columbus-Americas-Record-bank-loan-sailor-North-America-1497-hints-first.html.

Weeden, Brian and Victoria Samson. “Global Counterspace Capabilities: An Open Source Assessment.” Secure World Foundation. April 2018. Accessed December 29, 2018. https://swfound.org/media/206118/swf_global_counterspace_april2018.pdf.

Weeden, Brian and Victoria Samson. “Op-ed | India’s ASAT test is wake-up call for norms of behavior in space.” Space News. April 8, 2019.Accessed May 31, 2019.https://spacenews.com/op-ed-indias-asat-test-is-wake-up-call-for-norms-of-behavior-in-space/.

Winer, Stuart and Shoshanna Solomon. “Israeli spacecraft aims for historic moon landing… within months.” The Times of Israel. July 10, 2018. Accessed March 21, 2019. https://www.timesofisrael.com/in-first-israeli-spacecraft-set-for-trip-to-the-moon/.

Winser, Shane. “Vasco de Gama: The search for trade routes.” BBC. February 17, 2011. Accessed March 20, 2019. http://www.bbc.co.uk/history/british/tudors/vasco_da_gama_01.shtml.

Wong, Andrew. “Space mining could be a real thing – and it could be worth trillions.” CNBC. May 15, 2018. Accessed November 21, 2018.

https://www.cnbc.com/2018/05/15/mining-asteroids-could-be-worth-trillions-of-dollars.html.

Wooten, Joel. "A decade of commercial space travel – what's next?" The Conversation. September 27, 2018. Accessed December 17, 2018. https://theconversation.com/a-decade-of-commercial-space-travel-whats-next-103405.

Yiannopoulos, Philip. "Inside the epic debate on rethinking our 50-year-old Outer Space Treaty." Fast Company. September 24, 2018. Accessed January 2, 2019. https://www.fastcompany.com/90240304/inside-the-epic-debate-on-rethinking-our-50-year-old-outer-space-treaty.

Yuhas, Alan. "The new space race: how billionaires launched the next era of exploration." The Guardian. February 9, 2018. Accessed April 17, 2019. https://www.theguardian.com/science/2018/feb/09/new-space-race-billionaires-elon-musk-jeff-bezos.

Zak, Anatoly. "Unmanned missions to Mars." Russian Space Web. June 18, 2018. Accessed November 5, 2018. http://www.russianspaceweb.com/spacecraft_planetary_mars.html.

Zaleski, Andrew. "Luxembourg leads the trillion-dollar race to become the Silicon Valley of asteroid mining." South China Morning Post. April 18, 2018. Accessed July 5, 2018. https://www.scmp.com/news/world/europe/article/2142100/luxembourg-leads-trillion-dollar-race-become-silicon-valley.

APPENDIX 1

Interviewwith senior executive in charge of space programs of a leading electronics company. (29 November 2018 / Ankara)

What are your reflections on the commercialization of deep space, especially with respect to the role and interactions between state and non-state actors?

Military and security concerns are the reasons for development of the technology, and this improvement is the trigger for those activities. Yes, there are many actors; but I believe states are at the forefront, and they will support and encourage their companies. In China, the state maintains restrictions over the private sector. However, the US may drive forward one of the US companies; the company would nonetheless get technical support from NASA. States are making long term plans for deep space and they may not reach their goals in the near future. But the technology they develop on the way to space mining may lead to different innovations. They may also cooperate to pursue a faster and easier path towards deep space, as they did in the project of ISS. States,although in conflict in some areas,completed the ISS project cooperatively.

How would you comment on the technical feasibility of space mining and the role of emerging technologies thereof?

The 3D printer is a breakthrough invention. Necessary components and much equipment can be produced in space by this method. The company Airbus uses 3D printing techniquesin the production of satellites.

How do you see the legal dimension of human activities in deep space, and the likelihood of cooperative schemes between spacefaring actors?

I do not think it is possible to establish an international agreement in the near future. But currently there are few states that can go to deep space, so there may not be a problem for a while. They may negotiate with each other and share the cake. If a problem occurs, they will discuss it and create agreements among themselves. I see the US and China as major actors and they may well sign agreements with each other. In time Russia may join them.

In addition, because of this absence of legal norms, it is important to develop defense capabilities. Who can prevent attacks and protect the actors' activities? Space has potential to be a new war domain, so it is important to develop technology to protect spacecraft and satellites against offensive attacks.

APPENDIX 2

Interview with former director of a leading science of technology research organization's space institute. (28 November 2018 / Ankara)

What are your reflections on the commercialization of deep space, especially with respect to the role and interactions between state and non-state actors?

Until now, the commercialization of space activities has been limited to communication-imaging and navigation services in LEO. Space studies have a special characteristic; the important thing is not profit, but prestige and competition. Space tourism may become commercialized. Space mining may not be profitable at the beginning, but over time methods may be found to make space mining more economical.

Without support from state governments, access to deep space cannot be commercialized. In this context, to protect their own private corporations, states will create their own laws. No state will allow its firms to engage in a destructive struggle with others in such a pioneering field, and it will be impossible for companies to compete without state regulation and protection. The private sector can only act within the area determined by the states. Governments will direct and regulate.

How would you comment on the technical feasibility of space mining and the role of emerging technologies thereof?

First of all, spacecraft for mining should be unmanned, because having a manned mission would make it much more difficult. The possibility of failure of even 1% according to reliability analysis, would not be acceptable. Besides, more equipment is needed in the design of manned vehicles, and everything added means extra cost. The examples we see of manned space vehicles and laboratories are in Earth orbit, and it is easy to access themand intervene if a problem occurs. However, rapid access to a manned spacecraft in deep space is impossible. This shows the necessity of artificial intelligence. But, unfortunately, autonomous robotic systems are prone to conflict. While a human being can re-evaluate policy when an unpredictable situation arises, an autonomous system follows the instructions given. In addition to artificial intelligence, 3D printing would be necessary for maintenance.

I think the Moon will be the first place where space mining takes place, and this situation will continue for a long time. Space stations will be established on the Moon and will try to use the resources of the Moon as far as possible. The aim would be to create a cycle, for example to establish a space station and have it sustain itself with resources found on the Moon. Moreover, the force of gravity on the Moon is lower than on Earth, and therefore it is easier to gain access to other planets and celestial bodies from there.

On the question of bringing the ores to Earth, that could become economical after a while. First, a self-sustaining facility should be established, which is the most costly part of the business, but the cost would fall as it began production. It would eventually possible to carry these materials to Earth with a simple impulse method, but the first transportations would take years, due to the distance. However, it doesnot matter how fast they come after regular shipment starts. To land to the Earth is a heat-fighting job, there is heat to get rid of and this heat increases with closer approach to the Earth. However, this would not be a big problem because they areheat-resistant. With the necessary electronic systems, it may be achieved without very high costs.

How do you see the legal dimension of human activities in deep space, and the likelihood of cooperative schemes between spacefaring actors?

One of the existing agreements, the Moon Agreement, was not signed by many space-faring nations because of the possible opportunities that they thought future developments would bring. Technicallyadvanced states did not want to be party to any binding agreement. The OST, which was agreed by both the US and the USSR, emerged during the 1st space age as a measure to avoid destructive conflict.Both thosecountries created a framework to limit weaponization, and after those two superpowers had signed, other states followed them. But the Moon Agreement was more idealistic, and most states which already possessedthe capability to reach space did not agree to sign it. In general, whenever a conflict occurs so thatmaking an arrangement would benefit the competitors, then it follows that an agreement is created.I believe bilateral agreements will be made when conflict reaches a certain level. After several bilateral agreements, an international agreement will subsequently be established to manage them. But unless there exists a multi-polar system, these agreements will not be idealistic; they will be directed towards protection of interests, and this ground will always be related to power. If the capabilities of the leading states are close to each other they will compromise, but if not, the dominant side will attempt to hamper the progress of other.

It is obvious that the absence of international norms will cause some problems. For instance, if two actors try to reach same asteroid, which rules should be applied? In this complex situation, the actors will develop and apply techniques to defend themselves against attack, or they themselves may attack.

As I said, all relations will be related to power. As the powerful and technically advanced states make progress, they will want others to stay behind. Capitalism will be applied. There will be economic gaps between countries and technically inadequate states will be unable to close those gaps. Also, other countries may boycott astate which trades ores, to prevent it from making much profit.

APPENDIX 3

Interview with senior executive in charge of aerospace programs of international consultancy firm. (29 November 2018 / Ankara)

What are your reflections on the commercialization of deep space, especially with respect to the role and interactions between state and non-state actors?

Among deep space missions, the ultimate target may be Mars colonization, or,in terms of fuel efficiency, a Lunar station. The technological advances that need to be achieved to get there could create many unexpected possibilities in the future. But, if we talk about space mining, the first experiments could be made in the next 10-15 years, but it would take longer to commercialize operations. At the beginning, the only states which sent satellites into space were the US and the USSR. As technology advanced, many other states managed to do so. In the same way, asteroid mining will probably be monopolized by only a few states such as the US and China, for the next 20-30 years. But after that, technologically developing states will be able to make progress by cooperating with each other. With progress in technology and ease of access to technical information, there willsurely be an increase in the number of states operating in deep space.Musk has proved that private companies can send objects into deep space and that heavy loads can be transported with reusable rockets.The US wouldencourage private companies by providing direct and indirect support to ensure that their country stays ahead.The US mayalso form an alliance with anotherstate that would benefit it.

States which attract investment, such as Luxembourg,could have a say in the trade of minerals. In China, private companies would be under control of the state, which would want to be at the forefront. Besides these developed countries, India could be a major player in the field of deep space in the medium to long term; it has been producing satellites at very low cost and has managed to send a cost-effective vehicle to Mars. So, in general, a multi-polar environment is likely to develop.

I am doubtful about cooperation. The US maintains the ISS project because of benefits it gets. Rockets capable of carrying big payloads belong only to the Russians. When the project is over, we will see whether they can cooperate again. The tension between the US and Russia has not extended to space yet. However, Russia may act pragmatically, because it makes good money from the Proton rockets.

In many African countries, the economy is dependent on rare Earth minerals, and these countries remain secure because of these resources. Asteroid mining could change the economic balance of these states. Technologically developed countries would lose their dependence on developing and undeveloped countries, and hence might triggernew conflicts. Because of this, developing countries may seek to form alliancesfor joint development of technology, and set up legal agreements.A new procurement system would emerge along with space mining. Resources may also be sabotaged by states, soit is possible to predict conflict in deep space.

When asteroid mining becomes commercially viable, companies could take on a different character from the one they have at present. They could be aligned with the EIC,separate from military and technical activities. There may be conflicts between non-state actors in terms of dominance of technological power or security of ore supplies; these conflicts would probably take the form of cyber warfare.An example might be an illegal attempt to change the trajectory of a rocket.

How would you comment on the technical feasibility of space mining and the role of emerging technologies thereof?

The biggest challenge tospace mining is cost; there are already high costs when a spacecraft leaves the orbit.After that it must have sufficient endurance to cross the Van

Allen belt and enter the asteroid belt. Finally, there is the cost of landing on a celestial body, probing it, and collecting samples.

On the technical side, the spacecraft must be able to perform the necessary maneuvering to reach the appropriate celestial body.Since the target area is small, it will be necessary to create artificial intelligence to provide an instant reaction to unforeseeable situations. Whileit is easy to communicate with a spacecraft in Earth orbit, due to the shortdistance, this will not be possible for deep-space vehicles. For instance, sending a signal to Mars takes 17 seconds, and considering that some asteroids are much further away than Mars, it will not be possible to provide real-time communication and command to the outgoing vehicle. For this reason, the spacecraft will have to make decisions and implement them on its own. Besides autonomous robotic systems, having a 3D printer on board would be useful; it would then be possible to self-build an unmanned space base and to manufacture parts of vehicles which can move in deep space.

How do you see the legal dimension of human activities in deep space, and the likelihood of cooperative schemes between spacefaring actors?

During the Cold War there was a more appropriate environment for multinational agreements, but the present period is more appropriate for bilateral agreements. It is not possible to establish a deal under the leadership of the UN since the credibility and the sanction power of multinational organization has been eroded. Besides, the bigger the number of parties, the more difficult it is for states to pursue their interests and find a common denominator. And, I believe that the first problem needs regulation would be aboutownership rights.

APPENDIX 4

Interview with current senior researcherof a leading science of technology research organization's space institute. (4 December 2018)

What are your reflections on the commercialization of deep space, especially with respect to the role and interactions between state and non-state actors?

First of all, what contributions of the commercialization of deep space activities to the world economy would be determined, and thus, the objectives must be identified. The first step towards commercialization will be the creation of lunar stations necessary for refueling.

Among states, strategic acting ones and innovators will be dominant. States may not intervene directly in each other's activities in deep space, but, back in Earth, they may resort to economic tools and sanctions to hamper each other's deep-space initiatives. As for state non-state actor relations, once states eliminate the risks of deep space missions and they put the necessary infrastructure in place, they will then step aside in favor of private enterprises.

How would you comment on the technical feasibility of space mining and the role of emerging technologies thereof?

Shuttle between deep space and the Earth is costly. How much of the extracted material can be brought? Logistics discoveries can find solutions for that. Keeping pace with technological developments in this regard is another challenge.

How do you see the legal dimension of human activities in deep space, and the likelihood of cooperative schemes between spacefaring actors?

(This question was not addressed by the interviewee.)