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Publication Date

2019-05-13

Undergraduate

The post-Cold War issues of the space conquest*Thoughts on the future of an increasingly attractive space***Introduction:**

In 1957, the satellite Sputnik was launched into orbit by the soviet space agency, a first in History. This scientific event of global significance represents the beginning of the space race between the United States and the USSR, which lasted until the end of the Cold War in 1991. Resulting from a political quest for leadership of those two countries, the space race allowed significant technological progress, as well as outer space discoveries. It marked a new era in human History, an era of scientific ambitions beyond Earth.

The space race was a pretext of the United States and the USSR to improve their military technology and show their greatness universally. It was mainly a communication campaign where politics and scientists worked hand-in-hand. When the USSR dissolved in 1991, the incentives to pursue such a technological race were greatly decreased for the United States. From this moment, the paradigm of international relations linked to the exploration of space shifted and became progressively a model of global cooperation. The launch into orbit of the International Space Station in 1998, occupied by an international team dedicated to research, constitutes the perfect example of it. Nonetheless, it is still important to observe some persistence of national interests in space research.

Today, the world is facing new issues concerning space-related activities. Considered as a witness of a country's power, as well as an incredible potential source of economic profit, space exploration has attracted new players. The developing countries, which challenge developed countries in the classical competitive spheres such as economy, have now the will to compete in every domain, including space conquest. Besides, from the end of the 20th

century, devices deployed in space have increased the standards of living of the world population: weather forecast, Global Positioning System (GPS), telecommunication... The benefits are huge and space technology has become necessary to the daily life of many citizens of the world. Thus, private actors have been more and more interested in space, aware that it represents a profitable sector to invest in. Those two groups of new players are destabilizing the prosperity of global cooperation in space-activities, as their own interests foster competition.

The exploration of outer space began under the impetus of the two superpowers of the time. As they were focused on pursuing their technology progress as far and as fast as possible, the implementation of laws regulating their activities has been very slow. Step by step, shyly, space law developed under certain forms to fix constraints to states. However, it is still nowadays incomplete and some legal gaps have left the door open to some uses of space which, because of their dangerous and non-ethic characteristics, should be regulated. How is it possible to ensure the sustainable use of outer space in a world where space-related activities have been reshaped at the end of the Cold War?

To begin, this paper will examine the historical perspective of the space race during the Cold War and how it later resulted in the promotion of global cooperation in space-related activities (I). Then, the role of the rising players in the space conquest will be studied, especially to question their potential risk of disturbing the prosperity of the non-competitive space environment (II). Finally, the topic of space law will be reviewed to address the necessity of an extended regulation covering modern issues (III).

1 - Space activities during and after the Cold War: a shift of paradigm within the main space powers, from competition to cooperation

1.1 - The United States vs. the USSR during the Cold War: the power of technology to the service of politics

1.1.1 The rush on German advanced technology as a prelude to the space race

In 1945, the United States and the USSR appeared as two winners of the Second World War, with two opposite political ideologies and visions of the post-conflict world. On the one hand, the United-States promoted democratic liberalism and gained many allies in Western Europe, especially thanks to its Marshall Plan launched in 1948 to boost the economic recovery of countries accepting American supervision. On the other hand, the USSR spread communism and had a large influence on countries of Eastern Europe. During the several decades separating the end of the Second World War and the burst of the USSR in 1991, the two countries and their respective blocs faced each other throughout several political and military events. If tensions between the two blocs were strong during the whole period, direct-violence had always been avoided. Raymond Aron, a French writer, described the ambiguity of the Cold War as “Impossible Peace, Unlikely War”.

In this context of quest of hegemony, competition arose between the United-States and the Soviet Union in every possible arena, including space. The prelude of the space race consists in the haste of the winning powers of the war, the United States, the USSR and the United-Kingdom, on Nazi revolutionary rocket technology in 1945. One of the Nazi invention was the V2 rocket, developed from the 1920's and first used in September 1944 over European capitals such as Paris and London. What made the singularity of the V2 was its capacity to take the rocket 50 miles above the earth and to contain an automatic guidance system which allowed it to reach a precise target. As described by Richard Holligham, “it was much more sophisticated than anything built before and effectively the world's first space rocket” (1). After the defeat of the Nazis, the Americans and the Soviets realized the Nazis machines was far more technologically advanced than them. The United-States captured the engineer who

created the V2 rocket, Werner Von Braun, while the Soviet Union stole its technology. This technological hunt by the Americans and the Soviets can be considered as unethical, as the political context in which those destruction engines had been developed was totally ignored. The first American astronaut in space was launched thanks to a derivative of the V2 rocket on which Von Braun had worked. While having been associated with the Nazis horrors, Von Braun became a hero of the space conquest.

1.1.2 A prestige race mostly dominated by the Soviet Union

The space race truly began in 1957, when the satellite Sputnik 1 was launched into orbit by the Soviet Union on October 4th. This achievement follows the announcement in 1955 of both the American and the Soviet goal to launch an artificial satellite in space for the Geophysical year beginning in July 1957 (2). The success of the Russians marked their supremacy in terms of technological advancements, a gap that the United States had immediately been willing to bridge. After a second success from the Russians, Sputnik 2 launched into space with a dog as its passengers, and several failures from the Americans, a launch exploding on the launchpad in December 1957 and another one breaking up in flight in February 1958, it had become urgent for the Americans to assert themselves in the race. The National Aeronautics and Space Administration (NASA) was created for this purpose in July 1958, as a federal agency dedicated to spatial innovation. The budget of the NASA rose consequently from 1958, with 732 million of 2014 dollars representing 0.1% of the Fed budget, to 1966, with 43.5 billion of 2014 dollars representing 4.41% of the Fed budget. The Russian space budget had never been more than 10 times smaller than the American one. To pursue his space leadership policy, the American President Eisenhower signed the *National Defense Education Act* in September 1958. Its purpose was to provide funding for education, especially in the fields of science and technology, to help the “educational system meet the demand posed

by national security needs” (3). It directly referred to the competition with the USSR concerning space conquest. While technology was at the service of politics during the Cold War, technology represented also a benefit for society, especially through this act which improved the American educational conditions.

The following years were devoted to a series of “first times”, dominated by the Soviet Union: first lunar probe in 1959, first “(man) from Earth (flying) in the void of space” (2) in 1961, first successful landing on the moon in 1966... Those Russian achievements were extremely important for science. Technological progresses would not have been as fast if the superpowers had not engaged in a competition for leadership in space technology and discovery.

1.1.3 The first man on the Moon as an end to the space race

The year 1969 constituted finally the peak of the space race, consecrating the American efforts and money spending for more than a decade. It represented the success of the Apollo 11 mission, part of the *Apollo* program which aimed to bring a man on the moon. If this event is a political victory for the Americans who managed first to make a man walk on the moon, it is also a great moment for science. Indeed, the samples collected on the moon’s surface were later analyzed to further the understanding of the solar system. “The Americans had achieved unquestioned leadership in the Space Race” (4), Professor Anne Millbrooke says. American men had walked on the moon from 1969 to 1972, while neither the Soviet Union nor any other country have achieved it until now. During the space race, the world witnessed a media and political campaign of the greatness, where liberalism and communism tried alternatively to convince that it was thanks to their incredible scientific experiments. If the USSR seemed at first leading the space conquest, it had been proven later that its space technology was far less advanced than the one of the United States. The conflict was in fact a lot based on

communication. During the 1970's, the race progressively lost in intensity, as well as the competition between the two superpowers. The dissolution of the USSR in 1991 marked the end of the strict competition between the leaders of the two blocs, even if another model of global relations had already started to appear in terms of space-related activities: international cooperation.

1.2 - Towards a universally approved model of cooperation after the Cold War

1.2.1 A loss of the symbolic motivation for competition accompanied by budget constraints

“The Soviet Union, an ideological superpower, had very clear reasons to push forward into space: Communism was humanity's future, they believed, and that future was in space” Matthew Bodner writes (8). As well as for the United States, the defense of the Soviet political ideology during the Cold War gave the impetus of all the space technological innovations. After the end of the conflict, one observed a change in the symbolic motivation for achieving scientific exploits. This previous motivation was directly linked to the confrontation of two Empires that were far from considering the economic constraints at stake (7). The Cold War over, the incentives for space research decreased. Modern issues, such as the nuclear catastrophe of Chernobyl or the awareness of the necessity of universal democratic and human rights, became the priorities. National money should be spent on more tangible issues of the society. For example, when Bush proposed the Space Exploration Initiative in 1989, a program aiming at a human return to the moon, he faced congressional opposition (9). To this symbolic shift of motivation was added tough budgetary constraints in the United-States and in the USSR. At the end of the 20th century, after decades of high defense spending and substantial tax cuts, the United States was experiencing a large debt and trade deficit. The Russian economy entirely shaken after the dissolution of the USSR was also in a bad position, with a budget deficit up to 20% at the end of 1992. The post-Cold War period was thus characterized

by a technological disarmament as well as a large cut in national budgets dedicated to space research. The former superpowers could not anymore count only on themselves to further space conquest. Cooperation with other powers of the world had become necessary.

1.2.2 An increase in the number of space actors to collaborate with

The United States and the USSR were not the two only countries involved in space-related activities during the Cold War, though their influence hid the research of smaller space agencies. From the 1960's, new countries started to be seriously interested in the space conquest, especially France which launched a global dynamic in Europe. Indeed, the French President Charles de Gaulle had great ambitions for the country: competing with the spatial program of the United-States and the Soviet Union to strengthen French national independence (7). He created in 1962 the National Center of Space Studies (CNES) and his successor, President Georges Pompidou, convinced European countries to form the European Space Agency, created in 1975. The famous launcher Ariane constituted one of the first innovation of the space agency. It permitted European countries to launch satellites in orbit without being dependent on other powers. The principal purpose of this European cooperation was the lack of national funding for a country to develop on its own technologies competing with the American and Russian successes. This logic of cooperation based on gathering international funds and knowledge became the new model across countries. After the revolutionary boom of space technology during the Cold War, the size and complexity of space projects were increasing. For example, after having landed on the moon, the scientific sphere looked broader and became interested in the exploration of the planet Mars, involving more research and development costs. Increasing costs of technology innovation pushed nations to cooperate. The International Space Station, launched into low orbit in 1998, is “the most significant international cooperative program in the history of spaceflight” (10). The space agencies of the

United States, Russia, Canada, Japan and Europe participated to this project. The station should operate until 2030 and consists of a research laboratory in which an international crew conducts experiments on different aspects of space.

1.2.3 The emergence of the global security concept

“Today, space is indispensable for our global society, as we rely heavily on space assets” writes the geostrategist Nayel Al-Rodhan (11). He highlights another reason why international cooperation has appeared evident in the post-Cold War: space is nowadays highly related to global security. First, satellites are useful tools to predict and analyze the changes on the Earth environment. Data are collected to track weather, ocean currents, pressure but more importantly natural disasters and climate change. These issues concern the entire world population. Cooperation between national space agencies is the best mean to gather efforts in order to prevent global catastrophes. Moreover, space technology is very helpful in the health field, through telemedicine. This technique can be used to deal with epidemics, world-scale issues, limiting contact with the patients and the spread of the disease (11). In an era dominated by Big Data, the concept of global security also concerns data privacy and the insurance that individual, as well as governmental, data is used properly. With the significant increase of satellites applications in telecommunication, geolocation, the Internet etc., data security is closely related to space security. Severe damages on satellites could create a chaotic situation on Earth because of the world dependence on their applications, either for global market economy or daily civil uses. Global cooperation is necessary to set up control systems able to prevent the misuse of data. Thus, for national economic, political and scientific reasons, as well as for global security issues, international cooperation has arisen since the end of the Cold War. The superpowers of the Cold War which avoided at any cost cooperation now collaborate on many aspects, helped by other countries willing to participate to the space effort.

1.3 - The unavoidable and necessary persistence of space competition

1.3.1 The will to avoid American dependence

If cooperation has become the new model of international relations for space activities since the end of the Cold War, it would be incorrect to assume that competition has completely disappeared from space. After the collapse of the USSR in 1991, the United States constituted the only superpower in the world, leading to a unipolar vision of the world. With the purpose to strive for a multipolar vision of the world, where the power is shared between different countries, great powers have intended to escape the American monopoly. As it has been proven since the 1950's, the space field is the reflection of international politics. Thus, from the 1990's, medium space agencies have been aiming to develop space capacities independent from the American technologies. The most striking example concerned the different alternatives developed by the ESA, China and Russia to the American famous Global Positioning System (GPS) (6). The research on GPS started in the 1960's to track American submarines transporting nuclear missiles. Later, in the 1970's, the Department of Defense had wanted to create a fully operational navigation system using satellites. Operating with 24 satellites, the system was totally operational in 1993 (12). This American achievement is followed very quickly by the Russian positioning system, GLONASS, with a working system finished in 1995. A few years later, in 2003, Galileo from the ESA and Beidou (or COMPASS) from the Chinese space agency became new operational positioning systems. Today, a strong cooperation exists between these systems, each of them benefiting from each other. For example, GLONASS is known to operate more effectively at northern latitudes and Beidou is the only one to allow its users to communicate thanks to text messages. However, the will of space agencies to maintain and keep developing their own system is strong, as it is a crucial factor of independence, especially from the United-States.

1.3.2 The legitimate persistence of national security interests

The importance given by space agencies to independence can be observed through other aspects of space technology. International space cooperation is, in a sense, nuanced in strategic fields responsible for national security. Space applications related to national defense stay competences of states and contributes directly to political decisions in terms of involvement in armed conflict and conduct of military missions. Indeed, satellites represent powerful means for leading wars or managing crises on Earth. They are beneficial tools in terms of observation and listening of potential enemies. Thanks to positioning systems, they also allow safer and more precise military strikes. This process of using space technology to help military operations on Earth is called the militarization of space. This space application was present since the beginning of the space race during the Cold War. Indeed, military satellites were very quickly envisioned by the United States and the USSR to spy and control the military aspirations of their enemy. Between 1957 and 1991, 100 of all the American satellites were dedicated to defense and 2311 out of 2384 Soviet satellites were military ones (13). Improving technology for space applications was also a great means to improve military technology. Today, the necessity to own an effective system of national defense persists, even if it is more a mean of prevention. Per the French Minister of the Armies, Florence Parly, it is fundamental for France to maintain its own liberty of access and action in space (14). This way of thinking can be applied to every country willing to exist on the international stage, and it results obviously in a form of competition at the expense of international cooperation.

1.3.3 Competition as a driver of better cooperative performances

Nowadays, space is no longer just the playground of politics; a considerable importance is given to space exploration and innovation for the purpose of science. The ambitions are

diverse: better understanding of the solar system and its planets, search for habitable planets, search for life beyond Earth... These are large-scale projects which necessitate important funding for research and development. In the world's situation discussed above, where space innovation is no more a countries' priority, maintaining competition between space agencies is a relevant way to keep innovation in the center of their activities. "Cooperation on a global scale draws on the competences of the various partners, created and stimulated through competition" (15), tells Jan Woerner on the ESA website. Generally, each space agency brings to a project its best capacities, in terms of technology but also of qualified scientists. Competition is a necessary tool to obtain a fruitful cooperation. Thus, competition and cooperation cohabitate in the post-Cold-War era, though the overall trend is to collaborate to address modern space topics. However, if this first part concentrates mostly on the traditional great powers, one cannot raise a complete analysis of the space post-Cold War issues without studying the new rising actors of the field. The impact of developing countries and the private sector on space-related activities are at the core of current and future preoccupations of outer space.

2 – The rise of new players in space related activities: a threat for the prosperity of global cooperation?

2.1 - The developing countries, with China at the lead, at the origin of a new space race?

2.1.1 BRICS on the road to space

For the past years, while global cooperation has barely stabilized, new trends in space-related activities have alerted us to the ability of space actors to ensure its prosperity. This vigilance is mostly due to the growing importance of emerging space actors (EMSAs) which destabilized the established order. The first group of actors consists of the developing countries

involved in the space conquest, particularly China, India and Brazil. They can be described as countries which “have achieved the capability to autonomously produce space technology, have developed (...) indigenous launch capability for both orbital and geosynchronous satellite placements, and have national space agencies, and whose space programs evolved from research and development (...) of ballistic missile and nuclear programs.” (6). From the beginning of its existence, the Chinese space program was very collaborative. In 1970, thanks to French and German technology, the first Chinese satellite was launched into orbit. In 2003, they became the third country in History to have launched a manned spacecraft. Today, China has the second highest space budget after the United States and attempts to challenge it in the Pacific area. If cooperation with the ESA and Latin American countries was very developed, China has kept competitive relations with India. The Indian space agency was created in 1969. While its satellites play today a major role in agriculture, a sector in which 60% of the Indian population is employed, the space agency was originally designed as an instrument of power directly related to the government (6). For its part, Brazil has developed a space program since the 1960's and has benefited a lot from its Alcântara Launch Center which opened in 1990. This launch site is the closest on Earth to the equator, attracting many other countries. Indeed, being close to the equator constitutes a perk for launching geosynchronous satellites, satellites which have the same orbital period as the Earth. For several years, China, Brazil and India have been willing to bridge the gap with developed countries through more national development and influence over the world. They use space activities to strengthen their leadership over their own region of the world. Indeed, space achievements provide prestige but also huge economic opportunities, which will be described later.

2.1.2 The increasing global influence of China in space activities

Very recently, the 3rd of January 2019, China landed a spacecraft on the far side of the moon, that no lander had ever touched before. It was part of the Chinese Lunar Exploration Program launched in 2007 by the China National Space Administration (CNSA). There were real obstacles as this side is out of sight of Earth, complicating the communication from the lander to the teams in China (17). This lunar landing is considered as a huge step forward for China's wider ambitions in outer space. If this event has been recognized by the NASA administrator Jim Bridenstine as "an impressive accomplishment" (17), others consider Chinese progresses as a threat. China is currently at the core of political science and international relations' preoccupations, thanks to its growing role in many spheres of the society, especially the economy. The Chinese economic growth is almost three times higher than American growth, reaching 6.6% in 2018. Its large amount of exports allows the country to have a trade surplus, while the United-States has experienced a trade deficit since 1975. Fears of an economic conflict between the United-States and China are common, as China's power is likely to grow more and more until reaching a point where American and Chinese aspirations will be inconsistent. This fear is also one that can be applied to space activities. China's non-democratic political situation and goal to become a great power have raised the vigilance of the international community. In 2007, China destroyed a weather satellite with an anti-satellite missile, demonstrating its high technological capabilities. China's space program is highly oriented towards militarization, even if it denies it in its public interventions. If some experiments are said to be realized for science by the Chinese government, one might think that it covers military tests. For example, China launched a new anti-satellite missile in 2013, which was justified as a test for scientific research. Nevertheless, "experts have suggested that this test was likely a high-altitude direct-ascent (anti-satellite missile) test that could reach satellites as high as geosynchronous orbit (GEO), which includes satellites used for missile warning, military communications" (18). China is currently developing technologies

challenging more and more developed countries' technologies, and India and Brazil could follow this path. What worries the scientific and political sphere is the uncertainty on whether they will be able to find a balance in space activities, such as developed countries have been trying to do since the end of the Cold War, or they will become a threat by exceeding the virtual limits imposed by international customs.

2.1.3 The unequivocal reaction of the United States

To these recent achievements in outer space proving the technological capabilities of the emerging space actors, especially China, traditional great powers have reacted in different ways. While Russia is largely taking advantage of it with a close cooperation through bilateral space exploration programs negotiated with China, the United States seem less enthusiastic. In the American annual report to congress named "Military and Security Developments Involving the People's Republic of China 2018", the Department of Defense raised concerns about Chinese counterspace weapons and expanding surveillance capabilities. What constitutes the best proof of the American concerns about China's progress in space is the 2017 decision of President Trump to reestablish the National Space Council. First created in 1989 under the impetus of the Bush administration, and disbanded in 1993, this council included members of the government whose missions were to address space policy matters, especially in terms of national security and international relations. "We will return American astronauts to the moon, not only to leave behind footprints and flags, but to build the foundation we need to send Americans to Mars and beyond," Vice-President Mike Pence said during a meeting of the National Space Council (19). This intervention seems clearly setting up the frame of a new competition with China, whose Lunar Exploration Program led to many impressive achievements since 2007. In his speech, Pence focused on a national-scale and highlighted the importance of an American success. It tends to exclude international cooperation from this new

space guideline. Besides, in 2018, the American government announced the establishment of a sixth branch of the armed forces by 2020, the US Department of the Space Force (20). In this context, Vice-President Pence claimed “the US will meet the emerging threats on this new battlefield”, arguing that “History proves that peace only comes through strength”. It can very easily remind the Cold War period, when the United States came out on top of the conflict after having demonstrate its power to the world and to the USSR. One can be worried about the birth of a new modern space race, in an era where technologies have an unmeasurable power.

2.2 - Will the private sector evict states and their space agencies from space activities?

2.2.1 The rise of the space industry

The second group reshaping space activities gathers the actors of the private sector. The increasing interest of countries in space-related activities since the middle of the 20th century has permitted the birth of a new industry, the space industry. The new private actors can be divided into three categories: the manufacturers dealing with rocket engines and small satellites, the launch providers and the spacecraft operators managing telecommunications among other activities (21). The wealth produced by the space industry in 2018 amounted to US\$ 360 billion, and is expected to grow exponentially in the next decades. From the space age, telecommunications have been one of the biggest commercial success in space (7). According to ESA, “satellite telecommunication is the most mature of space applications”. At first, they were used for telecommunication. This innovation has allowed a much easier communication between distant parts of the world, participating greatly to the process of globalization. Today, the evolution of technology and demand has shaped other uses of telecommunication satellites such as television programs transmitted by satellites, access to the Internet, distribution of text, audio and videos between phone users etc. Other commercial uses of satellites include weather forecast and control of agriculture, for example. In France, the

Farmstar Project developed by the company Astrium and its partners helps producers managing their plots of land by controlling them through satellites. It allows reducing the use of fertilizer, a benefit for producers' expenses and for the environment. For several years, some private companies have been targeting a new type of consumers' service: commercial human spaceflight. This dream to bring non-astronaut people in outer space is shared especially by the CEOs of three American firms: SpaceX, Blue Origin and Virgin Galactic. On the Space X website, the first thing one can read is the ambition to "revolutionize space technology, with the ultimate goal of enabling people to live on other planets". In 2018, Elon Musk, the CEO of SpaceX, announced that a Japanese billionaire was going to be their first space tourist, aiming to make him travel in 2023 in a four or five days' trip. The man would travel in a Big Falcon Rocket, a new space engine that SpaceX is currently building. Space tourism constitutes without a doubt the next commercial activity that will create a huge competition among private companies all over the world.

2.2.2 A space innovation agenda more and more settled by private companies, at the expense of governments

Operating as any other sphere of the economy, the space industry obeys the capitalist laws of the market. It implies a strong competition between companies, in order to propose the cheapest prices to customers and to maximize profit. This international economic competition has, for example, permitted to increase quickly the efficiency of telecommunications. Since the 1960's to the beginning of the 21st century, the space industry proved to be focused on two purposes: developing commercial space applications and answering government needs in terms of space development projects. Indeed, public funding has constituted the main source of financing for space exploration. Governments and their space agency have represented major consumers of the space industry, owning a sort of monopoly on the agenda of the future

innovative space exploration projects. Over the past decade, the economic relations between private companies and governments have shifted. Today, private companies attract more and more private investors, as space is considered a profitable field of investment, especially thanks to the soon-to-exist space tourism industry. In the last few years, almost US\$ 1 billion per year was invested in terms of venture capital in the space industry. Thus, governments are included in the laws of the market, becoming one among many possible consumers. Their funding is not essential anymore for the survival of companies, which means they do not drive requirements anymore. More than just reducing governments to simple consumers, private companies such as the biggest one mentioned before - Space X, Blue Origin and Virgin Galactic - are directly competing with states' technologies. "On a low-orbit basis, prices for (satellites) launch have come down about 90% over a decade, which is just incredible" Noah Poponak, Aerospace and Defense equity research analyst at Goldman Sachs, explains (23). Through more competition with other companies and space agencies, the private sector has been able to reduce costs of production, which represents a fundamental progress for future space projects. Private companies also tend to develop their own innovating projects, beyond governments' contracts, overstepping states' space programs. Space X, as well as Blue Origin, has been focused on the concept of reusable rocket for a few years. Poponak describes it at "Launching something to space on a rocket, and then bringing the rocket back down on Earth and landing it" (23). SpaceX achieved the world's first reflight of a rocket in March 2017, an exploit that no states had succeed to do before. The CEO of Space X, Elon Musk, believes that with reusability "the cost of access to space will be reduced by as much as a factor of a hundred" (24).

2.2.3 The current low risk of state eviction by the private sector over space

If this new importance taken by the private sector could have many positive consequences on the future of space activities, some risks must be considered. First, reducing

more and more the costs of space programs, through a decrease of space technology costs, could be dangerous. Indeed, “when you are pushing the envelope on the edge of technology and capability, you are more likely to have failures” (23). Saving money on components or time of preparation could have dramatic effects if the consequences of a failure were not controlled, endangering human lives. Secondly, the role of governments and space agencies could be expected to be undermined by the new global competition, opposing the private and the public sectors in space activities. As space exploration programs will more and more rely on private companies, the established role of space agencies could disappear step by step. To qualify these two concerns, Robert Frost, Instructor and Flight Controller at NASA, argue that companies cannot fully replace states in outer space activities. “There are areas of space utilization that will be best fulfilled by the private sector and there are areas that are and will continue to be best fulfilled by the public sector. The relationship between the two is symbiotic, not parasitic”, he explains (25). If some of their fields of interest are similar, space agencies cover usually more topics than private companies do. NASA or ESA, among others, have the ambitions to improve their knowledge on space science. What is our place in the cosmos? What is the origin of Neptune’s smallest moon? What is beyond the Universe of Gaia? These are typical questions one can encounter on their website. Space agencies also still have a monopoly in terms of defense and military affairs, which represents a huge part of the total spending on space programs, at least in the United States and China. More generally, many private companies still rely on government support, which can define companies and states more as partners than competitors. Spaces activities will represent in the next decades a powerful factor of economic growth, a reason which pushes states to be willing to increase private activity in space. The Commercial Space Launch Competitiveness Act of 2015 is an update to the American law allowing US citizens “to engage in the commercial exploration and exploitation of ‘space resources’”. Besides, NASA is dedicated to entrepreneurship with a competitive grant

system which promotes private and academic innovation. In the United States, while there is today a difference between public and private space activities, they still have a role to play together. The control of the government over private companies' activities could prevent an over-falling of the prices of the market and ensure a safe and sustainable development of space technologies. To this purpose, companies and governments must refer to space law, which have started to develop from the Cold War but is still today subject to worldwide controversy.

3 – The necessary evolution of space law to adapt to the new international environment

3.1 - The multi-structure of space law

3.1.1 International treaties as the essence of space law

Following the beginning of the space race at the end of the 1950's, the international community has started to develop a legal framework for space activities, to control the use of outer space and ensure the security of all countries. Gathered under the term "space law", the very diverse series of norms have been created over the years by different organizations, at different scales of the society. The fundamental legislator of the outer space activities is the United Nations, with its five treaties on outer space. The first one is the "Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, including the Moon and Other Celestial Bodies", which can be shortened to "Outer Space Treaty". This treaty was surprisingly proposed by the two superpowers of the Cold War, the United States and the Soviet Union, and by the United-Kingdom. The political "Détente" between 1963 and 1979, a period of appeasement of the tensions between the superpowers, provided an enabling environment for such a treaty. It was signed by the General Assembly of the United Nations in 1967 and represents the fundamental basis of the space law, with 12 articles establishing the following core principles: outer space as the "province of all mankind", "free for exploration

and use by all states”, “not subject to national appropriation by claim of sovereignty”, prohibition of weapons of mass destruction in outer space, responsibility and liability of states for national space activities and finally prohibition of “harmful contamination of space and celestial bodies” (26). The importance of this treaty, ratified by 107 countries, can be compared to the importance of a country’s constitution, in a sense that any following law about outer space has had to respect its core principles. In 1968, 1972, 1976 and 1984, the United Nations adopted further treaties to deepen regulations concerning the rescue of astronauts, the liability for damage caused by space objects, the registration of objects launched in space, as well as the activities on the moon and other celestial objects.

3.1.2 The necessity of national legislation to regulate non-governmental space activities

A second prominent source of space law is national regulation. National space law allows controlling space activities of the different actors within a country. In many country, national law defines the framework of the activities of the space agency. In France, for example, a law was adopted in 1961 to define the “Statute of the Centre National d’Etudes Spatiales (CNES)”. Canada, Brazil, Chile, Japan, Russia and South Africa are, among others, countries which define a legal framework for their space agency. However, with the increasing commercial activities of the private sector in space, national space law has also appeared essential to establish rules about the private space activities. As an example, in Finland, private activities must respect the “Decree of the Ministry of Economic Affairs and Employment on Space Activities” implemented in 2018. It includes the requirement of an authorization before launching or acquiring an object in orbit, the necessity to own insurance and to provide information on the conduct of the operation (27). More generally, Fabio Tronchetti, Professor of Space Law and Policy, explains the necessity of a “mechanism to supervise and control (private space activities)” (29). Indeed, if private companies were to cause harm or damage

through their space operations, it would legally be the responsibility of the state to which they pertain, according to the Outer Space Treaty calling for the responsibility and liability of states for national space activities. Governments must ensure that the private sector will respect the international space law applicable to nations while launching their operations in space. The two main obligations concern registration and liability. Articles VII and VIII of the Outer Space Treaty establish the liability of a country in case of space damage, *i.e.* the need of insurance, and the requirement to register objects sent into outer space at a national and an international level. As an example, in the United States, this need of national regulation is materialized by an entity, the Office of Commercial Space Transportation of the Federal Aviation Administration, which issues licenses for commercial launches while controlling insurances or ability to pay in case of liability claims.

3.1.3 UN specialized agencies and multilateral treaties as complements of space law

To a lesser extent, specialized United Nations agencies and multilateral treaties play a role in the international space law. The International Telecommunication Union is an example of a specialized agency, existing since 1865. Originally called the International Telegraph Union, the organization evolved as the same time as technology. Today, it plays a role in assigning the orbits to satellites launched in space. Another important specialized United Nations agency linked to space activities is the International Civil Aviation Organization, created in 1944. While the organization is mostly focused on international air navigation, it is organizing a series of events to discuss the link between air and space navigation, as well as the necessity to create a space traffic management in the short-run. Multilateral and bilateral treaties have also played a significant role in the development of international space regulation and cooperation. The United States and the Soviet Union/Russia are the countries sharing the most significant number of bilateral treaties concerning space (30). Treaties between the two

powers have existed since 1962 with the “Bilateral Space Agreement”. However, this agreement was not specific in its scope and did not result in a true cooperation as both countries were focused on beating its adversary to lead the space race. It will take several decades for a real cooperative treaty to emerge between the United States and Russia. In 1992, the “Agreement Concerning Cooperation in the Exploration and Use of Outer Space for Peaceful Purposes” was concluded between the two states and is still today the legal basis for their space cooperation. Multilateral treaties have also been adopted by other countries to regulate their relations on a certain topic, such as the “Agreement between the French Government and the European Space Agency concerning the Guiana Space Centre” in 1993.

3.1.4 The multiplicity of dispute settlement mechanisms

To complete the development process of international space law, dispute resolution mechanisms were also created to solve conflicts linked to the use of outer space. The Liability Convention of 1971, an extension of the Outer Space Treaty, constitutes the first framework of dispute settlement by providing the ability to pursue claims against a country for damage caused by a space object. If the claim can also be pursued through national courts, it cannot be pursued through both systems simultaneously. The International Court of Justice (ICJ) represents another mechanism of conflict resolution. However, only states can pursue claims through this mechanism. In addition to these international courts, the Permanent Court of Arbitration situated in The Hague proposed in 2011 its Optional Rules for Arbitration of Disputes Relating to Outer Space Activities. These rules represent a model of arbitration agreement to insert into contracts. This model can apply for disputes among states, international organizations and private entities, which constitutes a perk as non-governmental activities in space are increasing. Arbitration, compared to claims in court, is a way to “reduce the burden on court systems” (31).

3.2 The main loopholes in current space law

If space law is very developed and mostly well-organized, some ambiguities persist and question the accuracy of today's space regulation. Some core principles defined by the United Nations through its treaties are subject to controversy. It is necessary to focus on these treaties because they influence each new decision in terms of space law and the behaviors of the different actors.

3.2.1 The controversy of the non-appropriation rule

First, some consider there is an ambiguity concerning the non-appropriation rule defined as the prohibition of “national appropriation by claim of sovereignty, by means of use or occupation, or by any other means” in Article II of the 1967 Outer Space Treaty. Marcus Schladebach, Professor of Air & Space Law at the University of Potsdam in Germany, points to some cases in which actors had taken advantage of the treaty's lack of accuracy. Since 1996, Denis Hope, an American citizen, has sold properties on the Moon. He decided to claim ownership for the Moon in 1980, to the US Governmental Office for claim registries, basing his arguments on the Homestead Act of 1862 which allowed any citizen to qualify for a grant of public land under certain conditions. Without examining the legality of his claim, the US Office made him landowner of all claimed celestial bodies (28). The wording of the article specifies “national appropriation”, which could be interpreted as not concerning private persons. However, the major opinion of experts is to say there is no legal gap in the Article II of the Outer Space Treaty, as it is largely acknowledged that if states are prohibited to declare ownership on celestial bodies, private entities must follow the same rule. Besides, the Moon Treaty of 1984 is more accurate on this point, specifying that “Neither the surface nor the subsurface of the moon (...) shall become property of any State, international

intergovernmental or non-governmental organization, national organization or non-governmental entity or of any natural person.” (33). However, if the Outer Space Treaty has been ratified by 107 parties, including the most influent space powers, the Moon Treaty has only been ratified by 18 parties, not including the United States, China, and Russia. Experts analyze the lack of involvement in this treaty as the result of its prohibition to harvest the natural resources of the moon, except through an international regime. Another case pointed out by Professor Schladebach highlights today’s issues on the appropriation of the moon. The American Space Launch Competitiveness Act signed in 2015 by Barack Obama (28) proclaims that “A United States citizen (...) shall be entitled to any asteroid resource or space resource obtained, including to possess, own, transport, use, and sell the asteroid resource or space resource obtained (...).” (32). This rule can directly be related to asteroid mining, an activity consisting in mining minerals from a celestial body for using it in space or taking it back to Earth. In 2017, Luxembourg also passed an act approving the right of ownership to resources found in space (34). Mining celestial bodies, especially the Moon, is an idea that has been discussed by scientists for several years, since the discovery of the precious raw materials available. With the increasing development of space activities by private companies, asteroid mining is more and more at the core of the attention, since it would represent a highly profitable opportunity. If companies do not possess yet the final technology to achieve asteroid mining, companies such as SpaceX, Blue Origin or Planetary Resources supported by Google executives are currently working on probes and rockets able to approach and exploit celestial bodies. The exploitation of space platinum, iron, nickel and cobalt is said to be worth trillion dollars. Asteroid mining is not the playground of the sole private sector, as it is a relevant alternative to the Earth’s scarce resources and a solution that could help space exploration. ESA and the company ArianeGroup concluded a contract in January 2019 to explore mining regolith on the moon (35). Regolith allows the extraction of water and oxygen, which could

facilitate humans' time on the moon. The perspective of fossil fuel on the Moon is also seen as a great opportunity to be able to carry spacecraft further in the solar system. China also has plans in mining, aiming to land a permanent Moon base to mine helium 3 in future years. These new ambitions of the public and private sector are out of the international legal framework based on the Outer Space Treaty and the Moon Treaty. The only way to ensure a sustainable and proper use of the celestial bodies' resources, especially the Moon, would be to form an international committee with a binding regulation power, as it is planned in the Moon Treaty. As examples of regulating rules, one can imagine the delivery of licenses as a requirement to be able to mine an asteroid, quotas established on space exploitation to limit the disparities between rich countries which will be able to mine in space and the others, the respect of a charter ensuring the sustainable mining of space etc.

3.2.2 A deep lack of international space law on space weapons regulation

Beyond the concept of non-appropriation of the celestial bodies, the militarization topic is another important debate related to outer space. Article IV of the Outer Space Treaty prohibits any kind of nuclear or mass destruction weapons in space, recalling that the celestial bodies should only be used for peaceful purposes. However, Article IV also mentions that "the use of military personnel for scientific research or for any other peaceful purposes shall not be prohibited". This opens the door to many different interpretations, which do not limit the weaponization process of space. Space weapons refer to both mass destruction weapons placed in space and weapons on Earth able to target space objects. Then, the term "weaponization" when related to outer space represents the proliferation of aggressive technologies in space and towards space. In 1983, the American President Ronald Reagan initiated the Strategic Defense Initiative, also known as Star Wars. The goal of this program was to develop anti-ballistic missiles to answer potential attacks from other countries. What was controversial at the time

was the will to create, among other things, space-based nuclear lasers able to intercept foreign ballistics while flying to the United States. Eventually, the Strategic Defense Initiative was abandoned, avoiding a conflict with the international space legal framework. Today, the fear of a new arms race in space is very widespread. First, the North Korean space program, closely related to its missiles program, is alerting the international community. In 2017, more than a dozen ballistic missiles were tested by the country, violating space law (28). North Korea ratified the Outer Space Treaty in 2009, but it reveals difficult to prove that the goal of North Korea is not to further scientific research. In June 2018, the initiation of negotiations between the North Korean leader Kim Jong-Un and the American President Donald Trump about the denuclearization of North Korea seemed to have helped reduce the military activity of the country in space. However, the recent breakdown of the second summit between Donald Trump and Kim Jong Un, in March 2019, is correlated with the beginning of a new satellite rocket launchpad, as well as a new engine test site (36). While the development of the North Korean space technology is not advanced enough to become an immediate threat, it should be closely watched in the next years. As studied in a previous part, China and the United States seem also on the verge of entering a new arms race, and Russia is not far behind.

To respond to the threat of arms proliferation in outer space, which could provoke conflicts of interests and possibly space wars in the long run, space law has tried to adapt. Since the 1980's, the United Nations tried to pass a resolution called "Prevention of an arms race in outer space" (PAROS), acknowledging the lack of accuracy of the Outer Space Treaty to prevent a new arms race in space. Today, the United States is the only country opposed to this resolution, while China and Russia have trying to convince the US to sign it. In 2008, the European Union proposed a Code of Conduct for Outer Space Activities. The code proposed to establish policies and procedures to ensure the freedom of access to space for peaceful purposes, the security and integrity of space objects as well as the legitimate defense interests

of states. Again, the United States, among China, Russia and India, rejected the proposal. “The dominance and strategic dependence of the US on space assets for military purpose has fostered an uneven and tense playing field, in which its rivals seek to catch up in terms of weaponization and the US seeks to maintain its dominance”, Professor Nayef Al-Rhodan explains. Eventually, the prohibition of weapons in space must be clearly adopted through space law. The risk of an escalation of violence is too high to balance the benefits of weapons testing in space. To achieve this goal, a code of conduct must be imposed on every country willing to develop activities in space. A new code of conduct should be related to a committee dedicated to regulate, with binding measures and sanctions, the use of weapons in space.

3.3 The future challenges of space law

The previous paragraphs focus on flaws of space law which lead to diverse interpretations and potential threats for the future of outer space. The following part will address completely new challenges of the past few years, that space law has almost never dealt with. They result from the increase in space activities and from the new perspectives seen by some actors in space.

3.3.1 Commercial private spaceflights: a new form of tourism in the making

As mentioned previously, human spaceflight is a preoccupation of many private companies working on space innovations. Space tourism denotes “any commercial activity that offer customers direct or indirect experience with space travel” (40). Bringing people into outer space to have an overview of the Earth or travel around the Moon represents both the dream and the ambition of the major space companies’ CEOs. Today more than ever, companies such as SpaceX with its Falcon Heavy rocket, Blue Origin with its New Shepard crewed rocket or

Rocket Lab with its Electron rocket, are on the brink of building proper engines to achieve human spaceflight. The space tourism market is predicted to be worth billion dollars within 20 years (39). If commercial human spaceflights as a widespread service to customers do not exist today, a few experiences approaching space tourism have already taken place in the past. From 2001, 7 people had the chance to fly on the Russian Soyuz spacecraft and to live for a few days alongside professional astronauts in the International Space Station. The participants were charged \$20 million by the organizing company, Space Adventures. But what are the legal implications of space tourism? Can current space law, more than 50 years old, deal with a new activity, using a new technology and dedicated to new users? The immediacy of space tourism as a widespread commercial service implies the development of new appropriate legislation.

Only a few references in international space law could be applied to private spaceflight. The Article V of the Outer Space Treaty and the Rescue Agreement concerns the assistance to be provided to an endangered astronaut, principles that could potentially be applied to private participants in space. The Article VI and VII of the Outer Space Treaty, as well as the Liability Convention, could be interpreted as a country's responsibility and liability for their space travelers, and for their compliance with international space law. At a national level, if many countries possess laws regulating private space activities in general, the United States is the only country which has adapt its national legislation to private spaceflight. The American Commercial Space Launch Act of 1984 is a federal law addressing the topic of the commercialization of space. The Act allows private companies to develop commercial launch vehicles and to operate private launch sites. Through this act, the role of registering and controlling commercial launches, issuing licenses and promoting safety standards is assigned to the Office of Commercial Space Transportation, a branch of the US Federal Aviation Administration. In 2004, an amendment was made to the Commercial Space Launch Act of 1984 to establish a regulatory regime for the future commercial spaceflight industry. It declares

the Associate Administrator for Commercial Space Transportation as the authority regulating such transportation, allows the issuance of an unlimited number of experimental permits to encourage the development of a commercial space flight industry and requires space flight participants to execute waivers of claims with permits and the Federal government

Built in a context of national and multinational space actors, the international space law lacks a regulatory framework for private spaceflights. First, should law operate a distinction between astronauts and spaceflight participants? If the international community considers those two groups to have different rights, then, the Outer Space Treaty and the followings treaties should be amended, or a special one created, in order to define the law which applies to spaceflight participants. If no distinction is decided between the two groups, should space tourists go through a form of selection, as astronauts, such as health tests, mental preparation and physical training? The answer is probably yes, as space can easily be considered a risky environment where one should be ready to confront very unusual situations. What would happen in case of dispute or criminal affair in outer space? Would law applicable on Earth serve as jurisprudence? If certain means of regulation could probably be useful to settle some disputes in space, it is evident that new legal situations will arise without any possible jurisprudence on Earth. In addition, which country would have the responsibility to settle the dispute, as outer space is “the province of all mankind” (33)? If commercial spaceflights become very popular in the next decades, which authority will regulate the navigation of the spacecraft to avoid damage and collision? A sort of international space navigation administration would be necessary to set up the agenda of spaceflights, authorize the launches, trajectories and landings. States, finally, also have a lot to do in terms of private spaceflight regulation. They must specify how international norms apply to private companies. For example, though the Outer Space Treaties refers to the national responsibility of any space operations, states should transfer the responsibility and liability on companies in case of a

dispute during a private spaceflight. The international and national space law has many topics to address, while there is only little time before commercial private spaceflight becomes a concrete achievement.

3.3.2 Pollution in outer space: the issue of space debris

The increase of public and private activities in space has generated fears about the protection of the space environment. Space debris represent the most alarming issue in terms of sustainable use of outer space. Space Debris refers to space objects sent by men and remaining in space while not having any purpose anymore. They have accumulated since the launch of Sputnik in 1957 and consists of pieces navigating around the solar system. Millions of pieces of debris move today around the Earth as fast as 36,000 km/h. According to Article IX of the Outer Space Treaty, states are required to “avoid harmful contamination of outer space” (26). Over the years, the contamination of outer space has been progressive and commonly achieved. The proliferation of space debris demonstrates that it is an issue beyond the framework imagined by the regulators in 1967. Today, different problems exist related to the spread of space debris. The major problem concerns the collisions that can occur between space debris and satellites or any other space objects. It has already happened several times, proving the reality of the situation. In 2009, for example, a satellite from the company Iridium and a deactivated Russian military satellite collided in space. The North American Defense Command, the aerospace warning organization of the United-States, failed to prevent such a collision. The probability of collisions will doubtless increase, as the future development of the private spaceflight industry will multiply the number of launches and eventually the amount of space debris. Major issues also arise when authorities try to identify the origin of the space debris having damaged another space object. This identification is yet fundamental to apply the responsibility and liability rule of the Outer Space Treaty.

During the past decades, a consequent number of guidelines have been written by international organizations to take steps towards the mitigation of space debris. The Inter-Agency Space Debris Committee, the International Telecommunication Union or the European Space Agency were part of them. They all identified “standards (...) for missions’ requirements for planned spacecraft and orbital stages” (41). They established protected areas where the limitation of space debris should be particularly enforced, such as Low Earth Orbit and Geosynchronous Earth Orbit. Space debris in Low Earth Orbit could endanger the Earth and its citizens if the gravitational field of the planet eventually pulled the space debris down. Most of today’s satellites are situating in the Geosynchronous Earth Orbit, which means that damage by space debris could lead to a harmful chain of collisions. The guidelines also provide fundamental safety and protection measures, such as prohibiting intentional destruction of space objects and limiting objects release during normal spacecraft operations (41). The Space Debris Mitigation Guidelines of the Committee on the Peaceful Uses of Outer Space, endorsed by the United Nations General Assembly in 2007, gathers these voluntary guidelines for the mitigation of space debris. If some states have implemented national mechanisms to prevent the overspread of space debris and to help remove it, the international guidelines are only voluntary and non-binding. Professor Al-Rhodan believes that “nations should agree on removing set amounts of debris each year”, depending on their space budget, space presence and amount of debris produced (11). If this approach is essential to free space from the current trash, international space law should focus on a binding international agreement, basically using the rules defined in the guidelines but combined with a sanction mechanism in case of violation by any party.

Conclusion:

Thus, outer space activities have seen an exponential growth since the 1950's. The Cold war, first, gave the impetus for the conquest of space. The United States, defending democracy and liberalism, faced the USSR, defending communism, in a race for leadership in space activities. After the indisputable victory of the Americans thanks to the first man on the Moon in 1969, relations between the two countries concerning space became more peaceful and open to cooperation. This model of cooperation expanded to other states willing to play a role in the space conquest. The growing ambitions of space agencies, combined with new actors such as developing countries and private companies also full of innovating projects represent exciting perspectives in terms of technological progress and improving knowledge about space. Nonetheless, serious issues have emerged concerning the use of outer space, involving the potential new competition between actors or the diverse interpretations of space law. To address these problems, the implementation of an effective international space law is key.

Currently, states and private companies developing space activities seem to evolve without considering the direct consequences of their operations. Mistakes of the *world globalization* should not be reproduced in the *space globalization* that has already started. Pollution (with the proliferation of space debris), disparities between developed and developing countries (with the exploitation of precious celestial bodies' resources), migration (with the future increase of human spaceflights), territorial conflicts (with the appropriation of celestial bodies and the weaponization of space) must be regulated before they generate global-scale problems as has happened on Earth. While for a long time the world did not pay attention to the harm these topics could do on Earth, today, we have the power to act before concrete problems appear in outer space. There is a need to ensure peaceful and sustainable activities.

As a global answer to the upcoming issues concerning space, the establishment of an international space organization provided with powers to implement and enforce sanctions is essential. The international space law effort to provide guidelines and codes of conduct

represents a first step, but is not sufficient at all to regulate the growing aspirations of the public and the private sector in space. The different actors must recognize the settlement of common and binding rules as the only way to ensure a safe access to space on the long run. The United States, leader in terms of space activities, and China, on its way to accomplish historic space exploits, represent the two key space powers to convince. If they do not participate in the elaboration of a new international regulation and agree on its binding characteristics, other countries' efforts will be in vain. As in many other fields of human society, such as the economy or the protection of the environment, global governance is the only mechanism which can organize international cooperation and replace certain national selfish interests by a commitment to Earth and outer space prosperity.

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