COMPARATIVE VISIONS IN SPACE LAW

Edited by
Sirio Zolea

Consumatori e Mercato 18

Università degli Studi Roma Tre
Dipartimento di Giurisprudenza

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15. E. Poddighe, *I tatuaggi fra società, persona e diritto*, 2023
16. A.M. Mancaleoni, R. Torino, *Agri-Food Market Regulation and Contractual Relationships. In the Light of Directive (EU) 2019/633*, 2023
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Table of contents

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Mario Pasquale Amoroso

Troubling Technologies in Outer Space: How to Hold States Accountable for Military Activities in Orbit

1. *Introduction*

On 15 February 2024, the US intelligence briefed the national security spokesman, John Kirby, on evidence of Russia's development of a new space-based nuclear anti-satellite weapon, a programme described as 'troubling' despite the absence of any 'immediate threat to anyone's safety'[1]. This information, that immediately leaked to the British media[2], raised obvious security concerns and prompted the US House Intelligence Committee to call on President Biden to declassify information on this and other space threats[3]. Despite the uncertainty about the nature of the threat, the call for immediate responses is indicative of the sensitivity of interstate relations in outer space, an area considered crucial to maintaining military and strategic superiority in the international arena.

In fact, this is only the latest in a series of (alleged) offensive activities enacted by Russia in outer space, which along with China and the US, is

[1] J. Borger, *White House confirms monitoring of 'troubling' Russian anti-satellite weapon,* The Guardian, 15 February 2024, [https://www.theguardian.com/us-news/2024/feb/15/russia-anti-satellite-weapon-space-white-house].

[2] B. Debusmann Jr., *Top Republican's cryptic warning of US 'national security threat',* BBC News, 15 February 2024, [https://www.bbc.com/news/world-us-canada-68296879].

[3] *Russia 'developing space-based nuclear weapon' to target US satellites, sparking security concerns,* SkyNews, 16 February 2024, [https://news.sky.com/story/republican-warns-of-national-security-threat-amid-fears-of-russian-space-weapon-13071884].

one of the major space-faring nations with launch capabilities. In February 2020, the commander of the US Space Force, John Raymond, announced that two Russian satellites had begun to tail an American spy satellite, an 'unusual and disturbing behaviour', with a clear provocative intention[4]. In addition, China, along with Russia, is challenging the US power in outer space by developing and testing an extensive arsenal of weapons that could potentially destroy or disable US satellites on which the US relies to provide essential services to its citizens[5]. These tensions led the former President, Donald Trump, to declare space as a w*ar-fighting domain* not safe from the outbreak of international conflicts[6], also taking into account how new actors, such as India and Iraq, have joined the space superpowers by testing new military technologies in orbit[7].

The arms race in the outer space demonstrates the interest of States in gaining control of a domain that has become the new frontier for the projection of States' power. This can be explained in light of the military and strategic advantages that access to and control of the outer space can provide on Earth. Satellites, in particular, have come to play a critical role for several functions in the security sector, such as positioning, missile interception, and communications. This exposes them to the targeting activities of States wishing to acquire information and military superiority within the international community and explains the crowding of orbits by the most powerful nations with more developed anti-satellite (ASAT) systems.

This process of weaponisation of space has not yet led to the outbreak of hostilities that would constitute an armed conflict as defined by the 1949 Geneva Conventions[8]. International humanitarian law (IHL) applies

[4] W.J. Henningan, *Exclusive: Strange Russian Spacecraft Shadowing U.S. Spy Satellite, General Says,* TIME, 10 February 2020, [https://time.com/5779315/russian-spacecraft-spy-satellite-space-force/]

[5] C. Kube, D. De Luce, *How China is challenging the U.S. military's dominance in space,* NBC News, 13 December 2023, [https://www.nbcnews.com/politics/national-security/china-challenging-us-militarys-dominance-space-rcna128993].

[6] *Space Force: Trump officially launches new US military service*, BBC, 21 December 2019, [https://www.bbc.com/news/world-us-canada-50876429].

[7] S. Singh, India joins super space club with launch of anti-satellite missile, The Times of India, 27 March 2019.

[8] Geneva Convention for the Amelioration of the Condition of the Wounded and Sick in Armed Forces in the Field (GC I), 12 August 1949, 75 UNTS 31, (1949), Art. 2.1: " The present Convention shall apply to all cases of declared war or of any other armed conflict which may arise between two or more of the High Contracting Parties, even if the state of war is not recognized by one of them". The text is reproduced in the same terms also in the other Geneva Conventions.

to 'all forms of warfare and to all kinds of weapons'[9], therefore including ASAT weapons, and States Parties to the Geneva Conventions undertake to respect and to ensure respect for it in all circumstances[10], confirming the potential applicability of IHL to armed activities in outer space. Yet, for an international armed conflict to exist, there must be hostilities between the armed forces of two or more States, although without any threshold of intensity[11]. Since States have not yet entered into hostilities with each other and are only involved in testing and positioning new technologies, the application of IHL to military activities currently taking place in outer space should be excluded.

Nevertheless, expansionist ambitions have led States to deploy new weapons systems in orbit, only some of which are programmed to destroy space objects. While "kinetic" anti-satellite weapons are clearly designed to collide with other satellites and cause material damage, States have begun to develop new technologies aimed at temporarily or permanently disabling the functioning of satellites without destroying them. The use of such technologies would doubtfully amount to hostilities under the Geneva Conventions[12]; yet, it can give rise to international responsibility for harmful activities under the Outer Space Treaty[13] and other relevant legal regimes.

The purpose of this paper is therefore to define which of the hostile activities in outer space that take place outside the context of an armed conflict could still be of concern to States as a source of international responsibility. To this end, an overview of the most important space weapons developed by States will be provided (Section 2), followed by an examination of the regime of responsibility established in the Outer Space Treaty (Section 3). In conclusion, the provisions limiting the recourse to ASAT weapons, both within and outside the outer space legal regime, will

[9] International Court of Justice (ICJ), *Legality of the Threat or Use of Nuclear Weapons,* Advisory Opinion, 8 July 1996, §86.

[10] GC I, Article 1. The text is reproduced in the same terms also in the other Geneva Conventions.

[11] The ICRC commentary proposes this position, known as the 'first shot theory': J. Pictet, *Commentary on the Geneva Conventions of 12 August 1949*, Vol. IV, (1952), pp. 20-21; ICRC*, Updated Commentary on the Geneva Conventions of 12 August 1949*, Vol. I, (2016), par. 218.

[12] E. Pobjie, Outer Space, Military Uses of, MPEPIL, 2024, §33.

[13] Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, including the Moon and Other Celestial Bodies, 10 October 1967, 610 UNTS 205, Article VI.

be analysed in order to verify whether States could be held accountable for the recourse to these technologies (Section 4).

2. *The weaponisation of orbits: features and uses of space military technologies*

Space is currently populated by various technologies programmed to perform hostile functions, and the resulting congestion of the orbits has increased the likelihood of conflicts. The placement of new weapons systems in orbit has been recently driven by the will of some States to disrupt the functioning of satellites, which are essential for the provision of certain key services, particularly military ones. Space systems used to this end fall into the category of "anti-satellite weapons" (ASAT weapons), i.e. "weapons designed to destroy or disable a satellite in space by nuclear or conventional explosion, collision at high speed, or directed energy beam"[14]. These technologies can be easily classified as "space weapons", i.e. technologies with the destructive potential of objects positioned in space[15]. Although not all of them are programmed to materially destroy other space objects States could be held responsible for interfering with the interests of other States by resorting to technologies that disable satellite functions, such as electronic weapons. These new systems have led to an expansion of the category of ASAT weapons: it may thus be relevant to start with an overview of technologies designed to perform hostile functions against satellite systems, in order to have a complete picture of military activities in outer space that could determine international responsibility.

a. From land to space battlefield: the development and different uses of ASAT weapons

Since the beginning of the process of exploration of outer space, global superpowers started positioning and testing nuclear warheads in outer space, delivered through intercontinental ballistic missiles (ICBMs)[16]. The United States and the Soviet Union started these operations immediately

[14] United Nations Institute for Disarmament Research Geneva, *Prevention of an Arms Race in Outer Space: A Guide to the Discussions in the Conference on Disarmament*, New York. 1991, p. 177.

[15] B. Jasani, *Peaceful and non-peaceful uses of space: problems of definition for the prevention of an arms race*, New York, Taylor & Francis, 1991.

[16] R.A. Ramey, 'Armed Conflict on the Final Frontier: The Law of War in Space' in *The Air Force Law Review,* 48(2000), 2000, p. 12.

after the launch of the first artificial satellite, Sputnik 1, showing interest in asserting their presence in what was then a completely unexplored area[17]. However, the detonation of nuclear weapons in outer space immediately raised concerns about the long-term effects it could have on the space environment. Indeed, the electromagnetic pulse generated by the explosion would cause the widespread destruction of satellite circuits, rendering them inoperable, with catastrophic consequences for terrestrial computing and communications infrastructures[18]. In addition, the electromagnetic radiation would cause environmental damage, most commonly associated with the formation of an artificial radiation belt around the Earth, potentially affecting the operability of electronics operating in the Earth's orbit[19]. These catastrophic consequences led States to establish clear legal prohibitions on the use of these weapons in outer space, such as those established in Article IV of the Outer Space Treaty that will be briefly analysed. However, the recent allegation, mentioned above, that Russia is developing nuclear-capable ASAT weapons could reopen debates on the use of these systems in the space context, in particular with regard to the potential violations of international law that could result from their positioning in orbit.

Similar legal prohibitions have not been clearly established in relation to other weapons systems that have crowded the orbits since the first explorations of outer space and have been frequently tested by States, i.e. kinetic ASAT weapons. These technologies belong to the category of hard-kill weapons, i.e. weapons designed to destroy their target by means of a high-speed impact or explosion[20]. This destruction results in the release of space debris, which are likely to damage other civilian satellites as they travel at high speed in the Earth's orbit, potentially rendering them unusable for extended periods of time[21]. A wide range of different kinetic ASAT weapons

[17] C. Gainor, 'The Nuclear Roots of the Space Race' in *Militarizing Outer Space: Astroculture, Dystopia and the Cold War,* Palgrave McMillan, Vol. 3, 2021, p. 72.

[18] M. Peel *et al., How could nuclear weapons be used in space?,* Financial Times, 25 February 2024, [https://www.ft.com/content/ea57d82c-e042-46d3-9989-ac1ef336766a].

[19] J. Loughran, *A singular nuclear explosion in space would threaten a 'significant proportion of satellites,* Engineering and Technology, 7 May 2024, [https://eandt.theiet.org/2024/05/07/singular-nuclear-explosion-space-would-threaten-significant-proportion-satellites].

[20] M. Bourbonniere, 'Law of armed conflict (LOAC) and the neutralisation of satellites or ius in bello satellitis' in *Journal of Conflict and Security Law,* 9(1), 2004, p. 56.

[21] D. Stephens, C. Steer, 'Conflicts in Space: International Humanitarian Law and its application to space warfare', in *McGill Annals of Air and Space Law,* XXXX (2015), 2015, p. 5.

have been developed in the early stages of space exploration, potentially resulting in the release of large amounts of debris. In particular, from the 1960', the Soviet Union started testing explosive proximity weapons, missiles launched in the same orbital plane of the target and controlled remotely in order to approach the target and explode in its proximity[22]. Similarly, States have also developed direct-ascent ASAT weapons, outfitted with conventional warheads, with the aim of targeting spacecrafts[23], and tested space mines, programmed to explode when entering in contact with the target or release shrapnel to damage a spacecraft[24].

The development of all these weapons systems shows how the need to control orbits has led to the advancement of space warfare since the first phases of the exploration of space, with the development of technologies that damage space objects without recourse to kinetic energy. This is the case of direct energy weapons, i.e. non-kinetic weapons using radiated energy, such as laser or microwave energy, to destroy, damage or interfere with space systems by heating their surface[25]. In particular, the first laser weapons, which used chemical reactions to produce concentrated radiation beams to hit targets at long ranges[26], were operational as early as 1980. The Mid-Infrared Advanced Chemical Laser (MIRACL), developed by the US Navy, was the first ground-based system tested in 1997 against the US Air Force's MSIT-3 satellite, causing only minor damage[27]. However, the distorting effect of passing through the Earth's atmosphere has led States to compete in the development of laser systems activated directly in the space domain, as demonstrated by the new French orbital space surveillance project, the FLAMHE, whose aim is to identify potential on-orbit threats to national assets, and if necessary, disable the threat with lasers mounted

[22] P.B. Stares, *Space and national security*, Washington, Brookings Institutional Press, 1987, p. 87.

[23] C. Swope *et al., Space Threat Assessment 2024,* Centre for Strategic and International Studies, April 2024, p. 3.

[24] *The Spectrum of Space Weaponry: An Examination of Potential Developments,* New Space Economy, 16 June 2023, [https://newspaceeconomy.ca/2023/06/16/the-spectrum-of-space-weaponry-an-examination-of-potential-developments/].

[25] C. Swope *et al., Space Threat Assessment 2024,* p. 4.

[26] W.H. Possel, *Laser weapons in space: a critical assessment*, Air War College, Alabama, AU/AWC /197/1998-04, pp. 18-19.

[27] C. Plante, *Pentagon beams over military laser test,* CNN, 20 October 1997, [https://web.archive.org/web/20071230052044/http://www.cnn.com/US/9710/20/pentagon.laser/].

on space objects[28].

All of the weapon systems described in this paragraph can have destructive effects on space targets as a whole or on individual components, potentially leading to the production of large amounts of space debris. Recently, however, new kinetic and direct energy weapons performing functions other than destructive ones are being developed.

b. From blinding to hacking: the new developments of space weaponry

International norms that set limits on State behaviour normally serve to deter behaviour that could harm the interests of other States or the international community as a whole. However, the pressing interest of some countries in gaining a competitive advantage in the process of space exploration and exploitation has led to the development of new weapons systems designed to avoid falling under existing prohibitions on the placement of certain weapons in space.

In fact, ASAT weapons have been adapted to pursue similar objectives, but by different means, in order to prevent satellites from performing their functions without causing their total or partial destruction. Among kinetic weapons, for example, we can find "orbital grapplers", i.e. technologies that physically manipulate the targeted satellite manoeuvring it to another location, thus rendering it inoperable[29]. Similarly, direct energy weapons, including laser weapons, which were originally designed to destroy spacecraft, are now being developed to perform new purposes, i.e. to 'dazzle' or blind satellite sensors, thus disabling their functions without creating space debris[30]. This is the case of the Peresvet, a laser weapon system designed to hit satellites from Earth in order to dazzle them and disable their functions[31].

The pace of technological development has led States more interested in controlling orbits to expand even more the range of hostile conducts that could be used to disrupt satellite functions. Among these, electronic interference can take several forms, all of which have a similar purpose, namely, to control the space electromagnetic spectrum, and thereby affect

[28] V. Machi, *Macron sends $438 billion military budget plan to French parliament*, DefenseNews, 4 April 2023, [https://www.defensenews.com/global/europe/2023/04/04/macron-sends-438-billion-military-budget-plan-to-french-parliament/].

[29] C. Swope *et al., Space Threat Assessment 2024,* p. 3.

[30] M. Byers, A. Boley, 'Anti-satellite Weapons and International Law', in M. Byers, A. Boley, *Who Owns Outer Space,* CUP, 2023, p. 342.

[31] B. Hendrickx, *Peresvet: a russian mobile laser system to dazzle enemy satellites,* The Space Review, 15 June 2023, [https://www.thespacereview.com/article/3967/1].

the satellite's ability to receive information from ground stations[32]. In particular, among these forms of interference, spoofing and jamming are those that States appear to be more interested in potentially employing to disrupt other states' space activities. While spoofing is the act of replicating or falsifying Global Positioning System (GPS) or communication signals in order to 'fool' a GPS device by manipulating its position, speed of movement and ability to measure time[33], jamming technologies transmit signals on the same radio frequency as the target but in the opposite direction, which can suppress or deceive the victim's GPS or communication receiver, making it unable to follow the signal for which it is programmed[34]. The use of these technologies on GPS satellites employed for military use could negatively affect the situational awareness of States involved in ongoing conflicts[35]. The prospect of States resorting to these technologies is not so far-fetched, as recent tragic historical events, such as the hostilities currently taking place in the Gaza Strip, show how GPS jamming has been used to disrupt Global Navigation Satellite Systems in order to support attacks on land[36].

Finally, the proper functioning of satellites could be hampered through cyber operations targeting space systems. In particular, offensive activities in cyberspace do not disrupt radio frequencies, but rather "target the data itself and the [satellite] system that uses, transmits and controls the flow of data" by intercepting or inserting false or corrupted data[37]. Cyber-attacks on space systems could result not only in the partial or total loss of data provided by a satellite, but also in more damaging consequences, such as the destruction or disabling of the internal machinery of satellites after remote control has been taken over, which could lead to the activation of

[32] US Joint Chiefs of Staff, *Electronic Warfare,* JP 3-13.1, 25 January 2007, I-2.

[33] M.L. Psiaki, T.E. Humphreys, 'GNSS spoofing and detection' in *Proceedings of the IEEE*, 104(6), 2016, p. 1258.

[34] L. Xiangjun *at al.,* 'Overview of Jamming Technology for Satellite Navigation', in *Machines,* 11(7), 2023, pp. 769 ff.

[35] E. Grey, *Satellites and spoofing – how hackers falsify situational awareness*, Army Technology, 17 November 2013, [https://www.army-technology.com/features/feature-satellites-spoofing-hackers-falsify-situational-awareness/?cf-view].

[36] M. Karlinski Zur, *Inside Israel's GPS jamming strategy in Gaza war,* Ynet News, 16 December 2023, [https://www.ynetnews.com/health_science/article/s1zex9ii6]; M. Berg, *Israel's using widespread GPS tampering to deter Hezbollah's missiles*, Politico, 23 October 2023, [https://www.politico.com/news/2023/10/23/israels-gps-tampering-deter-hezbollahs-missiles-00123026].

[37] T. Harrison, *Space Threat Assessment 2021,* Center for Strategic and International Studies, 2021, p. 5.

commands to self-destruct the electronic system or sensors[38]. Among others, China is suspected of being responsible for several cyber-attacks on foreign satellite networks, including remote sensing and weather satellites and Indian communications satellites[39].

Thus, the current picture of non-kinetic space weapons appears complex and diverse, making a clear classification of space weapon systems difficult and potentially subject to change in the near future. The next Section examines the regime of responsibility established in the 1967 Outer Space Treaty in order to understand whether (and when) recourse to the space weapons just described could lead to the establishment of international responsibility.

3. *The regime of international responsibility for national activities in outer space*

As early as 1963, just a few years after the beginning of the process of exploration of outer space, the General Assembly considered it urgent to emphasise the applicability of a regime of international responsibility for national activities in outer space[40]. This principle has been translated into the Outer Space Treaty, where the responsibility of States in the field of space activities takes a specific form, reflected in Articles VI and VII[41]. However, these two provisions establish two different regimes of responsibility.

Indeed, Article VII establishes a regime of objective liability of a State Party to the Outer Space Treaty that "launches or provides for the launching" of objects in outer space for the damage caused to other States Parties. Article VI, on the other hand, affirms the responsibility of States Parties for national activities not in conformity with the provisions of the Outer Space Treaty. This distinction is a fundamental premise for fully understanding which regime should be focused on when assessing international responsibility for military activities in orbit.

The special regime established in Article VII is interpreted by some

[38] M. King, S. Goguichvili, *Cybersecurity Threats in Space: A Roadmap for Future Policy,* CTRL Foreword, 8 October 2020, [https://www.wilsoncenter.org/blog-post/cybersecurity-threats-space-roadmap-future-policy].

[39] C. Swope et al., *Space Threat Assessment 2024,* p. 11.

[40] UNGA, *Declaration of Legal Principles governing the Activities of States in the Exploration and Use of Outer Space,* Res.1962 (XVIII), 13 December 1963, Principle 5.

[41] M. Pedrazzi, *Outer Space, Liability for Damage,* Max Planck Encyclopaedia of Public International Law (MPEPIL), 2008, §1.

scholars as a form of liability that is not linked to the commission of a wrongful act, but is simply applicable in cases of damage caused to other States Parties as a result of unintentional incidents[42]. Therefore, if this position is followed, Article VII, while applicable, is of limited relevance to the analysis presented in this paper, since recourse to certain weapons systems, such as weapons of mass destruction, constitutes an unlawful act, as does the use of other ASAT weapons.

In light of the foregoing, the relevant regime of international responsibility in the context of hostile activities in outer space has to be found in Article VI of the Outer Space Treaty. In particular, by establishing the international responsibility for all national activities of States Parties in outer space in contrast to the provisions of the Outer Space Treaty, this Article is an attempt to generalise the objective and subjective scope of international responsibility in the field of outer space law. In fact, it firstly applies irrespective of the actor, since international responsibility arises in the case of violations by both governmental and non-governmental actors. In addition, it recalls the provisions of the Outer Space Treaty, in particular those of Articles II to XII[43], establishing States responsibility for any of the national activities in contrast with these norms.

Moreover, as recalled in Article III of the Outer Space Treaty, States can be held responsible for intentional conducts that result in contrast with a substantial part of international law[44]. In particular, even if this provision does not encompass international law *in toto,* since not all international norms adapt to the specificities of outer space[45], its scope would include not only customary rules and fundamental principles contained in the UN Charter, such as the prohibition of the use of force and non-intervention[46], but also other branches of international law, including international

[42] ILC, *Preliminary report on international liability for injurious consequences arising out of acts not prohibited by international law, by Mr. Robert Q. Quentin-Baxter, Special Rapporteur,* A/CN.4/334 and Add.1 & Corr.1 and Add.2, Vol. II, p.253; L. Condorelli, 'La réparation des dommages catastrophiques causés par les activités spatiales', in Bibliothèque de la Faculté de Droit de l'Université Catholique de Louvain, *La réparation des dommages catastrophiques: Les risques technologiques majeurs en droit international et en droit communautaire* (Bruylant Bruxelles 1990), pp. 278-279.

[43] S. Hobe *at al., Cologne Commentary on Space Law: Outer Space Treaty,* Berliner Wissenschafts-Verlag, Vol. 1, 2009*,* p. 376.

[44] M. Lachs, *The Law of Outer Space – An Experience in Contemporary Law-Making*, Sijthoff, Leiden, 1972, p. 15

[45] *Idem,* p. 13.

[46] S. Hobe at al., *Cologne Commentary on Space Law: Outer Space Treaty,* p. 279.

humanitarian law and environmental law[47].

However, the regime of responsibility established by Article VI is strictly limited to national activities in outer space and therefore excludes the use of certain weapons, such as laser and cyber operations, that are activated from Earth with the aim of damaging space assets[48]. Therefore, States can be held responsible for such hostile activities only in cases where ASAT weapons are activated from space, even if controlled from Earth, and target other space objects. Nevertheless, the use of ASAT weapons, both kinetic and non-kinetic, could potentially lead to the establishment of the international responsibility of States acting in violation of the outer space legal framework considered in a broad sense, including the international norms recalled through Article III, thus demonstrating how the regime of responsibility established in Article VI could strongly contribute to deterring States from engaging in widespread hostile activities in outer space. In order to demonstrate this, in the following section, this paper will attempt to show how hostile activities in outer space could fulfil the objective element for the establishment of international responsibility, i.e. the violation of an international obligation, without going into questions of attribution, which constitute the subjective element of international responsibility.

4. *An (apparent) risky legal lag: an examination of the international regime regulating military activities in outer space*

Shortly after the launch of the first satellite into orbit, the Sputnik 1, the need for an international legal regime to limit the prerogatives of States in the exploration of this newly discovered domain became apparent. The novelty of the subject and the rapid development of space policies, particularly by the United States and the Soviet Union, led the 1960s to start negotiations under the auspices of the United Nations. The result was the Outer Space Treaty of 1967, which identified new principles of international law and adapted the existing ones to the new space landscape[49].

[47] A.C. Kiss, D. Shelton, *Guide to International Environmental Law*, Martinus Nijhoff, Leiden, 2007.

[48] L. Du, 'Cyber-attacks on Space Activities: Revisiting the Responsibility Regime of Article VI of the Outer Space Treaty', in *Space Policy,* 63(2023), 2023, p. 2.

[49] UNGA, *International Cooperation in the Peaceful Uses of Outer Space*, Res.1721 (XVI), 20 December 1961; *International Cooperation in the Peaceful Uses of Outer Space*, Res.1802 (XVII), 19 December 1962; *Declaration of Legal Principles Governing the*

Among these principles, the 'peaceful use of outer space' in the interest of mankind, which is stated in the Preamble, is of particular importance. Its inclusion as one of the fundamental guidelines for State activities in outer space proves that the risk of using weapons in outer space was already a pressing issue barely ten years after the beginning of the explorations in this new domain. However, these concerns did not lead to a commitment to total demilitarisation of outer space, as, under the pressure of the major space powers, it was interpreted only as a prohibition of aggressive uses of outer space, justifying the recourse to space weapons systems for self-defence[50]. This interpretation is also in line with the idea, reflected in Article III of the Outer Space Treaty, that orbits are not only a physical domain but also a legal one in which international law, in particular the Charter of the United Nations, applies, including the right of self-defence enshrined in Article 51 of the Charter of the United Nations.

Despite the absence of a commitment to total orbital disarmament, the high risk posed by the potential use, even in self-defence, of certain weapons, namely nuclear weapons and other weapons of mass destruction, led the States Parties to the Outer Space Treaty to agree on more stringent obligations, also in view of the need to guarantee the common interest of the international community in the exploration and use of outer space. It is therefore essential to examine the scope of legal restrictions on the militarisation of outer space in order to understand which weapon systems are clearly prohibited under the Outer Space Treaty and what restrictions on ASAT systems can be derived from the outer space legal framework in its entirety.

a. The scope and content of international legal restrictions to military activities in outer space

The principle of the 'peaceful use of outer space' is given concrete meaning in Article IV of the Outer Space Treaty, which establishes a dual legal regime for the demilitarisation of outer space[51]. In fact, while the Article identifies a regime of partial demilitarisation for the orbits, limited to certain weapons systems, it establishes more stringent obligations of full

Activities of States in the Exploration and Use of Outer Space, Res. 1962 (XVIII), 3 ILM 157, 13 December 1963.

[50] S. Hobe *at al., Cologne Commentary on Space Law: Outer Space Treaty*, pp. 159-160. This conclusion is also confirmed by the General Assembly: UNGA, *Question of general and complete disarmament*, Res. 1884 (XVIII), A/RES/18/1884, 16 October 1963.

[51] S. Courteix, 'Le traité de 1967 et son application en matière d'utilisation militaire de l'espace' in *Politique étrangère*, 1971, p. 260.

demilitarisation for the Moon and other celestial bodies.

More in detail, the first paragraph of Article IV prohibits the placement of 'any object carrying out nuclear weapons or any other kinds of weapons of mass destruction' in Earth's orbit, as well as their installation on celestial bodies and the stationing of weapons in outer space. This attempt of partial demilitarisation of the orbits should be read in conjunction with another international agreement, the Partial Test Ban Treaty of 1963, which prohibits any test or use of nuclear weapons in space. Even if Article IV of the Outer Space Treaty does not clearly prohibit the use and testing of mass destruction weapons systems, such a prohibition can be derived from a systematic interpretation of Article IV in the light of Article 1 of the Moscow Treaty, also taking into account that not restricting the use of these systems would in any case be contrary the peaceful use of the orbits. The different wording of the two provisions illustrates how the negotiations for the Outer Space Treaty led to weaken an earlier commitment, following the interest of some States to acquire or maintain control of orbits.

Be as it may, the prohibition of Article IV is limited to weapons of mass destruction[52]. Therefore, the deployment of any type of weapon that falls outside this category, including most of the ASAT systems described in the previous Section 2, is not prohibited under Article IV. The scope of this provision seemed even more limited, as it only prohibited the placement of weapons in Earth orbit. This wording led States such as the US and the Soviet Union to develop nuclear warhead delivery systems, namely Fractional Orbital Bombardment Systems (FOBS), which use orbital motion without completing an orbital rotation to hit targets by deorbiting before reaching them[53]. In particular, the United States and the Soviet Union, relying on an interpretation of the term "placement" as "fixed presence" in Earth's orbit[54], claimed that these systems did not fall under the prohibition of Article IV because the missiles did not complete an orbital rotation. Although this interpretation is not supported by the ordinary

[52] UNGA, *Prohibition of the development and manufacture of new types of weapons of mass destruction and new systems of such weapons,* A/RES/32/84/B, 1977. Weapons of mass destruction include "atomic explosive weapons, radioactive material weapons, lethal chemical and biological weapons, and any weapons developed in the future which might have characteristics comparable in destructive effect to those of the atomic bomb or other weapons mentioned above".

[53] B.B. Eisel, *The FOBS of War,* Air and Space Forces Magazine, 1 June 2005, [https://www.airandspaceforces.com/article/0605fobs/].

[54] O. Giarini, 'L'espace et le droit international' in *L'Europe et l'espace*, Lausanne, Centre de recherches européennes, 1968, p. 153 ff.

meaning of the provision[55], the attempt to circumvent the prohibition of Article IV shortly after its adoption shows how the ambiguous wording of this provision and its limited scope of application make it vulnerable to obsolescence as new weapons systems are developed.

Turning to the second paragraph of Article IV, as already noted, it establishes a regime of complete demilitarisation of the Moon and other celestial bodies, to be used only for peaceful purposes. In particular, it expressly prohibits "the establishment of military bases, installations and fortifications, the testing of weapons of any kind and the conduct of military manoeuvres". The restrictions to military activities are clearly more stringent for celestial bodies than for the space between them, since the provision prohibits any form of testing and use of any kind of weapon system, potentially including all the ASAT weapons described in the previous section. However, its reference to the principle of the "peaceful use of outer space" is interpreted by some as allowing the use of weapons systems in self-defence[56]: in this case, a regime of complete demilitarisation could not result even from Article IV, paragraph 2.

As shown above, the international demilitarisation obligations provided for in Article IV impose only limited restrictions on the military use of outer space. Thus, in order to understand the extent to which States are prohibited from engaging in military activities in space, it is essential to look at more general international obligations, in particular the prohibition of the use of force and the principle of non-intervention.

b. Going beyond the scope of Article IV: the prohibition of the use of force and the principle of non-intervention

Despite the quite limited scope of the obligations under Article IV, the Outer Space Treaty can still be read as incorporating a more comprehensive restriction of the military use of outer space. By recalling the prohibition of the use of force through the clause of Article III, also clearly re-stated in the Moon Agreement[57], the Treaty actually contains more stringent legal obligations with regard to the use of ASAT systems. The relevance of this prohibition, which does not exclude the placement of weapons in orbit for self-defence purposes, in the context of outer space is confirmed by regional instruments such as the 2014 International Code of Conduct for Outer Space Activities and the recently adopted Woomera Manual on the

[55] S. Hobe at al., *Cologne Commentary on Space Law: Outer Space Treaty*, p. 309.

[56] *Idem,* pp. 159-160.

[57] Agreement Governing the Activities of States on the Moon and Other Celestial Bodies, 11 July 1984, 1363 UNTS 3, Article 3.

International Law of Military Space Activities and Operations[58]. However, given the absence of boundaries in outer space, it is essential to understand how the prohibition of the use of force 'against the territorial integrity or political independence of any State' can be applied in this context.

Firstly, this prohibition applies to 'any use of force, regardless the weapons employed'[59], since what counts is the simple physical effect of the application of the force. By focusing on the effects, it would allow to consider the intentional creation of space debris through the use of kinetic weapons in certain circumstances as a use of force prohibited by the UN Charter[60]. On the other hand, it is more problematic to apply this qualification to non-kinetic weapons, since their use would determine only temporary adverse effects on satellite systems, however impairing their military and civil functions, including positioning, missile interception and disaster relief. In this regard, inspiration could be drawn from the practice developed in the context of cyber operations, which considers under the prohibition on the use of force not only attacks that cause or are likely to cause physical damage to property, loss of life or injury to persons, but also those that determine a significant disruption of the functioning of critical infrastructures[61], severely disrupting the delivery of critical services. Therefore, if the use of non-kinetic weapons, such as laser and cyber operations against satellites are likely to determine the consequences just described, their use could be qualified as conduct contrary to the prohibition of the use of force.

With regard to non-kinetic attacks that fall below the threshold of the use of force, therefore not reaching a certain degree of severity, they could still be considered violations of the customary principle of non-intervention if they are carried out with the intent to coerce the target State to take or not take actions on sovereign matters in which each State is permitted to decide freely[62]. Indeed, in the context of cyber warfare, any non-armed conduct that causes or is intended to cause the loss of functionality of critical

[58] J. Beard, D. Stephens, *The Woomera Manual on the International Law of Military Space Operations,* OUP, 2024.

[59] ICJ, Legality of the Threat or Use of Nuclear Weapons, §39.

[60] E. Pobjie, *Outer Space, Military Uses of, §27.*

[61] M. Roscini, *Cyber Operations and the Use of Force in International Law,* OUP, 2014, Chapter 2. The Tallinn Manual on the International Law Applicable to Cyber Warfare defines cyber-attacks as those that cause damage consisting of a malfunction that requires the replacement of physical components: NATO Cooperative Cyber Defense Centre of Excellence, *Tallin Manual on the International Law Applicable to Cyber Warfare*, Rule 30, §10.

[62] ICJ, *Military and Paramilitary Activities in and against Nicaragua (Nicaragua v USA)*, Merits, Judgment, 27 June 1986, §205.

infrastructure with the disruption of essential services would be contrary to the principle of non-intervention if carried out with the intention of coercing another State to obtain the subordination of the exercise of its sovereign rights or any kind of advantage from the hostile conduct[63]. It is, therefore, clear that interference with data receivers of satellite systems by means of cyber-attacks may also be considered as conduct in violation of the principle of non-intervention, when it cannot be qualified as the use of force. Even if responsibility for conducts in contrast with this principle would arise with regard to a limited number of cyber-operations, since Article VI only applies cyber-attacks carried out with the help of space objects, the act of taking control of another satellite in order to jam the radio signals of another space object or to deorbit in order to hit it would be contrary to the principle of non-intervention[64]. By analogy, these considerations can be applied to hostile acts that disrupt the operation of satellites ensuring the functioning of essential services, such as telecommunications networks, which would violate the principle of non-interference.

In particular, with regard to electronic jamming, it should also be considered in light of the international telecommunications' legal regime. The Constitution of the International Telecommunication Union requires Member States to establish and operate all radio stations so as not to cause harmful interference to the radio services and communications of other States[65]. More specifically, the Radio Regulations clarify what is meant by harmful interference, defining it as a form of 'interference which endangers the functioning of a radionavigation service or of other safety services or seriously degrades, obstructs, or repeatedly interrupts a radiocommunication service'[66]. These provisions are therefore even more specific in prohibiting forms of electronic interference than the general principle of non-intervention, clearly impeding jamming activities that endangers communication satellites, unless they are used for hostile purposes, such as espionage, in which case jamming may be used for self-defence purposes or as a non-forcible countermeasure. However, there is a legal obstacle weakening the scope of these obligation: the Constitution recognises Member States freedom of action with regard to radio military

[63] M. Roscini, 'Cyber Operations as a Use Of Force', in *Research Handbook of International Law and Cyber Space,* Edward Elger Publishing, 2015, p. 252.

[64] L. Du, 'Cyber-attacks on Space Activities: Revisiting the Responsibility Regime of Article VI of the Outer Space Treaty', in *Space Policy,* 63(2023), 2023, p. 2.

[65] Constitution of the International Telecommunication Union (ITU Constitution), 22 December 1992, Article 45.

[66] ITU, *Radio Regulations,* 1st Edition, 2020, Article 1.169.

installations, establishing an exception to the general regime[67]. This undermines the possibility of concretely limiting the use of jamming systems, which by definition are electronic counterspace weapons falling into the category of military radiocommunications installations[68]. Therefore, the provisions of the ITU Constitution would doubtfully apply to electronic interference with satellite systems, leading to the applicability of the more general regime established under the principle of non-intervention.

Therefore, even though Article IV does not provide for a comprehensive system of limitations with regard to the demilitarisation of Earth's orbit, some assistance in holding States accountable for their harmful activities against other spacecraft can be found by taking a closer look at general international law. For the sake of completeness, other provisions of the Outer Space Treaty could also reinforce the restrictions on the use of weapons in orbit, in particular Article IX, which prohibits activities that interfere with the use and exploration of outer space by other States.

c. The prohibition of harmful interference in the use and exploration of outer space

Outer space is an environment with characteristics that are obviously different from those of the Earth's environment. In particular, for its natural characteristics, outer space could be easily subject to intentional or unintentional contamination, affecting the use and exploration of outer space by the entire community of States involved in space activities[69]. The existence of such a risk justifies the existence in the Outer Space Treaty of a provision requiring States Parties to conduct their activities in with due regard for the interests of other States Parties.

Article IX of the Outer Space Treaty imposes an obligation of due diligence, aimed at ensuring that the exercise of rights by States in outer space do not interfere with corresponding interests of other States Parties or threatens the security of space operations[70]. Outer space activities are, by their very nature, ultra-hazardous activities, not only because of the unintentional transport of living and other matters extraneous to the outer space environment, but also because of the rapid circulation of space objects at the orbital speed in this context. And if the obligation in Article

[67] ITU Constitution, Article 48.

[68] T. Harrison, *et al., Space Threat Assessment 2022,* Centre for Strategic and International Studies, April 2022, p. 4.

[69] D.E. Terrill Jr., *The Air Force Role in Developing International Space Law*, Maxwell AFB, AL: Air University Press, 1999, p. 59.

[70] S. Hobe at al., *Cologne Commentary on Space Law: Outer Space Treaty,* p. 568.

IX applies to unintended consequences of space exploration, it applies even more so to intentional damages to other space objects[71], such as the use of ASAT weapons, given that, according to the wording of Article IX, such damage results from '[national] activities in outer space'.

This due diligence obligation is reinforced by the second sentence of Article IX, which requires States Parties to avoid harmful contaminations of outer space. Even if the wording of the Article refers only to studies and exploration activities, a contextual reading of this obligation, in light of the prohibition of harmful interference[72] in outer space established in the first sentence of Article IX, allows for an extension of the obligation to avoid harmful contamination also to any use of outer space[73] . Harmful contamination is a broad concept, covering all forms of harmful interferences, both deliberate and unintentional[74], and should also be read in conjunction with the principles of international environmental law, applicable in the outer space context thanks to Article III of the Outer Space Treaty. In particular, the principle of prevention, which requires States to ensure that activities within their jurisdiction or control do not cause damage to the environment of other States or of areas beyond the limits of national jurisdiction[75], including outer space[76], finds application in the legal framework under examination. More in detail, in the context of military activities, environmental obligation are enshrined in the First Additional Protocol to the Geneva Conventions, which prohibits the use of 'methods or means of warfare which are intended, or may be expected, to cause widespread, long-term and severe damage to the natural environment', and remains applicable in the event of hostilities in outer space[77]. However, in the absence of such hostilities, another international

[71] D.A. Cypser, 'International Law and Policy of Extraterrestrial Planetary Protection' in *Jurimetrics*, 33(2), 1993, p. 325.

[72] The notion of harmful interference in the context of Article IX has a sectoral meaning that must be distinguished from the notion of non-intervention examined in the previous paragraph.

[73] P. Achilleas, 'Planetary Protection-Legal Issues', in *Proceedings of the 46th Colloquium on the Law of Outer Space*, 2003, p. 215

[74] S. Hobe at al., Cologne Commentary on Space Law: Outer Space Treaty, p. 573.

[75] UNGA, *Declaration of the United Nations Conference on the Human Environment (Stockholm Declaration)*, A/CONF.48/14/Rev.1, 16 June 1972, Principle 21; *Rio Declaration on Environment and Development,* A/CONF.151/26, 12 August 1992, Principle 2.

[76] ICJ, *Legality of the Threat or Use of Nuclear Weapons, §29.*

[77] Protocol Additional to the Geneva Conventions of 12 August 1949, and relating to

instrument, i.e. the Convention on the Prohibition of Military or any Hostile Use of Environmental Modification Techniques (ENMOD Convention), clearly prohibits any military or hostile use of environmental modification techniques, i.e. 'techniques for changing - through the deliberate manipulation of natural processes - the dynamics, composition or structure of the Earth', including outer space[78]. All these commitments contribute to the definition of a complex legal construct from which further restrictions on the use of ASAT systems can be derived.

This legal structure clearly covers the use of kinetic weapons, taking into account their impact on the space environment. In particular, the production of space debris from the high-speed impacts or explosions is a form of harmful contamination in contrast with Article IX[79]. Thus, the destruction of space objects would be prohibited under this legal framework if it could result in the release of debris, also taking into account the likelihood of damage to other space objects, as successive impacts could lead to the so-called Kessler effect, i.e. the multiplication of potentially untraceable debris threatening the functioning of satellites in crowded orbits[80]. This risk, even in the absence of a clear ban on the use of kinetic ASAT systems or any system likely to produce debris, has led States to issue unilateral declarations committing themselves to refrain from testing these weapons[81], also in line with the recent General Assembly intervention calling on States not to engage in such testing activities[82].

However, this conclusion is only tenable in cases where weapons interfere with the functions of satellite systems used solely for civil purposes, while it should be excluded when these systems are used to perform military or other hostile functions. In the latter case, any form of interference would be justified by recourse to circumstances precluding wrongfulness, in particular self-defence as applicable not only to responses to violations of the prohibition on the use of force, but to any wrongful act

the Protection of Victims of International Armed Conflicts, 1125 UNTS 3, 8 June 1977, Article 35.

[78] Convention on the Prohibition of Military or any Hostile Use of Environmental Modification Techniques, 1108 UNTS 151, 10 December 1976, Articles 1-2.

[79] D. Zannoni, 'Out of sight, out of mind? The proliferation of space debris and international law', in *Leiden Journal of International Law,* 35, 2022, p. 300-301.

[80] D.J. Kessler, B.G. Cour-Palais, 'Collision Frequency of Artificial Satellites: The Creation of a Debris Belt' in *Journal of Geophysical Research*, 83(A6), 1978.

[81] E. Pobjie, *Outer Space, Military Uses of*, §7.

[82] UNGA, *Destructive Direct-Ascent Anti-Satellite Missile Testing*, UN Doc A/RES/77/41, 2022, §1.

under international law[83]. In addition, any hostile use of satellite weapons would also run contrary to the obligation of cooperation established in the first sentence of Article IX, therefore allowing the recourse to non-forcible countermeasures[84], including activities interfering with the normal functioning of satellite systems used to perform military functions.

The analysis in this paragraph has therefore attempted to show how hostile activity in outer space could potentially be considered also as a violation of the obligation under Article IX to have due regard for the interests of other Parties and to avoid any form of harmful interference. Thus, this violation is a wrongful act that allows States to be held responsible for the use of ASAT weapons in outer space as results clearly from the responsibility regime established under Articles VI and VII of the Outer Space Treaty previously examined.

5. *Conclusions*

The development of new and more sophisticated military technologies in outer space has proceeded at a pace that was hardly imaginable for the drafters of the Outer Space Treaty. In fact, new ASAT weapons are being programmed by the States more involved in the process of exploring and exploiting outer space, with the aim of taking control of a territory not subject to sovereign prerogatives. Therefore, the gap between law and technological development justifies the inadequacy of Article IV, whose objective was to establish clear obligations for the demilitarisation of orbits only limiting the deployment and testing of weapons of mass destruction in outer space.

However, as this paper has attempted to demonstrate, while the demilitarisation obligations are limited in scope, the drafters of the Outer Space Treaty have established other obligations that fill the gaps in the regulation of military activities in outer space. Indeed, States are obliged to comply with international rules, in particular the prohibition of the use of force and the principle of non-intervention, which would concretely limit the use of ASAT weapons if they could cause the destruction of property or the loss of functionality of critical infrastructure. The complexity of this

[83] ILC, A*rticles on the responsibility of States for Internationally Wrongful Acts,* Supplement No. 10 (A/56/10), November 2001, Article 21.

[84] *Ibid.,* Article 22, 49.

legal framework, which also prohibits interference with the interests of other States in the use and exploration of outer space in accordance with Article IX, helps to deter States from engaging in hostile activities in outer space that would result in a violation of the international norms by which they are bound.

This is reinforced by the presence in the Outer Space of a sectoral regime of responsibility, which clearly establishes a relationship between all the norms cited and the international responsibility of States conducting activities in outer space in contrast to them. This shows that the legal gaps often invoked by States to justify the potential use of military technologies in outer space can be filled by looking at the Outer Space Treaty in its complexity and at other international norms applicable to State activities in outer space. In light of the foregoing, a systematisation of these norms, as recently undertaken in the Woomera Manual, could be useful in order to have a clear picture of the scope of the prohibition of the military use of outer space, since the current state of international law is quite comprehensive but clearly needs to be integrated in order to avoid misinterpretation of existing norms and any risk of hostilities in outer space.

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After decades of exceptional development of the digital sector, we are witnessing a renewed interest of public and private entities in outer space, with the simultaneous presence of national defense and geopolitical strategic interests and new business interests aiming to profit. Technological evolution and the consequent growing role of space economy require, at all the domestic and international levels, more detailed and certain legal rules. Selected contributions from the conference "Comparative Visions in Space Law" have been collected in this book, reflecting the cross-boundary approach which characterized the event: dialogue among a multitude of disciplines and legal experiences, shaping new horizons of collaboration which are indispensable to understand the economic, geopolitical, diplomatic stakes of space law, and its technical aspects and difficulties.

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