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THE LEGALITY OF ELECTROMAGNETIC INTERFERENCE WITH MARITIME AUTONOMOUS VEHICLES

Tracy L Reynolds[*] and Hitoshi Nasu[**]

1. Introduction

With the growth of drones and their proven effectiveness in warfighting, parallel efforts have emerged to develop counter-drone capabilities. One such capability is electromagnetic interference, such as radio jamming and high energy lasers, to disrupt or deny access to radio frequency signals or spoofing by transmitting false signals. Intentional electromagnetic interference has been recognized as a serious problem since the 1990s.[1] Spectrum use has been reported in particular regions with the effect of disrupting radio communication or positioning, navigation and timing (PNT) signals.[2] The capability to intentionally interfere with the electromagnetic spectrum in a manner that disrupts communication or navigation, or disables infrastructure dependent upon the spectrum, could be used for military purposes.

With greater use and sophistication, electronic capabilities have the potential to be an effective tool to ensure safety of flight and navigation of sovereign vessels and aircraft in international waters and airspace. The use of electromagnetic interference could become

[*] Tracy Reynolds is a commander in the US Navy. All views expressed in this chapter are the authors' own and do not represent the official view of the US Government, the Department of Defense, or the Department of the Navy.
[**] Professor of Law, United States Military Academy, West Point; Senior Faculty Fellow, Lieber Institute for Law and Warfare, West Point; Senior Fellow, Stockton Center for International Law, United States Naval War College, Newport; Principal Visiting Research Fellow, University of Reading School of Law, United Kingdom.
[1] William A Radasky, 'Electromagnetic Warfare Is Here: A Briefcase-Sized Radio Weapon Could Wreck Havoc in Our Networked World' (*IEEE Spectrum*, 25 August 2014) <https://spectrum.ieee.org/electromagnetic-warfare-is-here>.
[2] See, for example, Emilio P Marcos and others, 'Interference and Spoofing Detection for GNSS Maritime Applications Using Direction of Arrival and Conformal Antenna Array' (Proceedings of the 31st International Technical Meeting of the Satellite Division of the Institute of Navigation, 24–28 September 2018) 2907–2922.

the capability of choice to ensure safety of flight or navigation in instances where uncrewed systems such as maritime autonomous vehicles (MAVs), physically pose a safety risk to sovereign vessels or aircraft in international waters or airspace. Also, these electronic capabilities may enable the coastal state to adopt a layered approach in the exercise of its jurisdiction and control over uncrewed systems passing through its territorial waters.

On the other hand, uncrewed systems themselves could, intentionally or unintentionally, generate electromagnetic interference that threatens maritime security. This threat poses particular concern for the safety of ships, including warships, navigating on the high seas. For example, uncrewed systems that are equipped to emit high power signals across a wide spectrum of frequency (out-of-band jamming) could cause disruption to communication and navigation signals that use neighboring slots against any ships within the reach of these signals. It is also plausible that high power signals and lasers are capable of causing disruption to the coastal state from the high seas.

This chapter considers the legality of electromagnetic interference with the navigation and communication of uncrewed systems, including MAVs, to ensure safety of flight and navigation in international waters. Also, this chapter considers electromagnetic interference in the exercise of enforcement jurisdiction under international law. It does so by examining the general obligation of due regard on the high seas, the coastal state's rights of protection within its territorial waters and, in the context of military vehicles, its obligations under general international law relating to the prohibition of the use of force.

2. Electromagnetic Interference

The electromagnetic spectrum (EMS), from the lowest to the highest frequency, includes all radio waves, infrared radiation, visible light, ultraviolet radiation, x-rays, and gamma rays. The EMS is a natural resource that allows military forces to sense, command, control, communicate, test, train, protect, and project force effectively. Private companies and other government entities also utilize the EMS for economic activities and governance. Although use does not

permanently deplete, deteriorate, or degrade the EMS, there are limits to the number of users the spectrum can accommodate.[3] Mismanagement, overuse, and misuse can result in interference with one another.[4] Users may also choose to utilize capabilities that interfere with other users' access to the EMS.[5] For this reason, electromagnetic interference has the potential to be both a risk and an enhancement to civil and military use of the spectrum. Electromagnetic interference could become a measure of choice that ensures the safety of sovereign vessels and aircraft and military personnel when afloat, aloft, and submerged.

Watch standers on a ship's bridge constantly monitor surrounding water and airspace. Their goal is to identify unsafe or unprofessional behavior, whether aloft, afloat, or submerged, in sufficient time to make necessary course corrections that ensure safety of platforms and personnel.[6] All ships, whether commercial or warships, require

[3] Due to this non-exclusive nature, EMS has been characterized as a global common: see Ignacio Nieto, 'The Electromagnetic Environment and the Global Commons: Are We Ready to Take the Fight to the Spectrum?' (2020) 29 *Journal of the Joint Air Power* 61; Marvin S Soroos, 'The Commons in the Sky: The Radio Spectrum and Geosynchronous Orbit as Issues in Global Policy' (1982) 36 *International Organization* 665; Kathryn M Queeny, *Direct Broadcast Satellites and the United Nations* (Alphen aan den Rijn: Sijthoff and Noordhoff, 1978) 17; Patrick S Ryan, 'Application of the Public-Trust Doctrine and Principles of Natural Resource Management to Electromagnetic Spectrum' (2004) 10 *Michigan Telecommunications and Technology Law Review* 285.

[4] Marvin S Soroos, 'The Commons in the Sky: The Radio Spectrum and Geosynchronous Orbit as Issues in Global Policy' (1982) 36 *International Organization* 665. See also John R Hoehn, Jill C Gallagher, and Kelley M Sayler, 'Overview of Department of Defense Use of the Electromagnetic Spectrum' (*Congressional Research Service*, 8 October 2020); Major Stéphane Ricciardi and Major Cédric Souque, *Modern Electromagnetic Spectrum Battlefield* (National Defense University Press, 2021).

[5] US Department of Defense, 'Electromagnetic Spectrum Superiority Strategy' (October 2020) 3, 6 < https://media.defense.gov/2020/Oct/29/2002525927/-1/-1/0/ELECTROMAGNETIC_SPECTRUM_SUPERIORITY_STRATEGY.PDF >; US Joint Chiefs of Staff, 'Joint Electromagnetic Spectrum Operations' (Joint Publication 3-85, 22 May 2020) <www.jcs.mil/Portals/36/Documents/Doctrine/pubs/jp3_85.pdf>; United Kingdom Department for Science Innovation and Technology, Spectrum Statement (11 April 2023) <www.gov.uk/government/publications/spectrum-statement/spectrum-statement>.

[6] Convention on the International Regulations for Preventing Collisions at Sea (adopted 20 October 1972, entered into force 15 July 1977) 1050 UNTS 16

water space to change course. The bigger the ship, the more time required to avoid collision. Weather and ocean conditions, such as wave height and visibility, are also important considerations.[7] Failure to identify a contact on an intercept course in time to move away could result in a collision. In addition, during launch and recovery of aircraft, ships must maneuver to leverage wind envelops necessary for safety of flight. At sea, divert locations on land are often unavailable. Instead, the ship is the landing zone.

Electronic capabilities may enhance current systems and monitoring techniques to ensure that sovereign vessels have the necessary maneuver space to maintain safety of navigation and flight. The EMS could provide an additional mechanism to counter unsafe or unprofessional activities by uncrewed systems that adversely affect warships on the high seas.

First of all, EMS technology may serve as a tool to electronically examine the uncrewed system to identify its flag state. EMS sensors on the ship, for example, scan the uncrewed system's surface searching for sound or radio waves that provide information through

(hereafter COLREGS) r 1 (stating that the rules apply to all vessels upon the high seas and all waters connected to the high seas and navigable by seagoing vessels). See also US Navy, US Marine Corps and US Coast Guard, *The Commander's Handbook on the Law of Naval Operations* (NWP 1-14M/MCTP 11-10B/COMDTPUB P5800.7A, March 2022) (hereafter *The Commander's Handbook*) para 2.5.2 (noting that 'Sovereign-immune vessels are not legally required to comply with such sea lanes and traffic separation schemes but may do so voluntarily where practicable and compatible with the military mission and navigational safety dictates'); 33 United States Code (hereafter USC) ss 1601–1608; US Navy Regulations 1990, art 1139 (directing all persons in the naval service responsible for the operation of naval ships and craft shall diligently observe the 1972 COLREGS).

[7] Note that meteorological and oceanographic support is critical to mission planning and execution. Factors to be considered include 'the range of atmospheric (weather) and oceanographic phenomena, from the sub-bottom of the Earth's oceans up to the top of the atmosphere and outward into space (space weather)… Oceanographic phenomena include the physical characteristics of the ocean such as waves, tides, and currents, as well as chemical and biological factors (e.g., salinity, marine mammals, bioluminescence), bathymetry, hydrography, and geophysics': US Joint Chiefs of Staff, 'Meteorological and Oceanographic Operations' (Joint Publication 3-59, 10 January 2018) <www.jcs.mil/Portals/36/Documents/Doctrine/pubs/jp3_59.pdf>.

the Automatic Identification System (AIS).[8] EMS scanning could even intrude into the electronic systems on board the uncrewed system to gather further information. This mechanism enables the commanding officer at the scene to resolve safety issues that are posed by an uncrewed system when there is no means to establish a contact in the absence of a ship master to communicate with or a physical space to board

Second, electromagnetic interference may be an effective option to ensure the safety of navigation and flight on the high seas and within international airspace. An afloat commander may come across an uncrewed system performing air maneuver that interferes with safe navigation or launch and recovery of aircraft. In situations where such unsafe maneuver does not rise to the level of hostile intent or hostile act, the commanding officer may use EMS capabilities to briefly block communication between the uncrewed system and its operator. Once communication between the system and its operator is restored, the uncrewed system is normally programmed to return to its designated home point.

Third, EMS technology provides an electronic means of taking control over uncrewed systems. For example, a high-power signal could be inserted over a specific frequency within the transmission window to disrupt optical communication networks that use the jammed slots (in-band jamming).[9] In this scenario, a false PNT

[8] AIS provides an electronic chart display that includes a symbol for every significant ship within radio range with velocity vector indicating speed and heading. AIS also provides ship name, course and speed, classification, call sign, registration number, and other information. AIS is a helpful tool that increases domain awareness, but it does not find or track all surface contacts in a particular area. Automatic Identification System (AIS) Overview available at <https://www.navcen.uscg.gov/how-ais-works>. Identifying and tracking aircraft in international airspace from the surface or subsurface is trickier. Generally, surface ships rely upon organic sensors, transponder radio signal codes (squawk), and voice communications to identify aircraft. Airborne collision avoidance systems required by the International Civil Aviation Organization focus on aircraft to aircraft collision risks.

[9] See, for example, C Jing and others, 'Experiment of Low-Power Laser Jamming Free Space Optical System' (2012) 41(5) *Infrared and Laser Engineering* 1266.

signal could direct an uncrewed system to an alternative destination, such as the coastal state's port.

The use of electromagnetic interference by a state surface vessel in international waters against an uncrewed system maneuvering on the high seas or in international airspace may be perceived as an infringement of the freedoms of navigation and overflight that are otherwise enjoyed by the uncrewed system. However, as discussed below, the freedoms of navigation and overflight are not unlimited and there are circumstances in which a state's surface vessel is entitled to take enforcement action or exercise the right of visit on the high seas. A state could also justify the use of electromagnetic interference against uncrewed systems as countermeasures or, in cases where electromagnetic interference rises to the level of a use of force, as an exercise of the right of self-defense as will be discussed in Section 5.

3. The Obligation of Due Regard

Crewed and uncrewed vessels, submersibles, and aircraft enjoy high seas freedoms of navigation and overflight in accordance with Article 87(1) of the UN Convention on the Law of the Sea (UNCLOS).[10] High seas freedoms come with legal obligations, that is, the freedoms of navigation and overflight shall, in all instances, be exercised with due regard for the interests of other states in their exercise of these same freedoms.[11] In addition, high seas freedoms shall be exercised with due regard for the coastal state's rights provided under UNCLOS.[12] Under the Chicago Convention, those who maneuver within international airspace above the high seas

[10] United Nations Convention on the Law of the Sea (adopted 10 December 1982, entered into force 16 November 1994) 1833 UNTS 397, art 87(1) (hereafter UNCLOS). See also Office of General Counsel, US Department of Defense, *Law of War Manual* (June 2015, updated July 2023) s 14.1.1.4; *The Commander's Handbook* (n 6) ss 2.7.2–2.7.2.2; US Department of Defense, 'Instruction 4540.01: Use of International Airspace by U.S. Military Aircraft and for Missile/Projectile Firings' (2 June 2015, incorporating Change 1, 22 May 2017) (hereafter US DoD Instruction 4540.01) enclosure 3, para 3(c)(1).
[11] UNCLOS (n 10) art 87(2).
[12] UNCLOS (n 10) arts 58(3), 142(1).

have a duty of due regard to other craft also so engaged.[13] While uncrewed aerial and surface systems are not specifically regulated under UNCLOS or the Chicago Convention, questions arise whether these systems fit within the existing legal architecture for peacetime maritime and air operations.[14]

Article 3 of the Chicago Convention exempts the application of rules to military or state aircraft. As such, military uncrewed aerial systems are exempt from compliance with ICAO flight rules and civil air traffic control protocols, but nonetheless they must fly with due regard for the safety of navigation of civil aircraft.[15] US Navy policy is that airborne uncrewed systems operated by its own forces are military aircraft and not required to observe ICAO flight procedures.[16] That is, the US regards uncrewed aerial systems as "military aircraft" within the meaning of Article 3 of the Chicago Convention. Military aircraft, however, must still operate with due regard to other users of airspace.[17] Even though military aircraft are exempt from ICAO rules, as a matter of policy, US and other state military aircraft conducting routine point-to-point flights in

[13] Convention on International Civil Aviation (adopted 7 December 1944, entered into force 4 April 1947) 15 UNTS 295 art 3(d). For its linkage with freedom of navigation on the high seas, see Kay Hailbronner, 'Freedom of the Air and the Convention on the Law of the Sea' (1983) 77 *American Journal of International Law* 490.

[14] James Kraska, 'The Law of Unmanned Naval Systems in War and Peace' (2010) 5 *Journal of Ocean Technology* 44 (arguing that UNCLOS and the Chicago Convention apply to uncrewed systems *mutatis mutandis*). See also *The Commander's Handbook* (n 6) s 2.4.4; James Kraska and others, 'Newport Manual on the Law of Naval Warfare' (2023) 101 *International Law Studies* 1 (hereafter The Newport Manual) 59, para 3.10. But see Craig H Allen, 'Determining the Legal Status of Unmanned Maritime Vehicles: Formalism vs Functionalism' (2018) 49 Journal of Maritime Law and Commerce 477, fn 104 (noting that invoking the concept of *mutatis mutandis* as an economy of drafting device assumes that treaty drafters intended application of the rule sets to uncrewed systems).

[15] US DoD Instruction 4540.01 (n 10) ss 3.d, 3.e; *The Commander's Handbook* (n 6) ss 2.1, 2.3.5, 2.7.2.1, 2.4.4, 2.9.1.

[16] *The Commander's Handbook* (n 6) s 2.9.1.

[17] Ibid, s 2.9.3.

international airspace voluntarily adhere to ICAO flight procedures beyond the basic obligation of due regard.[18]

In this part, it is argued that a breach of the due regard obligation may represent a safety issue to others engaged in lawful activities on, under, or above the high seas. In such situations, electromagnetic interference could be considered a reasonable means to negate the safety issue. Moreover, UNCLOS has reinforced the importance of showing due regard for navigational safety in Article 109, contemplating the threat posed to states by unlawful broadcasting. The discussion below considers EMS within the frame of unlawful broadcasting under Article 109 of UNCLOS, as well as its use as part of the right of visit under Article 110.

3.1 Freedom of Navigation and Flight

Uncrewed systems, including MAVs and remotely piloted craft capable of watercourse navigation, enjoy the freedoms of navigation on the high seas as long as the system qualifies as a ship.[19] The right of freedom of navigation means 'unimpeded passage',[20] but its exercise is subject to other rules under UNCLOS and general

[18] Ibid, s 2.7.2.2 (noting that various operational situations do not lend themselves to ICAO flight procedures, including but not limited to military contingencies, classified missions, politically sensitive missions, or routine aircraft carrier operations. Operations not conducted under ICAO flight procedures are conducted under the due regard standard).

[19] For debates regarding the legal characterization of maritime autonomous vehicles, see Hitoshi Nasu and David Letts, 'The Legal Characterization of Lethal Autonomous Maritime Systems: Warship, Torpedo, or Naval Mine?' (2020) 96 *International Law Studies* 79; Yen-Chiang Chang, Chao Zhang and Nannan Wang, 'The International Legal Status of the Unmanned Maritime Vehicles' (2020) 113 *Marine Policy* 103830; Natalie Klein, 'Maritime Autonomous Vehicles Within the International Legal Framework to Enhance Maritime Security' (2019) 95 *International Law Studies* 244, 251–253; Robert Veal, Michael Tsimplis and Andrew Serdy, 'The Legal Status and Operation of Unmanned Maritime Vehicles' (2019) 50 *Ocean Development and International Law* 23; Daniel AG Vallejo, 'Electric Currents: Programming Legal Status into Autonomous Unmanned Maritime Vehicles' (2015) 47 *Case Western Reserve Journal of International Law* 405; Stephanie Showalter, 'The Legal Status of Autonomous Underwater Vehicles' (2004) 38 *Marine Technology Society Journal* 80.

[20] *Arctic Sunrise (Netherlands v Russia)* (Award on the Merits of 14 August 2015) PCA Case No 2014-02, para 227.

international law.[21] One such rule is the obligation of due regard under Article 87 of UNCLOS. Due regard applies to uncrewed systems including MAVs operating on or under the high seas and systems aloft in international air space, whether that system is autonomous or remotely piloted.[22]

An uncrewed system engaging in afloat, submerged, or aloft activities that can be reasonably characterized as unsafe or unprofessional is likely acting contrary to due regard obligations. This lack of due regard by the uncrewed system can cause injury, death, or loss of platform.[23] An uncrewed system using

[21] Douglas Guilfoyle, 'High Seas: Articles 86-111' in Alexander Proelss (ed), *United Nations Convention on the Law of the Sea: A Commentary* (CH Beck, 2017) 675–779, 681–682.

[22] *The Commander's Handbook* (n 6) ss 2.1, 2.2.1, 2.3.3, 2.3.5, 2.7.2.1, 2.4.4, 2.9.1. See also The Newport Manual (n 14) para 3.3; Comité Maritime International, International Working Group Position Paper on Unmanned Ships and the International Regulatory Framework 6 (the requirements of UNCLOS art 94 can 'arguably be met in case of remotely operated ships' and 'existing international conventions that define the term "ship" do not include references to crewing and at the national level … the definition of a ship is usually disconnected from the question of whether or not the ship is manned').

[23] Clearly, an uncrewed aerial system (UAS) strike on an aircraft is a serious safety issue. However, research is ongoing to quantitatively document exactly what to expect from its strike on different types of civil and military aircraft. In the absence of these findings, consider the impact of wildlife strikes on aircraft. In 2021, the Federal Aviation Administration (FAA) projected that wildlife strikes cost the U.S. aviation industry $328 million. From 1998 to 2021, more than 300 people were killed because of wildlife strikes aloft and nearly 300 aircraft were destroyed worldwide. In the U.S. in the last six months, more than 2,300 wildlife strikes have been reported. Preliminary FAA research has shown that UAS can cause significantly more damage than birds. Current tests cannot be transferred from birds to UAS since key components (motor, battery, camera) contain materials that are much denser and stiffer than birds (which are typically modeled as a fluid since they are over 70% water). An FAA study comparing bird and drone strikes found that airborne collisions, 'could introduce a significant economic burden to aircraft operators due to downtime and repairs'. Whether a UAS is sucked into an engine intake or collides with the aircraft, physical damage or loss of life could occur. See for example, 'Drone Strike on Aircraft Research' <https://www.easa.europa.eu/en/research-projects/desire>; Hannah Sampson, 'How Dangerous Are Bird Strikes to Planes?' (*The Washington Post*, 25 April 2023) <www.washingtonpost.com/travel/2023/04/25/bird-strike-plane-american-airlines/>; Alliance for System Safety of UAS through Research Excellence <www.assureuas.org/research-template/#>; 'Drone Collisions "Worse than Bird

electromagnetic interference as a means to prevent another vessel or aircraft's use of the EMS for communication or navigation may also cause harm to embarked personnel or platforms. Such interference could also reasonably be interpreted as contrary to the due regard obligation under UNCLOS.

Due regard is agnostic as to the uncrewed system's intent. Whether that system's maneuver or flight pattern is caused by incompetence, inexperience, poor judgement, technical failure, or other factors, due regard requires that the uncrewed system share international airspace, the high seas, and the water column in a way that avoids adversely affecting 'the use of the high seas by nationals of other States'.[24] States are required to abstain from activities that unreasonably interfere with the exercise of rights by other states, which depends on their importance, the extent of the anticipated impairment, the nature and significance of the impairing activities, and the availability of alternative approaches.[25]

If an uncrewed system maneuvers in international airspace, on the high seas, or within the water column in a manner that forces another vessel or aircraft to react in order to maintain safe navigation or flight, its maneuver may reasonably be characterized as adversely affecting another vessel or aircraft's use of the high seas or international airspace. Such activity by the uncrewed system is likely to constitute unreasonable interference with the freedom of navigation and flight exercised by other states, contrary to Article 87's due regard obligation. A warship maneuvering to avoid an uncrewed system (eg, repositioning either to avoid collision or to preserve wind envelopes so that aircraft may land aboard) may not be able to accomplish military objectives. In such a case, physical interference with a ship or aircraft's operation, 'as well as damage

Strikes for Planes"' *British Broadcasting Corporation* (5 November 2017) <https://www.bbc.com/news/technology-42238115>.

[24] International Law Commission, *Commentaries to the Articles Concerning the Law of the Sea*, UN Doc. A/3159 (1956) 278.

[25] *The 'Enrica Lexie' Incident (Italy v India)* (Award of 21 May 2020) PCA Case No 2015-28, paras 973-81*; Chagos Marine Protected Area Arbitration (Mauritius v United Kingdom)* (Award of 18 March 2015) PCA Case No 2011-03, para 519.

to the object of their activities',[26] could reasonably be construed as an infringement of the due regard obligation under Article 87 of UNCLOS.

3.2 Unauthorized Broadcasting

Article 109 of UNCLOS prohibits unauthorized broadcasting from the high seas, which is a special class of interference in breach of the obligation of due regard. Unauthorized broadcasting means 'the transmission of sound radio or television broadcasts from a ship or installation on the high seas intended for reception by the general public contrary to international regulations'. This prohibition excludes the transmission of distress calls. On the high seas, any person or ship engaged in unauthorized broadcasting can be seized and arrested when a state is allocated jurisdiction over it. UNCLOS goes beyond the traditional principle of exclusive flag state jurisdiction in this respect, allowing any states where unauthorized transmissions are received or authorized radio communication suffers interference to exercise a concurrent jurisdiction over unauthorized broadcasters.

Article 109 takes its aim at unauthorized broadcasts that may clog emergency frequencies and interfere with sea and air traffic control channels, thus jeopardizing maritime security.[27] As such, the primary state interest at play is to deter the use of broadcasting that negatively impacts the state's interest in spectrum management and access to EMS channels as regulated under the International Telecommunication Union.[28] Its regulatory focus does not reside in the safety of navigation and flight.

Nevertheless, when viewed through the lens of due regard requirements, Article 109 may be interpreted as also having a collateral purpose grounded in safety considerations. A broadcast

[26] Bernard H Oxman, 'The Regime of Warships under the United Nations Convention on the Law of the Sea' (1983) *Virginia Journal of International Law* 809, 827. See also COLREGS (n 6) r 2.
[27] Douglas Guilfoyle, *Shipping Interdiction and the Law of the Sea* (CUP 2009) 1701–1771.
[28] Constitution and Convention of the International Telecommunication Union (adopted 22 December 1992, entered into force 1 July 1994) 1825 UNTS 330.

relayed out of compliance with international telecommunication regulations could compromise radio communications on the high seas regarding distress calls, safety of flight, or safety of navigation. An unauthorized broadcast could monopolize spectrum bandwidth such that those engaged in high seas freedoms are not technologically capable of communications, or other lawful activities, reliant upon the spectrum. In addition, an uncrewed system's maneuver on the high seas' surface, within the water column, or in international airspace may also jeopardize safety of flight or safety of navigation. These potential safety issues may be mitigated by a sovereign vessel or aircraft using EMS capabilities.

Pursuant to Article 109(4) of UNCLOS, states are granted extra-territorial high seas enforcement jurisdiction over the whole vessel (or structure engaged in unauthorized broadcast) and all persons and equipment aboard. Israel, as the sole objector, requested deletion of enforcement powers, characterizing Article 109 as using 'a dreadnought to crack a sea-snail' and noting that Article 109 could be an 'unjustified interference with the freedom of navigation and certain basic human rights that should be exercisable on the high seas'.[29] Guilfoyle postulates that the lack of state objection to the inclusion of enforcement powers in Article 109, as compared with Article 108 on trafficking in narcotic drugs and psychotropic substances, indicates that Article 109 is less prone to abuse or use as a pretext for intervention.[30] Guilfoyle further expounds that while many vessels legitimately carry drugs, few engage in broadcasting, and Article 109's enforcement jurisdiction does not appear to have ever been used.[31] However, with the widespread use of MAVs generating electromagnetic interference, it could enable sovereign ships to exercise enforcement jurisdiction against MAVs (except for those sovereign immune), even in situations where their own freedom or safety of navigation is not in danger.

3.3 The Right of Visit

[29] Third United Nations Conference on the Law of the Sea, 163rd Plenary Meeting, UN Doc A/CONF.62/SR.163 (10 December 1982) 56, para 54.
[30] Guilfoyle, 'High Seas: Articles 86-111' (n 21) art 108, para 6.
[31] Ibid.

During the regular course of military and civilian operations at sea, watch standers regularly communicate with other watch standers.[32] Bridge to bridge communications in real time are a normal part of maintaining a common operating picture. Regular communications also ensure safety at sea. If a watch stander determines that any craft, whether afloat or aloft, is maneuvering in an unsafe or unprofessional manner, the watch stander will likely attempt to establish communications with that particular craft. If the craft is non-responsive, this fact becomes part of the common operating picture the on-scene commander will use as the basis for additional analysis to determine whether this particular craft is a threat to safety.

If a watch stander identifies an uncrewed system, attempts bridge-to-bride communication, and that system remains unresponsive, the on-scene commander must decide whether this interaction is safe and professional or a risk to safety. Any such decision will likely be heavily influenced by time sensitive information gathered by organic shipboard sensors and interpreted by watch standers. The on-scene platform commander's primary concern is safety of navigation and flight. Safety of flight is particularly important if the platform is engaged in the launch and recovery of military aircraft. In this situation, where the system is acting contrary to its due regard obligation, Article 110 of UNCLOS provides a legal basis, *mutatis mutandis*, to utilize the electromagnetic spectrum to ensure safety of navigation and flight.

Article 110 of UNCLOS grants a warship or military aircraft authority to board a foreign ship or aircraft under certain circumstances. This right of visit may only be exercised if the warship or military aircraft reasonably believes that the ship or aircraft to be visited is not a warship or military aircraft of another state or a warship/aircraft used exclusively on government non-commercial service. Also, the warship or military aircraft must reasonably believe that the ship/aircraft to be visited is (1) engaged in piracy, the slave trade, or unauthorized broadcasting, (2) is

[32] COLREGS (n 6) r 5.

without nationality, or (3) is actually under the same flag as the warship.

Visit in the maritime environment is normally executed by a small boat sent out by the ship exercising the right of visit to inspect the flag documentation of the questionable ship. If suspicion remains after examination of documents, the visiting officer may choose to board the questionable ship and conduct further inspections. If upon examination of documents, the inspecting ship determines no wrongdoing and that suspicions were unfounded, the visited ship is entitled to compensation for any loss or damage that may have been sustained during the visit.

The right of visit granted under Article 110 of UNCLOS can be exercised against unauthorized broadcast as one of three exceptions to the general principle of international law that a vessel on the high seas is ordinarily subject to the exclusive jurisdiction of its flag state and therefore immune from interference by foreign vessels. While recognizing that all states have some general police powers to maintain minimum public orders on the high seas, Guilfoyle finds no unifying principle underlying Article 110 either in terms of the subject matters covered or the powers allocated.[33] Klein, on the other hand, identifies as a common theme the deference to exclusive flag state authority over vessels on the high seas despite the seriousness of these problems that have been recognized.[34]

An uncrewed system's use of the spectrum such that a sovereign craft cannot access necessary communications channels might, in and of itself, present a safety issue. The basis for a right of visit in accordance with Article 110 is safety, not spectrum access or regulation. As Justice Joseph Story observed in the 1825 decision in *The Marianna Flora*, the right of visit for the purpose of ascertaining the real characters of any vessels descried at sea is 'indispensable for the fair and discreet exercise of their authority' to arrest pirates and 'other public offenders'.[35] Access to the EMS is a component

[33] Guilfoyle, *Shipping Interdiction and the Law of the Sea* (n 27) 24.
[34] Natalie Klein, *Maritime Security and the Law of the Sea* (OUP 2011) 117–118.
[35] *The Marianna Flora* 24 US 1, 43–44 (1825).

part of military and commercial activities at sea and in the air. Unsafe or unprofessional physical maneuver by the uncrewed system afloat on the surface, in the water column, or in the air is the reason why a warship would require knowledge of that uncrewed system's flag state. Further, the inability to determine whether the uncrewed system shares the same nationality with the warship, or is without nationality, serves as the additional basis that triggers access to the right of visit under Article 110. All is predicated on safety of navigation and flight.

The right of visit can also be exercised in cases where a watch stander monitoring the conditions surrounding a sovereign craft has identified an uncrewed system as a contact of interest without any indication of its engagement in piracy, the slave trade, or unauthorized broadcasting when there is limited information about the system's nationality or flag state.[36] This watch stander could be on a watch floor ashore as part of the warship's higher headquarters staff, on board the warship itself, or aboard a mother ship engaged in uncrewed system operations afloat. In any of these described instances, the warship's commander may use Article 110 as the legal basis to gather additional details about its nationality or to determine whether the system is actually under the same flag as the warship. At this point, the warship would have already hailed the system and attempted, but failed to engage in, bridge-to-bridge communications with its operator.

A range of efforts may take place on board the warship to gather relevant information about the uncrewed system, all in the pursuit of safety of navigation and flight. If there is no response from the system, no modes or codes provide identifying information, visual observation has not determined a tail number or other identifying marks, and shipboard electronic sensors cannot determine identifying characteristics of the uncrewed system such as a pre-

[36] The right of visit can arguably be exercised to identify the enemy character of a ship during an international armed conflict: See Himanil Raina, 'A Unified Understanding of Ship Nationality in Peace and War' (2022) 116 *American Journal of International Law* 731.

logged flight path, the warship may not be able to identify a flag state or remote operator.

These circumstances may provide a sufficient basis to justify the use of EMS capabilities for probing as an exercise of the right of visit. However, if the suspicion proves to be unfounded, the state that conducted the visit owes an obligation to compensate for any loss or damage sustained as a result.[37] In the event of property loss within US territorial waters, the military federal claims system is one method by which a remote operator could be compensated for any loss or damage sustained when a warship exercises the right to visit via the EMS.[38]

These procedures could be followed below the use of force and prior to the uncrewed system demonstrating a hostile intent or committing a hostile act. In this and similar situations, EMS technology provides a non-kinetic means to ensure safety of navigation and flight. It is reasonable to expect that other sea-faring nations may follow similar procedures if they encounter an uncrewed system under similar circumstances. These procedures could be abused to interfere with the legitimate operation of an uncrewed system with appropriate identification and within the authorized band of EMS. The potential abuse of the right to visit via the EMS is an important policy consideration. However, the potential of future abuse does not negate the legality of using electronic capabilities in the exercise of the right of visit pursuant to Article 110 of UNCLOS.

3.4 Self-Help

The right of visit does not of itself imply any further powers of law enforcement beyond those powers of visit, inspection, and search provided for in Article 110. Powers of detention and arrest must be found elsewhere in the UNCLOS (for example, Articles 105, 109,

[37] UNCLOS (n 10) art 110(4).
[38] The US Navy's Admiralty and Claims Division (Code 15) has worldwide responsibility for processing different types of claims under various statutes and regulations. Code 15 manages the Navy's Claims System pursuant to the Suits in Admiralty Act (SIAA) 46 USC ch 309; Public Vessels Act (PVA) 46 USC ch 311; Federal Tort Claims Act (FTCA), 28 USC ss 1346(b), 2671–2680; Military Claims Act (MCA) 10 USC ss 2733; Foreign Claims Act (FCA) 10 USC s 2734.

and 111) or must be granted by the flag state of the vessel subjected to visit and inspection. However, a sovereign craft can avail itself of other means of securing the safety of navigation on the high seas and overflight in international airspace by way of self-help. Such measures include the use of EMS capabilities against an uncrewed system to change its course by means of spoofing or to overpower and disrupt the uncrewed system's signal connection to the unknown remote operator.[39] Many small uncrewed aerial systems are designed such that, if signal connection to the operator is broken, they return to the last known signal location. There is also the possibility that the system, upon break in signal, will suffer a malfunction and splash.

The use of electromagnetic interference by a state surface vessel in international waters against an uncrewed system maneuvering on the high seas or in international airspace in order to alter the latter system's flight pattern may be perceived as an infringement of the freedoms of navigation and overflight that are otherwise enjoyed by the uncrewed system. However, the state can justify such an action, to the extent that it does not amount to a use of force, as a countermeasure in response to an internationally wrongful act committed by another state responsible for the operation of the

[39] Historically, a Naval on-scene commander was the decision-maker closest to the physical action; the person making the decision with full awareness of the tactical situation. Rule 5 of COLREGS requires every vessel to 'at all times maintain a proper look-out by sight as well as by hearing…'. An uncrewed system could only comply with COLREGS, as currently written, if Rule 5 is interpreted to include data communicated to the remote operator via onboard sensors, cameras, or microphones. That is, on board capabilities as analogous to direct observation by human senses. As technology advances, the term 'on-scene commander' may develop to encompass the decision-maker with access to sensor feeds and the authority to make navigational decisions. COLREGS may simply be interpreted in a manner that encompasses these technological considerations or modification to the treaty may be necessary. The International Maritime Organization (IMO) is considering a code specific to maritime autonomous surface ships. See IMO, 'Regulatory Scoping Exercise for the Use of Maritime Autonomous Surface Ships (MASS): Report of the Working Group' (23 May 2018) IMO Res MSC.99/WP.9; IMO, 'Report of the Maritime Safety Committee on Its Ninety-Ninth Session' (5 June 2018) IMO Res MSC/99/22; IMO, 'Outcome of the Regulatory Scoping Exercise for the Use of Maritime Autonomous Surface Ships (MASS)' (3 June 2021) IMO Res MSC.1/Circ.1638.

uncrewed system.[40] In cases where an uncrewed system threatens the safety of navigation in breach of its due regard obligation, an altercation to its course of flight can be a proportionate measure aimed to induce a return to compliance with international law.[41] Prior to taking action, the state must notify the responsible state of its intention to take countermeasures unless there is an urgent need to preserve its rights, such as freedom of navigation.[42]

Further, as will be discussed below, certain electromagnetic interference could be interpreted as amounting to a use of force or could be perceived as an action in advance of a use of force. Actions on the spectrum that are perceived as escalatory in nature could lead to additional responses between the sovereign vessel and the system's remote operator that culminate in kinetic action. Under such circumstances, a state may justify the use of electromagnetic interference to intercept an impending attack as an exercise of the right to defend its vessels from attacks, including those that undermine navigational rights and freedoms.[43] Even in cases where the armed attack is still incipient and has not yet materialized, the fact that an uncrewed system has been launched to cause damage is sufficient to justify forcible action.[44] The state does not owe an obligation to compensate for any damage that may be sustained as a result.

4. The Coastal State's Rights of Protection

The use of electromagnetic interference with a foreign-flagged MAV, to alter its course of navigation or to exercise jurisdiction over it, is an infringement of freedom of navigation guaranteed under UNCLOS. However, the coastal state has the right of

[40] Articles on the Responsibility of States for Internationally Wrongful Acts, GA Res 56/83 (12 December 2001) art 49.
[41] Ibid, art. 51.
[42] Ibid, art. 52.
[43] SC Res 2722 (10 January 2024) para 3. Whether this right has an independent legal basis in maritime practice or emanates from the State's right of self-defense was left unclear during the Security Council debate at the 9527th meeting, UN Doc S/PV.9527 (10 January 2024).
[44] Yoram Dinstein, *War, Aggression and Self-Defence* (6th edn, Cambridge University Press, 2017) 231-233.

protection provided for in Article 25(1) of the Convention in situations where the vehicle engages in non-innocent passage as defined in Article 19, such as intelligence gathering and the operation of any military device.

Article 25(1) of the Convention empowers the coastal state to 'take the necessary steps in its territorial sea to prevent passage which is not innocent'. What 'necessary steps' the coastal state is entitled to take is open to interpretation. Churchill and Lowe, for example, contemplated these steps might include the right to exclude the offending vessel from the territorial sea, making an arrest and instituting proceedings before municipal courts in cases where it has violated a coastal law, or even the use of force if the coastal state faces an imminent attack.[45] In their view, some breaches of coastal state laws may deprive the offending state's vessel of its right to innocent passage and therefore, electromagnetic interference would be considered as a reasonable means to exercise the coastal State's right of protection.

Gill, on the other hand, distinguishes this coastal state's right of protection from the enforcement of its laws and regulations relating to innocent passage and navigational safety as provided for in Articles 21 and 22 of the Convention.[46] In his view, the coastal state cannot justify measures of protection to enforce its laws and regulations against any ships even if violation involves an infringement of international law relating to navigational safety.[47]

[45] RR Churchill and AV Lowe, *The Law of the Sea* (3rd edn, Manchester University Press, 1999) 99.
[46] TD Gill, 'The Forcible Protection, Affirmation and Exercise of Rights by States under Contemporary International Law' (1992) 23 *Netherlands Yearbook of International Law* 105, 134.
[47] Cf Joint Statement by the United States of America and the Union of Soviet Socialist Republics 'Uniform Interpretation of Norms of International Law Governing Innocent Passage' (signed on 23 September 1989) para 5 ('Ships exercising the right of innocent passage shall comply with all laws and regulations of the coastal State adopted in conformity with relevant rules of international law as reflected in articles 21, 22, 23, and 25 of the Convention of 1982. These include the laws and regulations requiring ships exercising the right of innocent passage through its territorial sea to use such sea lanes and traffic separation schemes as it may prescribe where needed to protect safety of navigation').

The ability of the coastal state to interfere with the MAV's GNSS signals to alter its course of navigation, for example, for avoiding collision with another ship, is therefore denied.

Interpreting it with the presumption of full residual sovereign powers in the territorial sea,[48] it is reasonable to assume that states enjoy a wide discretion on how they respond to non-innocent passage.[49] State response to non-innocent passage is likely circumscribed by first attempting communication with the offending ship/aircraft to inform that ship/aircraft of the reasons why the coastal state questions the innocence of the passage and the provision of a reasonable opportunity for the offending vessel to clarify intentions or correct conduct in a reasonably short period of time.[50] The way in which the coastal state exercises enforcement jurisdiction at its discretion may vary, but typically involves requesting information, warning communications, warning shots, interdiction, boarding and inspection. The use of electromagnetic interference will provide the coastal state with an additional means to exercise its sovereign powers against MAVs engaged in non-innocent passage.

In practice, the coastal state would likely integrate electromagnetic interference into the range of response options available when a MAV is suspected of non-innocent passage in the coastal state's territorial sea. A remotely piloted or autonomous surface vessel, as previously discussed,[51] may well be entitled to innocent passage through a coastal state's territorial sea as provided in UNCLOS. If a MAV is suspected of non-innocent passage, such a suspicion would

[48] Ivan Shearer, 'The Development of International Law with Respect to the Law Enforcement Roles of Navies and Coast Guards in Peacetime' (1998) 71 *International Law Studies* 429, 433; Ivan A Shearer, 'Problems of Law Enforcement and Jurisdiction Against Delinquent Vessels' (1986) 35 *ICLQ* 320, 326–327.
[49] Richard Barnes, 'Article 25: Rights of Protection of the Coastal State' in Alexander Proelss (ed), *United Nations Convention on the Law of the Sea: A Commentary* (CH Beck, 2017) 222, 224. See also *The Commander's Handbook* (n 6) s 2.5.2.1.
[50] *The Commander's Handbook* (n 6) s 2.5.2.2.
[51] See further, Natalie Klein, 'Maritime Autonomous Vehicles: Challenges and Opportunities under International Law' in this volume.

likely be a reasonable inference based on details observed by watch standers afloat or ashore, organic sensors on board local Coast Guard vessels, or other methods.[52] Any non-innocent passage activities observed by the coastal state, either afloat or ashore, would likely lead to attempts to communicate with the MAV suspected of non-innocent passage.

If communication attempts by the coastal state are met with no response, the coastal state could reasonably rely upon electromagnetic interference to redirect the MAV to inspection at a coastal state's port. If the MAV is engaged in activities that make it a hazard to navigation for other vessels in the area, a coastal state could rely upon any relevant domestic statutory authority to require the MAV to leave the area. Electromagnetic interference or jamming could serve as a tactical mechanism by which the coastal state could enforce domestic legal authorities and exercise enforcement jurisdiction in the territorial sea.

If the MAV responds to coastal state hails and queries via bridge to bridge or other communication channels, the coastal state may collect information about the MAVs intent and scheme of maneuver directly from the remote operator or other flag state representative. If the MAV reiterates that it is engaged in innocent passage, the coastal state would likely then consider these responses to query against data collected by watch standers and sensors observing the MAV's activities. If the coastal state reasonably believes, based on the common operating picture and the MAV's activities, that the MAV is engaged in non-innocent passage then the coastal state could turn to the EMS as a mechanism by which to exercise its sovereign powers in the territorial sea.[53]

In addition, there are limited grounds upon which the coastal state is authorized to exercise criminal jurisdiction on board a foreign-

[52] See further, Simon McKenzie, 'The Future of Ocean Technology and Navigational Rights in the International Law of the Sea' in this volume.
[53] Such an option could become available in the Port State Measures Agreement. See: Agreement on Port State Measures to Prevent, Deter and Eliminate Illegal, Unreported and Unregulated Fishing (adopted 22 November 2009, entered into force 5 June 2016) [2016] ATS 21.

flagged commercial ship passing through the territorial sea.[54] It is plausible to envisage a situation where a privately owned MAV is suspected of carrying narcotic drugs or psychotropic substance for illicit traffic. In the absence of a ship master to communicate with, the coastal state may find the need to employ electromagnetic means to control and seize the MAV, especially when the weather conditions are not seaworthy. The obligation to notify a diplomatic agent or consular officer of the flag state before taking any steps would become moot as it is conditioned upon the request by the ship master.[55]

When the MAV is owned or operated by a foreign government, the coastal state's ability to use electromagnetic interference against it hinges upon the legal status of the MAV and the modality of immunities accorded to it. If it qualifies as a warship,[56] the coastal state can only require it to leave the territorial sea,[57] but it is debatable whether the use of electromagnetic interference is prohibited as a means of changing its course. Even if it does not qualify as a warship, government owned or operated MAVs are granted sovereign immunity.[58] But the question is whether the interference with the navigation of government owned or operated

[54] Article 27(1) of UNCLOS provides: 'The criminal jurisdiction of the coastal State should not be exercised on board a foreign ship passing through the territorial sea to arrest any person or to conduct any investigation in connection with any crime committed on board the ship during its passage, save only in the following cases:

(a) if the consequences of the crime extend to the coastal State;
(b) if the crime is of a kind to disturb the peace of the country or the good order of the territorial sea;
(c) if the assistance of the local authorities has been requested by the master of the ship or by a diplomatic agent or consular officer of the flag State; or
(d) if such measures are necessary for the suppression of illicit traffic in narcotic drugs or psychotropic substances'.

[55] UNCLOS (n 10) art 27(3).

[56] For this debate, see David Letts and Raul (Pete) Pedrozo, 'Maritime Drones at War: Legal Issues Affecting Characterization and Use' in this volume. See also Nasu and Letts, 'The Legal Characterization of Lethal Autonomous Maritime Systems' (n 19).

[57] UNCLOS (n 10) art 30.

[58] See James Kraska, 'Sovereign Immunity of Unmanned Maritime Vehicles' in this volume.

MAVs amounts to an exercise of the coastal state's jurisdiction in violation of sovereign immunity when, for example, its sole purpose is to turn them away from the territorial sea rather than boarding or inspecting them.

5. The Prohibition of Use of Force

Generally speaking, the use of electromagnetic interference does not constitute a use of force prohibited under Article 2(4) of the UN Charter and its equivalent under customary international law.[59] For example, Russia has been using jamming to interfere with the operation of US unmanned aircraft operating in Syria and the Black Sea.[60] Iran allegedly combined the jamming of satellite signals and the spoofing of geolocational data to capture the RQ-170 Sentinel unmanned aerial vehicle operated by the US government.[61] The United States, for its part, deployed Marine Air Defense Integrated System (MADIS) to bring down an Iranian drone that came close, ignoring multiple calls to stand down in the Strait of Hormuz, by

[59] Charter of the United Nations (opened for signature 26 June 1945, entered into force 24 October 1945) 1 UNTS XVI, art 2(4); *Military and Paramilitary Activities in and against Nicaragua (Nicaragua v United States)* (Merits) [1986] ICJ Rep 14, paras 188–190.

[60] See, for example, Theresa Hitchens, '"Local" Russian GPS Jamming in Ukraine Hasn't Affected US Support Ops, So Far' (*Breaking Defense*, 1 March 2022) <https://breakingdefense.com/2022/03/local-russian-gps-jamming-in-ukraine-hasnt-affected-us-support-ops-so-far/>; Ben Brimelow, 'Russian Military Jamming in Syria Is Seriously Affecting US Drones' (*Insider*, 10 April 2018) <www.businessinsider.com/russia-military-jamming-syria-affecting-us-drones-2018-4>.

[61] Scott Peterson and Payam Faramarzi, 'Exclusive: Iran Hijacked US Drone, Says Iranian Engineer' (*Christian Science Monitor*, 15 December 2011) <https://www.csmonitor.com/World/Middle-East/2011/1215/Exclusive-Iran-hijacked-US-drone-says-Iranian-engineer>. However, some experts doubt the credibility of this claim: Mark Clayton, 'Did Iran Hijacked the "Beast"? US Experts Cautious about Bold Claims' (*Christian Science Monitor*, 16 December 2011) <www.csmonitor.com/USA/Military/2011/1216/Did-Iran-hijack-the-beast-US-experts-cautious-about-bold-claims>.

jamming its communications.[62] No allegation has been made about the use of force in any of these incidents. Even in situations of armed conflict, the jamming of radio communications or television broadcasts has not traditionally been considered as an attack to which various targeting law rules apply.[63]

With the increased power levels of laser with different wavelengths, it is plausible to expect that certain types of electromagnetic interference, such as high-energy laser weapons, are capable of directly causing physical damage to MAVs.[64] These types of electromagnetic interference will become more akin to conventional arms due to their ability to cause physical harm directly. Questions then arise as to what degree of interference would amount to a use of force and whether it can be justified as an exercise of the right of protection within its territorial sea or as an exercise of the right of self-defense further ashore.

What precisely constitutes a use of force prohibited under international law remains a subject of debate. However, an increasing number of states have subscribed to the view that hostile activities by non-traditional means, such as cyber operations, may constitute a use of force when the scale and effect of such activities are comparable to those of a conventional act of violence prohibited under international law.[65] It is therefore plausible to argue that

[62] Kate O'Flaherty, 'U.S. Warship Took Down Iranian Drone Using New "Jamming" Technology' (*Forbes*, 22 July 2019) <www.forbes.com/sites/kateoflahertyuk/2019/07/22/u-s-warship-took-down-iranian-drone-using-new-jamming-technology/?sh=6f8cbb183363>.

[63] International Committee of the Red Cross, 'International Humanitarian Law and the Challenges of Contemporary Armed Conflicts' (Report prepared for the 32nd International Conference of the Red Cross and Red Crescent, Geneva, Switzerland, 8-10 December 2015) 41–42.

[64] See, for example, Louis A Del Monte, *War at the Speed of Light* (University of Nebraska Press 2021) 65–88; Jan Stupl and Götz Neuneck, 'High Energy Lasers: A Sensible Choice for Future Weapon Systems?' (2005) 1 *Security Challenges* 135.

[65] See Official Compendium of Voluntary National Contributions on the Subject of How International Law Applies to the Use of Information and Communication Technologies by States Submitted by Participating Governmental Experts in the Group of Governmental Experts on Advancing Responsible State Behaviour in Cyberspace in the Context of International

should it reach the level of intensity that directly causes severe damage to the operation of a MAV, the use of electromagnetic interference amounts to a use of force.

The requisite level of intensity cannot be settled on the basis of technical impact. One may argue that electromagnetic interference with the functionality of a MAV qualifies as a use of force if the restoration of functionality requires physical repair, drawing on the line of argument developed by a group of experts who drafted Tallinn Manual 2.0 on the application of international law to cyber operations.[66] However, this argument relates to the notion of an attack as the basis for a number of specific limitations and prohibitions in the law of armed conflict, rather than the use of force prohibited as a means of settling disputes in international relations. Its analogous application to the latter context is implausible where, unlike cyber-attack against computer systems, the degree of physical damage or degradation with the MAV's functionality (including whether it has caused permanent loss of functionality) is not easily discernible or verifiable unless the targeted MAV is recovered for close inspection.

Even if it amounts to a use of force, the coastal state could justify the use of high-powered electromagnetic interference against the MAV as an exercise of the right of protection under Article 25 of the Law of the Sea Convention. Indeed, Churchill and Lowe are of the view that the coastal state may use any force necessary to compel foreign warships to leave the territorial sea.[67] Gill is more cautious by restricting the use of force in the exercise of the right of protection to a situation where the refusal of the warship to comply with the coastal state's laws and regulations pertaining to innocent passage, coupled with its refusal to leave the territorial sea when requested to do so, poses a significant threat to the security of the

Security Established Pursuant to General Assembly Resolution 73/266, UN Doc A/76/136 (2021).

[66] Michael N Schmitt and others, *Tallinn Manual 2.0 on the Application of International Law to Cyber Operations* (CUP 2017) r 92, para 10.

[67] Churchill and Lowe, *The Law of the Sea* (n 45) 99.

coastal state or to the safety of navigation.[68] According to them, the sovereign immunity enjoyed by warships and other government vessels does not necessarily preclude the coastal state's right to take protective action.

Under customary international law, the use of force in maritime law enforcement does not fall foul of Article 2(4) of the Charter and can be justified to the extent strictly necessary to achieve the legitimate objective and reasonably proportionate in all the circumstances.[69] As the late Professor Ivan Shearer observed, this restriction has been developed in the context of maritime law enforcement against regulatory offences and, as such, might not preclude the use of more vigorous force if, for example, it was directed against a ship carrying arms to dissidents in the enforcing state or a large amount of narcotic drugs.[70] Of essence is that the use of force endangering human life is not justified, at least where purely regulatory offences are concerned.[71] The use of force directed against MAVs could be found more justifiable since there is no risk of endangering human life.

Beyond its territorial sea, however, the coastal state is restricted from using electromagnetic interference amounting to a use of force unless it can be justified as an exercise of the right of self-defense against an uncrewed system demonstrating a hostile intent or committing a hostile act. Consider a scenario where a foreign-flagged MAV navigating on the high seas threatens the coastal state's maritime security by generating in-band jamming to disrupt the coastal surveillance radar systems. Despite its adverse impact on

[68] Gill, 'The Forcible Protection, Affirmation and Exercise of Rights by States under Contemporary International Law' (n 46) 134.
[69] See *M/V 'Saiga' (No 2) (Saint Vincent and the Grenadines v Guinea)* (Judgment of 1 July 1999) ITLOS Reports 1999, paras 155–159; *Fisheries Jurisdiction (Spain v Canada)* (Jurisdiction) [1998] ICJ Rep 432, 466 para 84; *Guyana v Suriname* (Award of the Arbitral Tribunal of 17 September 2007) PCA Case No 2004-04, para 445; *Red Crusader*, Report of the Commission of Enquiry, Investigation of certain incidents affecting the British trawler Red Crusader (23 March 1962) 29 RIAA 521, 538; *SS I'm Alone* (Canada/United States) (9 January 1935) 3 RIAA 1609, 1618.
[70] Shearer, 'The Development of International Law with Respect to the Law Enforcement Roles of Navies and Coast Guards in Peacetime' (n 48) 441.
[71] UNCLOS (n 10) art 225; *M/V 'Saiga"* (n 69) para 155 ('Considerations of humanity must apply in the law of the sea').

the radar systems, this interference may not be considered as sufficiently severe to constitute a use of force, let alone an armed attack, against the coastal state due to the limited range of signal frequency used for disruption. It would also be qualitatively differentiated from unauthorized broadcasting discussed earlier as in-band jamming is specifically directed against a particular target rather than intended for reception by the general public. As such, the sovereign ship, where the transmission can be received or authorized radio communication suffers interference, is not entitled to exercise jurisdiction by boarding the vessel suspected of engaging in generating jamming.

In such a scenario, the coastal state would be prevented from employing barrage jamming that radiates over a wide band of frequencies without limiting its expanse. This is because its impact is not reasonably restricted to the extent necessary or proportionate by causing widespread radio communication and PNT signal failures, especially when there is a risk of collision as a result. The uncertainty of its effect on the MAV and other uncrewed systems navigating in the area also causes the coastal state to hesitate using laser scanning to identify the location of the malicious uncrewed system or to measure its distance from the coast.

6. Conclusion

Electromagnetic interference has the potential to become a measure of choice as a means of ensuring safety of navigation and flight on the high seas and within international airspace. The increased power and sophistication of electromagnetic radiation-emitting devices enables the state to employ a layered approach to the enforcement of its jurisdiction, ranging from in-band spot jamming to more widespread barrage jamming and all the way to laser beams capable of causing physical damage at a distance. It could also provide the coastal state with additional means to exercise the right of protection under Article 25 of the Law of the Sea Convention against the non-innocent passage of MAVs and arguably to enforce the coastal state's laws and regulations relating to innocent passage and navigational safety.

However, the same capabilities will equally be available to uncrewed systems, which could pose threats to maritime security. An uncrewed system will be breaching the obligation of due regard under Article 87 of UNCLOS when it maneuvers in international airspace, on the high seas, or within the water column in a manner that forces another vessel or aircraft to react in order to maintain safe navigation or flight, irrespective of the cause for that maneuver or flight pattern. Within the current framework of international law, sovereign ships could exercise enforcement jurisdiction against uncrewed systems when unauthorized broadcasting jeopardizes safety of flight and navigation pursuant to Article 109 of UNCLOS, even if their own freedom or safety of navigation is not in danger. Sovereign ships could alternatively exercise the right of visit in accordance with Article 110 of UNCLOS to determine whether the uncrewed system shares the same flag with the warship or is without nationality.

In cases where MAVs are conducting non-innocent passage within its territorial waters, the coastal state is authorized to protect itself from harmful activities. The coastal state could reasonably rely upon electromagnetic interference, for example, to redirect the MAV to inspection at its port, as a means of exercising enforcement jurisdiction. However, its use against MAVs that qualify as foreign warships will be controversial. The legality of such action to change their course can be challenged as exceeding the right of protection that the coastal state is entitled to exercise. There are also difficulties with the right of self-defense to justify forcible response and disruption to freedom of navigation when the harm emanating from the MAV is not severe enough to constitute a use of force or when the effect of counter-jamming is indiscriminate or uncertain.