

# A Walk in the Dark and the Law of Satellite Mega-constellations

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## Abstract

From professional to amateur astronomers, the dark skies represent a window to the universe. Whether from our backyards or millions of miles into the expanse, the distant lights that astronomers observe represent the next frontier of human exploration. However, a newer inhabitant of our space backyard threatens this much-needed future: satellite megaconstellations. This paper explores the notion of law and ethics as it applies to the use of satellite megaconstellations. The goal is to discover how space law may offer guidance and educate satellite operators while identifying possible solutions.

## 1. Introduction

It is unavoidable to look up and be in awe at the beauty of the day and night sky. Imagination and poetry quickly occupy our minds as we ponder the past, present, and future. Aldous Huxley explained it best: “Then, suddenly, my consciousness was lighted up from within and I saw in a vivid way how the whole universe was made up of particles of material which... were nevertheless filled with this intense and vital beauty.”<sup>1</sup> It is difficult not to remember childhood stories of stars above Bethlehem, the Giza Plato, or Mesoamerica. The light of our stars reminds us of ancient stories from humanity’s history. And there are many other examples of locations around the world where the visitor has the opportunity to walk in the dark and look toward the heavens. During the day, for example, it is possible to make observations during the longest day of the year (summer solstice) and the shortest day of the year (winter solstice).<sup>2</sup> In the U.S., Chaco Canyon in New Mexico is known for its petroglyph called the Sun Dagger, which allows the observer to see at noon a Sun’s wedge-shaped beam through in the summer

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1 Aldous Huxley, *Heaven and Hell*, first ed., Harcourt, Brace & World, 1955 at 10.

2 *The Sun’s Path: Solstices, Equinoxes, and the Zenith Passage*, Exploratorium, 2022, <https://www.exploratorium.edu/ancientobs/chichen/HTML/sun.html> (accessed 25.08.22).

and winter solstices.<sup>3</sup> Still, solar observations do not compare to the celestial images offered by the night heavens. Humanity's companions of the night, the bright stars above us, represent the open gateway to a universe that remains, for the most part, unknown and unexplored. Perhaps the most famous of those companions and memorable is Polaris, better known as the North Star.<sup>4</sup> This celestial body is "culturally, scientifically and navigationally... one of the most important stars of recent centuries."<sup>5</sup> More memorable examples include Orion's belt, Sirius, and Vega. Looking back in time, I see the wisdom of understanding our position in the solar system and the galaxy. Now humanity continues to learn new technologies, and outer space emerges as the exploration laboratory. Still, our terrestrial needs may threaten humanity's ability to extend the celestial borders.

The protection of astronomical observations is vital for humanity's connection with the cosmos. These observations have served as tools for navigation on land and at sea, allowing indigenous peoples around the world assemble their star knowledge to be handed down to their inheritors.<sup>6</sup> These observations have also inspired great science fiction stories and illustrate humanity's imagination and desire to explore the distant places of our cosmos. One of those stories illustrates a problem similar to the one presented by this article. We can only imagine the type of observations we will achieve once we enter the farthest reaches of our solar system. The story by Arthur C. Clarke, interestingly titled *The Star*, recounts a journey of human space exploration. As the story goes, a spaceship deviated course to investigate a solar explosion that turned into a supernova.<sup>7</sup> Among the explorers, a Jesuit priest stands in front of a window to observe the features of space anomalies and celestial bodies.<sup>8</sup> But a closer examination reveals that the Jesuit is more concerned with the meaning of humanity's existence

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3 6 Ancient Sites Aligned with the Solstice and Equinox, Almanac, 7 December, 2021, <https://www.almanac.com/content/ancient-sites-aligned-solstice-and-equinox>, (accessed 29.08.22).

4 Vicky Stein, Polaris: How to find the North Star, Space.com, 24 January 2022, <https://www.space.com/15567-north-star-polaris.html>, (accessed 29.08.22).

5 *Ibid.*

6 Louise Franco, Mega Constellations: Satellite Pollution Threatens Australian Skies and Indigenous Astronomy Practices, 25 April 2022, <https://www.natureworldnews.com/articles/50530/20220425/mega-constellations-satellite-pollution-threatens-australian-skies-indigenous-astronomy-practices.htm>, (accessed 29.08.22). *See also*, Karlie Noon, Thousands of satellites are polluting Australian skies, and threatening ancient Indigenous astronomy practices, *The Conversation*, 19 April 2022, <https://theconversation.com/thousands-of-satellites-are-polluting-australian-skies-and-threatening-ancient-indigenous-astronomy-practices-173840>, (accessed 29.08.22).

7 Arthur C. Clarke, *The Star*, in *The Nine Billion Names of God: The Best Short Stories of Arthur C. Clarke*, Harcourt Brace Jovanovich, New York, 1967, p. 271.

8 *Ibid.*, p. 272.

against the vastness of outer space.<sup>9</sup> Whether related to religion, philosophy, or law, there has always been a special connection between humanity and the great expanse. The conversations between the Jesuit and the ship's astrophysicist could be easily expected in many settings. The Jesuit recounted:

*He would come up to me in the gloom and stand staring out of the great oval port, while the heavens crawled slowly around us as the ship turned over and over with the residual spin we had never bothered to correct.*<sup>10</sup>

As the Jesuit continued pondering about their journey into deep space, he seemed overwhelmed by the knowledge that he (and all crew members) carried on the way back home to Earth.<sup>11</sup> He thought of Loyola, the founder of his religious order, and then thought of his faltering faith and the knowledge that had come into their keeping.<sup>12</sup> In the same manner, once humanity faces the effects of deep space missions, it will probably encounter unknown dangers and unexpected challenges. It would not be surprising to accept that long journeys may significantly affect astronauts. But back on Earth, we have our own cosmic challenges of faith: finding solutions not yet discovered by the keepers of international space law.

## 2. Satellite Dark Skies

The idea of losing our ability to clearly observe the night sky is unacceptable and unimaginable. If astronomical observations are so profoundly human, then it is not surprising, as Professor Carl Christol noted, that a “long sweep of history demonstrates that those who best understand the nature of their surroundings – including man’s physical circumstance – lead the most meaningful existence.”<sup>13</sup> The nature of our night skies represents part of that meaningful existence and enables opportunities for space law development. Professor John Cobb Cooper once noted that science and engineering had surpassed the legal field.<sup>14</sup> At the dawn of the space age, Cooper faced the same challenge we experience today. Professor Cooper warned that while a delay in catching up the law with science was expected, “the gap between technological and legal progress must never be permitted to become too

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9 *Ibid.*

10 *Ibid.*

11 *Ibid.*

12 *Ibid.*, p. 273.

13 Carl Q. Christol, What's Going on in Outer Space: A Developing New Field of Law, 50 A.B.A. J. 527-532 (1964) at 527.

14 John Cobb Cooper, Legal Problems of Upper Space, 23 J. Air L. & Com. 308-316 (1956) at 308.

wide.”<sup>15</sup> The challenge at hand involves our ability to continue enjoying the natural brightness of our night sky. For example, astronomers from the Carl Sagan Institute at Cornell University and the American Museum of Natural History in New York City identified 1,715 stars in our area of the galaxy.<sup>16</sup> These successful discoveries were feasible thanks to the stars’ gravitational forces that provided the precise position for detection.<sup>17</sup> Because our “planet temporarily blocks out part of the sun’s light,” their position allows astronomers to detect those distant exoplanets.<sup>18</sup> These existing discoveries remind us of other, more mundane observations. Most days, looking up at the stars becomes an unconscious matter. But our sky is in constant movement. “Our night sky changes throughout the year because Earth moves in orbit around the Sun. We only see stars at night when the Sun doesn’t outshine them.”<sup>19</sup> Thus, while on a dark night, an observer may see 2,500 stars without the use of any technology, the same observer within a city would see just a few.<sup>20</sup> This fact means that our planet is now much brighter.<sup>21</sup> This also means that astronomers’ ability to observe the sky is diminishing.

The Earth’s brightness pollution is undoubtedly a result of humanity’s technological developments. A group of researchers that studied light pollution shared their findings in an article in *Science*, the journal of the American Association for the Advancement of Science. The researchers explained that “[l]ight pollution is the alteration of night natural lighting levels caused by anthropogenic sources of light.”<sup>22</sup> According to NASA’s definition, anthropogenic sources are those that involve human activities.<sup>23</sup> Under normal circumstances, the visible night light would originate with celestial sources, such as the Moon and the stars.<sup>24</sup> Other sources would include “natural atmospheric emission (airglow)... and zodiacal light.”<sup>25</sup>

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15 *Ibid.*

16 Lisa Kaltenecker, Where Aliens Could Be Watching Us, *Nautilus*, 15 September 2021. <https://www.space.com/megaconstellations-could-destroy-astronomy-no-easy-fix>, (accessed 29.08.22).

17 *Ibid.*

18 *Ibid.*

19 *Ibid.*

20 Eric D. Lystrup, The Dark Side of the Light: Rachel Carson, Light Pollution, and a Case for Federal Regulation, 57(4) *Jurimetrics* 505-528 (2017) at 507.

21 *Ibid.*

22 Fabio Falchi, Pierantonio Cinzano, Dan Duriscoe, Christopher C. M. Kyba, Christopher D. Elvidge, Kimberly Baugh, Boris A. Portnov, Nataliya A. Rybnikova and Riccardo Furgoni, *The New World Atlas of Artificial Night Sky Brightness*, 2(6) *Sci. Adv.* (2016), p. 1.

23 Glossary, Earth Observatory, EOS Project Science Office, NASA Goddard Space Flight, <https://earthobservatory.nasa.gov/glossary/all>, (accessed 29.08.22).

24 *Ibid.*

25 *Ibid.*

Unfortunately, artificial light has changed how we observe our skies due to increased night sky luminance.<sup>26</sup> This luminance or artificial skyglow has altered how we connect with our celestial environment.<sup>27</sup> But one technology adds further injury to the already wounded night sky. The satellites that form part of megaconstellations represent an opportunity and a hazard. There is no official definition for megaconstellations within the body of international space law.<sup>28</sup> However, the term derives its meaning from its components and uses: “a group of artificial satellites cooperating together under common control” utilized for military or civil purposes.<sup>29</sup> Indeed, the age of ‘NewSpace’ encompasses participants with an increased desire to exploit the use of near orbits to launch thousands of satellites for various commercial reasons. “But that access comes at a cost” as there is potential for further contamination of astronomical observations.<sup>30</sup> As with many human endeavors, finding a balancing act is not easy. SpaceX’s Starlink, for example, will consist of more than 40,000 satellites.<sup>31</sup> “OneWeb, Amazon’s Kuiper, and China’s SatNet combined will deploy over 20,000 satellites.”<sup>32</sup> It is hard to imagine how an object orbiting so far in space could impede our ability to enjoy a starlit night. As we gaze into the night, the story of the Jesuit priest offers additional inspiration. The Jesuit recounted: “No other survey ship has been so far from Earth: we are at the very frontiers of the explored Universe.”<sup>33</sup> It was light, a celestial light originating from deep space, that had added a level of mystery to his journey.

*When a star becomes a supernova, it may for a little while outshine all the massed suns of the Galaxy... Our mission was to visit the remnants of such a catastrophe, to reconstruct the events that led up to it, and, if possible, to learn its cause.*<sup>34</sup>

The Jesuit, along with his crewmates, eventually discovered the origins of the supernova, and in the process, the story opens up a challenge to our perceptions of the universe. These perceptions are part of our situational awareness. While plenty of astronomical analysis has been associated with

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26 *Ibid.*

27 *Ibid.*

28 Damian M. Bielicki, Legal Aspects of Satellite Constellations, 45(3) Air and Space Law, 245-264 (2020), p. 246.

29 *Ibid.*

30 Falchiet al., *supra* note 22, p. 1.

31 Paul Sutter, Megaconstellations could destroy astronomy and there’s no easy fix, Space.com, 6 October 2021, <https://www.space.com/megaconstellations-could-destroy-astronomy-no-easy-fix>, (accessed 29.08.22).

32 *Ibid.*

33 Clarke, *supra* note 7, p. 273.

34 *Ibid.*

the deployment of megaconstellations, the same cannot be said of legal analysis. The same previously noted light pollution researchers have explained that “orbital altitudes of space objects range from a few hundred kilometers in the case of objects in Low-Earth Orbit (LEO) to beyond the 35,786-km height defining geosynchronous orbits.”<sup>35</sup> The challenge at hand is that at those altitudes, space objects are illuminated by sunlight, and for this reason, these are visible by “ground-based telescopes as streaks of various lengths and apparent brightness depending on the orbital parameters of the objects.”<sup>36</sup> Thus, it is up to space lawyers to guide humanity to better perceive and utilize – in peace – the natural environment that surrounds our planet.

### 3. Wanting Space Law

The rising utilization of our cislunar space, particularly megaconstellations, highlights the urgency to tackle the preservation of the environment and the ability to observe the night skies. This is the problem that, as Judge Lachs noted, requires the intervention of law in search of solutions for the technicalities associated with new technologies.<sup>37</sup> True, space law is not a missing factor in this equation but is inadequate. In fact, it needs revision. The problem is with the provisions of the treaties. While these were groundbreaking at the time of their drafting, the drafters could not anticipate the use of megaconstellations. Yet, assessing the available law and work from that point of departure is essential. We would be hard-pressed to find a space lawyer disagreeing with the Outer Space Treaty (OTS). OTS, Article I, paragraph 2 notes that:

*Outer space, including the Moon and other celestial bodies, shall be free for exploration and use by all States, without discrimination of any kind, on a basis of equality and in accordance with international law, and there shall be free access to all areas of celestial bodies.*<sup>38</sup>

The “exploration and use” of outer space, by extension, includes megaconstellations, while the term “without discrimination of any kind” can

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35 M Kocifaj, F Kundracik, J C Barentine, S Bará, The proliferation of space objects is a rapidly increasing source of artificial night sky brightness, 504(1) Monthly Notices of the Royal Astronomical Society: Letters, June 2021, pp. L40–L44.

36 *Ibid.*

37 North Sea Continental Shelf Cases (Federal Republic of Germany v. Denmark; Federal Republic of Germany v. Netherlands), Dissenting Opinion of Judge Lachs, [1969] I.C.J. Rep 3, at 230.

38 *Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, including the Moon and Other Celestial Bodies*, 27 January 1967, 610 UNTS 205, art III (entered into force 10 October 1967) [Outer Space Treaty].

apply to the launching and deployment of these space objects by the private sector.<sup>39</sup> OTS, Article III provides additional legal context for applying international law to megaconstellations.<sup>40</sup> It states in part that “States Parties to the Treaty shall carry on activities in the exploration and use of outer space, including the moon and other celestial bodies, in accordance with international law.”<sup>41</sup> The Legal Subcommittee of the Committee on the Peaceful Uses of Outer Space (COPUOS) recently note the responsibility provision included in OTS, Article VI.<sup>42</sup> In particular, it noted that responsibility applies “whether such activities are carried on... by non-governmental entities.”<sup>43</sup> The Legal Subcommittee also stated that while some States acknowledge their responsibility under OTS, Article VI, and jurisdiction and control under Article VIII, there are cases when the State is not the “launching State” or the “State of registry” for the purposes of the relevant conventions.<sup>44</sup> The subcommittee notes:

*In such cases, while information on space objects operated by non-governmental entities may be provided to the Secretary-General under article XI of the Outer Space Treaty, the space objects in question remain unregistered under the Registration Convention or General Assembly resolution 1721 B (XVI).<sup>45</sup>*

The subcommittee acknowledged the inconsistency among national regulatory mechanisms, the academic and commercial space activities, and even the State’s potential lack of knowledge of non-governmental space activities.<sup>46</sup> In addition, while the Outer Space Treaty, in turn, is supported by the Registration Convention<sup>47</sup> and the Liability Convention,<sup>48</sup> these also

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39 *Ibid.*

40 *Ibid.*, Article III.

41 *Ibid.*

42 Committee on the Peaceful Uses of Outer Space, Legal Subcommittee, Registration of large constellations and megaconstellations, Sixty-first session Vienna, 28 March–8 April 2022, A/AC.105/C.2/L.322, 2 February 2022, [https://www.unoosa.org/res/oosadoc/data/documents/2022/aac\\_105c\\_2l/aac\\_105c\\_2l\\_322\\_0\\_html/AC105\\_C2\\_L322E.pdf](https://www.unoosa.org/res/oosadoc/data/documents/2022/aac_105c_2l/aac_105c_2l_322_0_html/AC105_C2_L322E.pdf)

43 *Ibid.*, paragraph 8.

44 *Ibid.*, paragraph 11.

45 *Ibid.*

46 *Ibid.*, paragraphs 10, 13.

47 *Convention on Registration of Objects Launched into Outer Space*, 14 January 1975, 14:1 Intl Leg Materials 43 (entered into force on 15 September 1976) [Registration Convention].

48 *Convention on International Liability for Damage Caused by Space Objects*, 29 March 1972, 961 UNTS 187, 24 U.S.T 2389, TIAS 7762 (entered into force on 1 September 1972) [Liability Convention].

remind of inconsistency amongst national regulatory mechanisms.<sup>49</sup> “When registering relevant space objects, States of registry often do not indicate that an object is part of a large constellation or megaconstellation.”<sup>50</sup> Michel Bourély explains that “[c]ontrary to what happened in other high-tech sectors (like nuclear energy or computer science), it is the State’s intervention, since the beginning, which has helped the creation and development of space activities.”<sup>51</sup> Indeed, while technological mitigation measures are helpful, the States must lead the legal evolution of space activities.

#### 4. Astronautical Ethics

The satellites that now occupy our minds with thoughts of losing our ability to observe the skies remain needed objects for the development and benefit of humanity. But the history of science has taught us that some technologies also possess destructive powers. The idea of satellite constellations would probably be associated with improving the quality of life rather than the opposite.<sup>52</sup> Indeed, the way we seek to live and use technology, along with the “powers and modes of action, kinds of goals, states and changes of society, objectives and forms of politics,” would have a role to play in the manner we choose to address our problem at hand.<sup>53</sup> True, it would be an incomplete assessment not to consider motivators such as profit, power, security, and others to influence the development of technologies.<sup>54</sup> And “[w]ar, or the threat of it, has proved an especially powerful agent.”<sup>55</sup> Yet, we may wonder where the concept of the peaceful uses of outer space lies in this list of priorities. The nature of the cosmos is tightly related to our discoveries in cislunar activities and beyond. The available outer space resources offer future energy and other riches with significant incentives to enter a new age of exploration. Judge Manfred Lachs would agree that our global society is now the “catalyst for science, technology, and law.”<sup>56</sup> As Judge Lachs noted, humanity must use nature to satisfy the global community’s needs.<sup>57</sup> As we examine the use of megaconstellations, and as if Lachs could face our dilemma, he acknowledged that the road ahead would

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49 *Ibid*, paragraphs 16-17.

50 *Ibid*, paragraph 23.

51 Michel Bourély, *The Institutional Framework of Activities in Outer Space*, 26(1) *Journal of Space Law* 1-6 (1986), p. 1.

52 Hans Jonas, “Toward a Philosophy of Technology.” 9 (1) *The Hastings Center Report* (1979): 34-43, p. 34.

53 *Ibid*.

54 *Ibid*.

55 *Ibid.*, p. 36.

56 Manfred Lachs, *Thoughts on Science, Technology and World Law*, 86(4) *Am. J. Int’l L.* 673, 675 (1992).

57 *Ibid*, p. 677.



not be easy. “Even the cleverest of our ancestors probably found themselves on many occasions at a crossroads, near the solution of problems, but took the wrong turning and finished at a dead end.”<sup>58</sup> In that manner, the solution cannot be purely technological, political, or even legal. We must engage all human knowledge to embark on this new and extraordinary adventure of outer space exploration.

This grand adventure is illuminated by the story of the Jesuit and his crewmates once their ship approached a new solar system. This solar system, now destroyed, remained with one planet as the sole survivor, orbiting at the fringes of destruction.<sup>59</sup> The planet, saved by the distance from its sun, represented the ‘Pluto’ of another long ago civilization; vanished after their sun exploded as a supernova.<sup>60</sup> The desire to survive, explore and discover transcends any notion of terrestrial conflict. It is an innate trait of human society to seek answers and evaluate the meaning of existence. But for the former inhabitants of this desolate solar system, nothing remained of its peoples, except for the vault found on the remaining planet.<sup>61</sup> The Jesuit recounted: “A civilization that knew it was about to die had made its last bid for immortality.”<sup>62</sup> To think about this story is to perceive a potential future and emphasize a greater appreciation for the present time. Outer space is now a frontier of possibilities. It is a new commercial arena where astronomy and law intersect human activities.

No doubt, megaconstellations are a marvel of human ingenuity and engineering. The main component, the satellites, are visible due to reflected sunlight and by being in range above the horizon.<sup>63</sup> Their visibility also varies based on the position of the Sun’s elevation in relation to the local horizon.<sup>64</sup> These variables, in turn, cause the satellites’ polished bodies or solar panels to “act as mirrors, causing specular reflections that, when pointing toward Earth, affect a very small area of the planet but can cause an extremely bright flash.”<sup>65</sup> These reflections are the source of the problem and a challenge by design. In essence, satellites become sources of contamination and nuisance for astronomy since these are observable by telescopes as multiple bright smudges.<sup>66</sup> Beyond our atmosphere, human activities associated with these satellites challenge the present-day space law.

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58 *Ibid.*

59 Clarke, *supra* note 7, p. 274.

60 *Ibid.*

61 *Ibid.*, p. 275.

62 *Ibid.*

63 Olivier R. Hainaut and Andrew P. Williams, Impact of satellite constellations on astronomical observations with ESO telescopes in the visible and infrared domains, *A&A* 636, A121 (2020), p. 4.

64 *Ibid.*

65 *Ibid.*, p. 5.

66 Sutter, *supra* note 31.

John Cobb Cooper seemed to have anticipated similar questions when he considered the place of lawyers in the development of space law. Professor Cooper identified three priorities associated with satellites and their launching:

- the legal status of flight-space areas;
- the legal status of the satellite itself;
- and, the international questions associated with controlling flight-space.<sup>67</sup>

Professor Cooper explained the term flight as “any movement through space of man-operated or man-controlled devices or instrumentalities (to be known as flight instrumentalities) such as balloons, dirigibles, airplanes, rockets, guided missiles or space ships.”<sup>68</sup> He also noted that flight-space referred to outer space or, as he described it, the “universal space above and beyond the surface of the earth.”<sup>69</sup> In this manner, we must now extend this analysis to devise a solution, shed light on the reasons for megaconstellations, and enable these space objects to serve our goals into the future. The plans that propel activities in outer space are intrinsically human. And this humanity may be accessed by way of ethics.<sup>70</sup> Indeed, the uses of outer space rise as reminders that ‘rules of conduct’ are valuable, and these must be tempered by free will.<sup>71</sup> Ethics and morals become the guiding lights that illuminate our journey to space, promote our cooperative use of it, and protect our future existence.<sup>72</sup> “This raises moral questions beyond those which technology itself poses, that of sanctioning immoral means for a surpassing end.”<sup>73</sup> It is vital that these considerations remain at the forefront as we develop new technologies and encounter the associated moral ambiguities generated by good intentions, power, and expected goals.<sup>74</sup> In this way, when we think about space law, we must consider the future claims of States and the commercial sector regarding the deployment of megaconstellations.

The future of space travel is a mystery. Those exotics distant planets lightyears away represent the future of humanity. To ponder the possibilities is to dream about the scope and complexity of space exploration. Future exploration endeavors will be better served if new norms are devised to

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67 John Cobb Cooper, *Flight-Space and the Satellites*, 7 *Int’l & Comp. L.Q.* 82-91 (1958), p. 84.

68 *Ibid.*

69 *Ibid.*

70 Jacques Arnould, *Icarus’ Second Chance: The Basis and Perspectives of Space Ethics*, Springer-Verlag/Wien, Germany, 2011, p. 6.

71 *Ibid.*

72 *Ibid.*

73 Jonas, *supra* note 37, p. 43.

74 *Ibid.*

address the equal necessities of technology and law. I suggest that space lawyers join the search for astronomical ethics to reignite the cooperation among nations seen at the genesis of space activities. At the moment, good faith efforts are being made to remedy the brightness of satellites. “SpaceX, OneWeb, and Amazon have all been in talks with astronomers about how to mitigate the satellites’ brightness.”<sup>75</sup> This is a good beginning, but more is required to find the appropriate balance between use of outer space and its commercial benefits. Since ethics permeate human activities, these ethics can be understood to mean “what we should and shouldn’t do in space.”<sup>76</sup> While this approach to ethics may sound simplistic, it is precisely what we need.

The ethics of outer space may serve as a catalyst to rediscover the goals delineated in the Outer Space Treaty. The observational problems associated with megaconstellations rise to a conscious level where ethical considerations intersect the ambit of the law. Indeed, when we think of human activity in outer space, it is imperative that we find “a balance between unbridled exploitation and overbearing protection.”<sup>77</sup> Siegfried Wiessner, an international law expert, points toward activities in outer space guided by flexible rules that could be fairly novel and subject to the socio-economic context.<sup>78</sup> In this way, unavoidably, astronomical ethics must enter the fray and become one more ingredient in the search for a solution. Probably one of the most crucial ethical dilemmas associated with megaconstellations directly relates to the future of humanity. The dilemma is summarized by two words: Kessler Syndrome. In a recent report by VIASAT, the researchers explained that the Kessler Syndrome, “[f]irst postulated by NASA’s Donald J. Kessler in 1978... occurs when... cascading collisions... leads to exponential growth in the space debris density.”<sup>79</sup> Eventually, the debris density becomes unmanageable due to the collision rate of satellites.<sup>80</sup> While the danger to our dark skies is urgent, the problem has the possibility of escalating to dangerous conditions. As the VIASAT researchers noted, the danger becomes greater: “we risk bringing the Space Age to an inglorious end, and trapping

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75 Alexandra Witze, How satellite ‘megaconstellations’ will photobomb astronomy images, *Nature*, 26 August 2020, <https://www.nature.com/articles/d41586-020-02480-5>, (accessed 25.08.22).

76 Mark Williamson, Space ethics and protection of the space environment, *Space Policy*, Volume 19, Issue 1, 2003, Pages 47-52, p. 48.

77 *Ibid.*, p. 49.

78 Siegfried Wiessner, The Public Order of the Geostationary Orbit: Blueprints for the Future, 9 *Yale J. Int’l L.* 217, 236 (1983).

79 VIASAT, Managing Mega-Constellation Risks in LEO, October 2021, <https://www.viasat.com/content/dam/us-site/space-and-network-operations/documents/Viasat-White-Paper-Managing-Mega-Constellation-Risks-in-LEO-26-Oct%2021-A4-final.pdf>, (accessed 29.08.22).

80 *Ibid.*

humanity on Earth under a layer of its own trash for centuries, or even millennia.” This potential end brings me back to Clarke’s story about the former inhabitants of a desolate solar system and the vault found on the remaining planet. As the Jesuit explained:

*Everything that they wished to preserve, all the fruits of their genius, they brought here to this distant world in the days before the end, hoping that some other race would find it and that they would not be utterly forgotten!*<sup>81</sup>

What will be said of the human race in twenty years? Or a hundred? Astronautical ethics is concerned with the establishment of norms associated with the activities delineated by the space treaties. “It would be ideal to live long enough to see the development of humanity in peace and the span of the next space age... But this outcome will be possible only if humanity survives its own destruction.”<sup>82</sup> In an age that lacks opportunities for the development of new space law treaties, a new foundation is needed. Today we face questions about satellite constellations, and tomorrow it will be about crewed missions around the Moon and Mars. “Indeed, the tests that future astronauts will endure will likely push the limits of their minds, bodies, and souls.”<sup>83</sup> The ultimate solution may lie with the human spirit.

## 5. Conclusion

The future of human activities in outer space is inescapable. The technical and legal challenges associated with satellite constellations are real. The prescribed solutions cannot be purely technological, political, or even legal. The protection of astronomical observations is vital for humanity’s connection with the cosmos and our overall future. We must engage all human knowledge to embark on this new and great adventure of outer space exploration.

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81 Clarke, *supra* note 7, p. 274.

82 Roy Balleste, Nature’s Law and the Nature of the Cosmos: Ancient Human Stories about Perennial Moral Concerns, 14 Intercultural Hum. Rts. L. Rev. 249-262 (2019), p. 251.

83 Roy Balleste, The Ethics of Space Exploration: Harrowing Stories of Death, Survival, and the Unknown, 37(2) Connecticut Journal of Int’l Law 141-161 (2022), p. 142.