

## NOTES

# STATE LIABILITY FOR ORBITAL MODIFICATION OF A NEAR-EARTH OBJECT

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## ABSTRACT

*Near-Earth Objects (NEOs)—asteroids and comets that orbit the Sun near the Earth—pose serious threats to our planet. Approximately 1,000 discovered NEOs that are similar to the Chicxulub Impactor responsible for the Cretaceous–Paleogene Extinction Event roughly sixty-six million years ago are capable of causing regional or global devastation. Over 24,000 discovered NEOs that are similar to the Chelyabinsk Meteor—which impacted Russia in February 2013, damaged over 7,200 buildings, and injured more than 1,600 people—are capable of causing severe local or regional harm. And, in only the last five years, the number of discovered NEOs has nearly doubled.*

*One potential strategy to prevent an NEO–Earth impact is to change the NEO’s orbit. A state acting in good faith launches a spacecraft (called a gravity tractor) that orbits near the NEO in such a way that it pulls the NEO toward the spacecraft, gradually modifying the NEO’s orbit so that the NEO does not impact Earth. But the spacecraft’s mid-mission failure is possible. If the spacecraft is able to modify the NEO’s orbit only partially, then the NEO will still impact Earth, but it will impact a different state than if the spacecraft had done nothing. Worse yet, a state may deploy a gravity tractor in bad faith, hoping to deliberately redirect the NEO so that it impacts a different, particular state.*

*This Note analyzes whether, in these two scenarios, the redirecting state—that is, the state that launches and operates the gravity tractor—is liable to the state that the NEO impacts. Looking through the lens of international law, specifically the Liability Convention, the Outer Space Treaty, and the U.N. Charter, this Note concludes that a redirecting state that acts in good faith is liable to the impacted state under the Liability Convention and the U.N. Charter but not under the Outer Space Treaty. This Note then concludes that a redirecting state that acts in bad faith is liable to the impacted state under all three instruments.*

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## I. INTRODUCTION

Near-Earth Objects (NEOs) are, conceptually, asteroids or comets whose orbits bring them near Earth's orbit. NEOs, particularly those with diameters exceeding 140 meters, pose some of the most serious threats to Earth. For example, the impact of a ten-kilometer-wide NEO is the leading explanation for the cause of the Cretaceous–Paleogene Extinction Event, which occurred approximately sixty-six million years ago.<sup>1</sup> As of March 2021, there were 25,416 discovered NEOs, at least 890 of which have an average diameter of one kilometer or more.<sup>2</sup> And astronomers are discovering new NEOs at an alarming rate. As of March 2016, astronomers had discovered 13,971 NEOs,<sup>3</sup> meaning that in only the last five years the number of discovered NEOs nearly doubled.

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1. Peter Schulte, Laia Alegret, Ignacio Arenillas, José A. Arz, Penny J. Barton, Paul R. Bown, Timothy J. Bralower, Gail L. Christeson, Philippe Claeys, Charles S. Cockell, Gareth S. Collins, Alexander Deutsch, Tamara J. Goldin, Kazuhisa Goto, José M. Grajales-Nishimura, Richard A. F. Grieve, Sean P. S. Gulick, Kirk R. Johnson, Wolfgang Kiessling, Christian Koeberl, David A. Kring, Kenneth G. MacLeod, Takafumi Matsui, Jay Melosh, Alessandro Montanari, Joanna V. Morgan, Clive R. Neal, Douglas J. Nichols, Richard D. Norris, Elisabeth Pierazzo, Greg Ravizza, Mario Rebolledo-Vieyra, Wolf Uwe Reimold, Eric Robin, Tobias Salge, Robert P. Speijer, Arthur R. Sweet, Jaime Urrutia-Fucugauchi, Vivi Vajda, Michael T. Whalen & Pi S. Willumsen, *The Chicxulub Asteroid Impact and Mass Extinction at the Cretaceous–Paleogene Boundary*, 327 SCIENCE 1214, 1214 (2010). The remnant of the object's impact is the 180-kilometer-wide Chicxulub Crater near the Yucatán Peninsula. *Id.*

2. See *Discovery Statistics: Cumulative Totals*, NASA JET PROPULSION LABORATORY: CTR. FOR NEAR EARTH OBJECT STUD., <https://cneos.jpl.nasa.gov/stats/totals.html> [<https://perma.cc/2MYA-AKTR>] (in the table, locate the intersections of the row of data corresponding to March 13, 2021 and the columns of data labeled “NEO” and “NEA-km”) (last visited Mar. 15, 2021).

3. See *id.* (above the table, select “Show 100 entries,” and in the table, locate the row of data corresponding to March 1, 2016 and the column of data labeled “NEO”).

## STATE LIABILITY FOR ORBITAL MODIFICATION OF AN NEO

Orbital modification of an NEO is one of the most potentially effective proposed strategies to prevent an NEO–Earth impact. Such an orbital modification could be achieved by a gravity tractor: a spacecraft that is sent to the NEO, orbits nearby, and slowly changes the NEO’s trajectory. That strategy, however, carries with it the question of state liability under international law.

For example, suppose that astronomers detect an NEO that is certain to impact Earth and is capable of causing at least localized destruction.<sup>4</sup> Astronomers would calculate, based on the NEO’s orbit, the Earth’s rotation, and the Earth’s orbit, the most likely locations that the NEO would impact Earth—a band referred to as the risk corridor.



FIGURE 1: Hypothetical risk corridor, shown in red, for the International Academy of Astronautics’ 2019 Planetary Defense Conference.<sup>5</sup>

Suppose further that astronomers publish this calculated risk corridor, which lies solely in the territory of state *A*. State *A* then installs a gravity tractor spacecraft near the NEO, hoping to prevent the destructive impact. As the spacecraft slowly changes the NEO’s orbit, the risk corridor

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4. Depending on the NEO’s kinetic energy, such an NEO would receive a rating of 8 (“capable of causing localized destruction”), 9 (“capable of causing regional devastation”), or 10 (“capable of causing a global climatic catastrophe”) on the Torino Scale, a method that classifies NEO–Earth impact risks by assigning to an NEO a whole number between 0 (a negligible threat) and 10 (a certain, global catastrophe). See Richard P. Binzel, *The Torino Impact Hazard Scale*, 48 *PLANETARY & SPACE SCI.* 297, 301 (2000). The Torino Scale accounts for both the kinetic energy of the NEO and the probability of its collision with Earth. See *id.* at 299. For a deeper discussion, see *infra* note 24.

5. *Risk Corridor*, EUR. SPACE AGENCY (Apr. 25, 2019), [https://www.esa.int/ESA\\_Multimedia/Images/2019/04/Risk\\_corridor](https://www.esa.int/ESA_Multimedia/Images/2019/04/Risk_corridor) [<https://perma.cc/3MM9-9HFZ>].

also changes from lying in the territory of state *A* to lying in the territory of state *B* until, hopefully, the risk corridor disappears when the NEO will no longer impact Earth at all. However, before state *A*'s gravity tractor completes its mission, it fails, and the NEO ultimately impacts the territory of state *B*.

Separately, suppose that astronomers discover a similar NEO and predict that it will pass harmlessly by Earth. But state *A* installs a gravity tractor near the NEO, hoping to attract the NEO to Earth so that it impacts state *B*.<sup>6</sup>

This Note addresses whether state *A* is liable to state *B* under international law in these two hypotheticals. More specifically, this Note discusses the liability under international space law of a state that, acting in good faith or bad faith, modifies the natural orbit of an NEO such that the NEO impacts another state.

This Note proceeds as follows. Part II provides technical background, focusing particularly on the threat that NEOs pose to Earth and the proposed strategies to prevent a destructive impact. Part II also provides legal background, distinguishing between responsibility and liability under international law and summarizing the principles of treaty interpretation. Part III analyzes the issue of state liability under international agreements, specifically the Liability Convention, the Outer Space Treaty, and the U.N. Charter. A conclusion follows.

## II. BACKGROUND

### A. *Technical Background*

#### 1. The Threat of Near-Earth Objects

An NEO is, officially, a Small Solar System Body—a celestial object that orbits the Sun, is not a planet,<sup>7</sup> is not a dwarf

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6. Notably, astronomer Carl Sagan implored the world to develop planetary defense technologies only after the discovery of an NEO certain to destructively impact Earth. He reasoned that humanity's history of violence counsels against the preemptive development of such technologies because, according to Sagan, any strategy that could be used to divert an NEO could be used to attract one. See Carl Sagan & Steven J. Ostro, *Long-Range Consequences of Interplanetary Collisions*, 10 ISSUES SCI. & TECH. 67, 70–71 (1994); see also CARL SAGAN, PALE BLUE DOT: A VISION OF THE HUMAN FUTURE IN SPACE 249–66 (1994) (providing more background for the argument).

7. A planet is a celestial body that orbits the Sun, “has sufficient mass for its self-gravity to overcome rigid body forces so that it assumes a hydrostatic equilibrium (nearly round) shape,” and “has cleared the neighbourhood around its orbit.” Int'l Astronomical Union, Resolution B5: Definition of a Planet in the Solar System, at 1 (2006), [https://www.iau.org/static/resolutions/Resolution\\_GA26-5-6.pdf](https://www.iau.org/static/resolutions/Resolution_GA26-5-6.pdf) [https://perma.cc/9XGL-Q6FA].

planet,<sup>8</sup> and is not a satellite (artificial or natural)<sup>9</sup>—that has at perihelion a distance from the Sun of less than 1.3 astronomical units<sup>10</sup> (AUs).<sup>11</sup> As of March 2021, there are 25,416 discovered NEOs, at least 890 of which have an average diameter of one kilometer or more.<sup>12</sup> Because NEOs are remnants of the formation of the solar system, which included the chaotic eras of planetary accretion and heavy bombardment, the 25,416 discovered NEOs likely represent a fraction of the total NEOs.<sup>13</sup>

Although the diameter of the largest NEO, 1036 Ganymed, is between thirty and forty kilometers,<sup>14</sup> Figure 2 shows that the sizes of discovered NEOs span a wide range.

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8. A dwarf planet is a celestial body that orbits the Sun, “has sufficient mass for its self-gravity to overcome rigid body forces so that it assumes a hydrostatic equilibrium (nearly round) shape,” “has *not* cleared the neighbourhood around its orbit,” and is not a satellite (artificial or natural). *Id.* (emphasis added). Pluto, classified as a planet until 2006, is the most famous example of a dwarf planet. Int’l Astronomical Union, Resolution B6: Pluto, at 1 (2006), [https://www.iau.org/static/resolutions/Resolution\\_GA26-5-6.pdf](https://www.iau.org/static/resolutions/Resolution_GA26-5-6.pdf) [<https://perma.cc/9XGL-Q6FA>].

9. A natural satellite—for example, Earth’s Moon—is a celestial body that orbits a larger celestial body, usually a planet or dwarf planet. *See Satellite*, BRITANNICA, <https://www.britannica.com/science/satellite> (last visited Mar. 15, 2021). An artificial satellite—for example, the International Space Station—is a spacecraft that orbits a celestial body, usually a planet, dwarf planet, natural satellite, or the Sun. *See id.*

10. One astronomical unit is approximately the distance between the Earth and the Sun. However, because the orbit of the Earth is an ellipse and the definition of the astronomical unit impacts the definitions of other units, such as the parsec, the International Astronomical Union defines the astronomical unit to be a “unit of length equal to 149,597,870,700 m[eters] exactly.” Int’l Astronomical Union, Resolution B2: On the Re-definition of the Astronomical Unit of Length, at 1 (2012) (commas separating numerals added), [https://www.iau.org/static/resolutions/IAU2012\\_English.pdf](https://www.iau.org/static/resolutions/IAU2012_English.pdf) [<https://perma.cc/MN9Z-W4N9>].

11. *See NEO Basics: NEO Groups*, NASA JET PROPULSION LABORATORY: CTR. FOR NEAR EARTH OBJECT STUD., [https://cneos.jpl.nasa.gov/about/neo\\_groups.html](https://cneos.jpl.nasa.gov/about/neo_groups.html) [<https://perma.cc/K24Y-5GMH>] (last visited Mar. 14, 2021).

12. *See Discovery Statistics: Cumulative Totals*, *supra* note 2.

13. *See* JEFFREY O. BENNETT, MEGAN O. DONAHUE, NICHOLAS SCHNEIDER & MARK VOIT, THE COSMIC PERSPECTIVE 235 (7th ed. 2013); INTERAGENCY WORKING GRP. FOR DETECTING & MITIGATING THE IMPACT OF EARTH-BOUND NEAR-EARTH OBJECTS, NAT’L SCI. & TECH. COUNCIL, NATIONAL NEAR-EARTH OBJECT PREPAREDNESS STRATEGY AND ACTION PLAN 4 (2018), <https://perma.cc/V85P-R9XQ> (“Since 2005, . . . the total number of catalogued NEOs has increased by almost five times . . .”).

14. P. Michel, R. Gonezi, P. Farinella & Ch. Froeschlé, *Dynamical Evolution of 1036 Ganymed, the Largest Near-Earth Asteroid*, 347 ASTRONOMY & ASTROPHYSICS 711, 711 (1999).

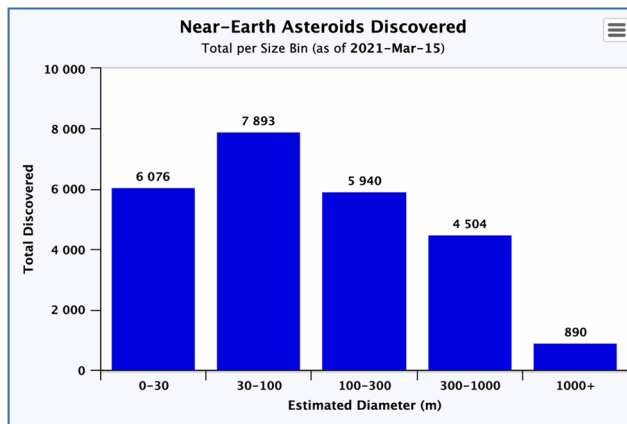


FIGURE 2: Distribution by diameter of discovered Near-Earth Asteroids as of March 15, 2021.<sup>15</sup> Please note that Figure 2 reports that there are 25,303 discovered Near-Earth Asteroids, which together with Near-Earth Comets (113), constitute the group of Near-Earth Objects (25,416).<sup>16</sup>

The compositions of discovered NEOs also vary, but most NEOs are made of siliceous materials and nickel-iron.<sup>17</sup>

Potentially Hazardous Asteroids (PHAs) constitute the most concerning subset of NEOs. A PHA is an NEO whose orbit brings it within 0.05 AU of Earth's orbit and that is at least 140 meters in diameter, sufficiently large to cause regional or global devastation if it were to impact Earth.<sup>18</sup> As of March 2021, there are 2,174 PHAs, 158 of which have an average diameter of at least one kilometer.<sup>19</sup> The largest PHA, (53319) 1999 JM8, has an average diameter of seven kilometers.<sup>20</sup> A PHA of

15. See *Discovery Statistics: By Size*, NASA JET PROPULSION LABORATORY: CTR. FOR NEAR EARTH OBJECT STUD., <https://cneos.jpl.nasa.gov/stats/size.html> [<https://perma.cc/L6D8-GUP9>] (last visited Mar. 15, 2021).

16. See *Discovery Statistics: Cumulative Totals*, *supra* note 2 (in the table, locate the intersections of the row of data corresponding to March 13, 2021 and the columns of data labeled "NEC," "NEA," and "NEO").

17. Andrew S. Rivkin, *An Introduction to Near-Earth Objects*, 27 JOHNS HOPKINS APL TECH. DIG. 111, 116-17 (2006) ("The spectroscopic evidence suggests that the most common NEOs (S-class objects) have similarities to ordinary chondrites. . .").

18. *NEO Basics: NEO Groups*, *supra* note 11 (defining a PHA by both its diameter and absolute magnitude *H*, which represents its intrinsic brightness); see INTERAGENCY WORKING GRP. FOR DETECTING & MITIGATING THE IMPACT OF EARTH-BOUND NEAR-EARTH OBJECTS, *supra* note 13, at 3-4.

19. See *Discovery Statistics: Cumulative Totals*, *supra* note 2 (in the table, locate the intersections of the row of data corresponding to March 13, 2021 and the columns of data labeled "PHA" and "PHA-km").

20. See Lance A. M. Benner, Steven J. Ostro, Michael C. Nolan, Jean-Luc Margot, Jon D. Giorgini, R. Scott Hudson, Raymond F. Jurgens, Martin A. Slade, Ellen S. Howell, Donald B. Campbell & Donald K. Yeomans, *Radar Observations of Asteroid 1999 JM8*, 37 METEORITICS &



roughly ten kilometers in diameter, commonly referred to as the Chicxulub Impactor, is the leading explanation for the cause of the Cretaceous–Paleogene Extinction Event that occurred approximately sixty-six million years ago.<sup>21</sup>

The threats from PHAs are not confined to the past. On April 13, 2029, 99942 Apophis, a PHA of roughly 300 meters in diameter, will pass 31,300 kilometers from Earth.<sup>22</sup> In other words, a PHA capable of causing regional or global devastation will soon pass Earth within 0.08 lunar distances, eight percent of the average distance between the Earth and the Moon. Before astronomers made further observations that reduced the uncertainty of its orbit, 99942 Apophis set the record for the highest threat rating ever assigned—level 4<sup>23</sup>—on the Torino Scale, a method that classifies NEO–Earth impact risks.<sup>24</sup> Even non-potentially hazardous NEOs continue to pose threats. For example, on February 15, 2013, the Chelyabinsk Meteor, which had a diameter of less than twenty meters, impacted Russia,<sup>25</sup> causing damage to over

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PLANETARY SCI. 779, 779 (2002) (reporting 1999 JM8's average diameter to be within twenty percent of seven kilometers); *Goldstone Radar Observations Planning: Asteroid 3200 Phaethon*, NASA JET PROPULSION LABORATORY, [https://echo.jpl.nasa.gov/asteroids/Phaethon/Phaethon\\_planning.2017.html](https://echo.jpl.nasa.gov/asteroids/Phaethon/Phaethon_planning.2017.html) [<https://perma.cc/PW5J-FDJA>] (last visited Dec. 21, 2020) (“Phaethon is the third largest near-Earth asteroid classified as ‘Potentially Hazardous’ after 53319 1999 JM8 (~7 km) and 4183 Cuno (~5.6 km).”).

21. Schulte et al., *supra* note 1, at 1214.

22. *NASA Rules Out Earth Impact in 2036 for Asteroid Apophis*, NASA JET PROPULSION LABORATORY (Jan. 10, 2013), <https://www.jpl.nasa.gov/news/news.php?release=2013-017> [<https://perma.cc/LL72-WRQS>].

23. Don Yeomans, Steve Chesley & Paul Chodas, *Near-Earth Asteroid 2004 MN4 Reaches Highest Score to Date on Hazard Scale*, NASA JET PROPULSION LABORATORY: CTR. FOR NEAR EARTH OBJECT STUD. (Dec. 23, 2004), <https://cneos.jpl.nasa.gov/news/news146.html> [<https://perma.cc/E5Y5-GWNE>].

24. To evaluate the risk of an NEO, the Torino Scale takes as input two numbers: the probability of the NEO impacting Earth and the kinetic energy of the NEO at the time of possible impact. Binzel, *supra* note 4, at 300. Based on those inputs, the scale then outputs a whole number between 0 and 10. *See id.* at 297, 301. That numerical rating then signals the warranted level of public concern regarding the NEO. A rating of 0 represents an event having no likely consequences. *Id.* at 301. A rating of 5 signifies a “close encounter, with a significant threat of a collision capable of causing regional devastation.” *Id.* A rating of 10 is assigned only to a “collision capable of causing a global climatic catastrophe.” *Id.* Importantly, the scale does not consider in its calculations the time until the possible collision. *See id.* at 300.

25. Olga P. Popova, Peter Jenniskens, Vacheslav Emel'yanenko, Anna Kartashova, Eugeny Biryukov, Sergey Khaibrakhmanov, Valery Shuvalov, Yuriy Rybnov, Alexandr Dudorov, Victor I. Grokhovsky, Dmitry D. Badyukov, Qing-Zhu Yin, Peter S. Gural, Jim Alters, Mikael Granvik, Láslo G. Evers, Jacob Kuiper, Vladimir Kharlamov, Andrey Solovyov, Yuri S. Rusakov, Stanislav Korotkiy, Ilya Serdyuk, Alexander V. Korochantsev, Michail Yu. Larionov, Dmitry Glazachev, Alexander E.

7,200 buildings and injuring more than 1,600 people.<sup>26</sup>

## 2. Planetary Defense Strategies

In the face of these threats, the international and scientific communities have proposed strategies that aim to prevent a destructive NEO–Earth impact—a field referred to as planetary defense.<sup>27</sup> One such strategy is to detonate a nuclear weapon near or below the surface of an NEO.<sup>28</sup> The nuclear weapon strategy, although expected to be highly effective,<sup>29</sup> is legally controversial because Article IV of the Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, Including the Moon and Other Celestial Bodies (Outer Space Treaty) prohibits states from “plac[ing] in orbit around the earth any objects carrying nuclear weapons . . . , install[ing] such

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Mayer, Galen Gisler, Sergei V. Gladkovsky, Josh Wimpenny, Matthew E. Sanborn, Akane Yamakawa, Kenneth L. Verosub, Douglas J. Rowland, Sarah Roeske, Nicholas W. Botto, Jon M. Friedrich, Michael E. Zolensky, Loan Le, Daniel Ross, Karen Ziegler, Tomoki Nakamura, Insu Ahn, Jong Ik Lee, Qin Zhou, Xian-Hua Li, Qiu-Li Li, Yu Liu, Guo-Qiang Tang, Takahiro Hiroi, Derek Sears, Ilya A. Weinstein, Alexander S. Vokhmintsev, Alexei V. Ishchenko, Phillipe Schmitt-Kopplin, Norbert Hertkorn, Keisuke Nagao, Makiko K. Haba, Mutsumi Komatsu & Takashi Mikouchi, *Chelyabinsk Airburst, Damage Assessment, Meteorite Recovery, and Characterization*, 342 SCIENCE 1069, 1069 (2013). The Chelyabinsk Meteor did not directly impact the ground but exploded in an airburst at an approximate altitude of twenty-seven kilometers, which produced pieces of meteorite that impacted the ground. *See id.*

26. *Five Years After the Chelyabinsk Meteor: NASA Leads Efforts in Planetary Defense*, NASA (Feb. 15, 2018), <https://www.nasa.gov/feature/five-years-after-the-chelyabinsk-meteor-nasa-leads-efforts-in-planetary-defense> [<https://perma.cc/R466-WPPR>]; Rick Smith, *Marshall Center Astronomer Bill Cooke, Other NASA Researchers Among International Science Coalition Issuing Chelyabinsk Meteor Findings in New Papers*, NASA (Nov. 8, 2013), <https://www.nasa.gov/topics/solarsystem/features/watchtheskies/russian-meteor-nature.html> [<https://perma.cc/H5VC-96XC>].

27. The field of planetary defense, or asteroid impact avoidance, is distinct from planetary protection, a principle in interplanetary travel that a launching state should take measures to prevent the biological (forward) contamination of the target celestial body and (back) contamination of Earth, if the mission is a sample-return mission. *See generally* John D. Rummel, *Planetary Protection Policy Overview and Application to Future Missions*, 9 ADVANCES SPACE RES. 181 (1989).

28. *See, e.g.*, V. A. Simonenko, V. N. Nogin, D. V. Petrov, O. N. Shubin & J. C. Solem., *Defending the Earth Against Impacts from Large Comets and Asteroids*, in HAZARDS DUE TO COMETS AND ASTEROIDS 929, 930–31 (Tom Gehrels et al. eds., 1994); *see also* ARMAGEDDON (Touchstone Pictures 1998) (dramatizing the planetary defense method of detonating a nuclear weapon); DEEP IMPACT (Paramount Pictures 1998) (same).

29. *See* NASA, NEAR-EARTH OBJECT SURVEY AND DEFLECTION ANALYSIS OF ALTERNATIVES: REPORT TO CONGRESS 2 (2007), [https://www.nasa.gov/pdf/171331main\\_NEO\\_report\\_march07.pdf](https://www.nasa.gov/pdf/171331main_NEO_report_march07.pdf) [<https://perma.cc/2RCD-JC98>] (“Nuclear standoff explosions are assessed to be 10-100 times more effective than the non-nuclear alternatives . . .”).



weapons on celestial bodies, or station[ing] such weapons in outer space in any other manner.”<sup>30</sup>

A second potential strategy is to focus laser energy on the surface of the NEO to ablate its mass.<sup>31</sup> This strategy, like the nuclear weapon strategy, is problematic. But unlike the nuclear weapon strategy, this strategy is marred principally by its efficacy, not its legality. Even assuming that a sufficiently powerful laser array could logistically be deployed, multiple factors affect whether laser energy could successfully ablate an NEO. Chief among these factors are the NEO’s composition and shape, particularly because these two characteristics affect whether the laser could produce a sufficiently high temperature—approximately 3,000 Kelvin—on the NEO’s surface to trigger sublimation.<sup>32</sup>

A third strategy, and the one on which this Note focuses, is to change the orbit of the NEO rather than destroy it. This strategy could be accomplished by at least two different methods: kinetic impact or gravity tractor.<sup>33</sup> Under the kinetic impact method, a spacecraft with a high velocity rams into the NEO, aiming to transfer sufficient momentum to the NEO to change its orbit.<sup>34</sup> NASA expects that this method would be effective in general but, critically, not against an NEO with a nonrigid composition.<sup>35</sup> Alternatively, under the gravity tractor method, a spacecraft orbits a spatial point that is near but not on the NEO.<sup>36</sup> Because of their proximity, the spacecraft and the NEO gravitationally attract each

30. Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, Including the Moon and Other Celestial Bodies art. 4, ¶ 1, Jan. 27, 1967, 18 U.S.T. 2410, 610 U.N.T.S. 205 [hereinafter Outer Space Treaty].

31. See, e.g., JOHN M. URIAS, IOLE M. DEANGELIS, DONALD A. AHERN, JACK S. CASZATT, GEORGE W. FENIMORE III & MICHAEL J. WADZINSKI, PLANETARY DEFENSE: CATASTROPHIC HEALTH INSURANCE FOR PLANET EARTH 47–48 (1996), <https://apps.dtic.mil/dtic/tr/fulltext/u2/a392673.pdf> [<https://perma.cc/RJ85-FVMK>].

32. See PHILIP LUBIN, TRAVIS BRASHEARS, GARY HUGHES, QICHENG ZHANG, JANELLE GRISWALD & KELLY KOSMO, EFFECTIVE PLANETARY DEFENSE USING DIRECTED ENERGY: DE-STARLITE 4, 6 (2015), <http://128.111.23.62/wordpress/wp-content/uploads/2013/09/PDC-2015-Lubin-e.pdf> [<https://perma.cc/4PZF-N7EV>].

33. See NASA, *supra* note 29, at 3–4.

34. See COLIN R. MCINNES, *Deflection of Near-Earth Asteroids by Kinetic Energy Impacts from Retrograde Orbits*, 52 PLANETARY & SPACE SCI. 587, 587–88 (2004).

35. Compare NASA, *supra* note 29, at 21 (“Non-nuclear kinetic impact[s] . . . are the most effective non-nuclear option . . .”), with *id.* at 22 (“Kinetic impactors may also be significantly less effective for objects which are essentially loose rubble piles.”).

36. See DANIEL D. MAZANEK, DAVID M. REEVES, JOSHUA B. HOPKINS, DARREN W. WADE, MARCO TANTARDINI & HAIJUN SHEN, ENHANCED GRAVITY TRACTOR TECHNIQUE FOR PLANETARY DEFENSE 6–7 (2015), <https://ntrs.nasa.gov/api/citations/20150010968/downloads/20150010968.pdf> [<https://perma.cc/YUG9-JQDM>]. Like other proposed strategies, the gravity tractor method faces logistical difficulties. To be effective, the method would require at least years of advance warning and, to exert a

other. The spacecraft, however, counters its gravitational attraction to the NEO by continuously producing thrust in the opposite direction, perhaps through ion propulsion. The net force between the spacecraft and the NEO, therefore, is the gravitational attraction of the NEO to the spacecraft. This force slowly pulls the NEO toward the spacecraft, gradually modifying the NEO's orbit.

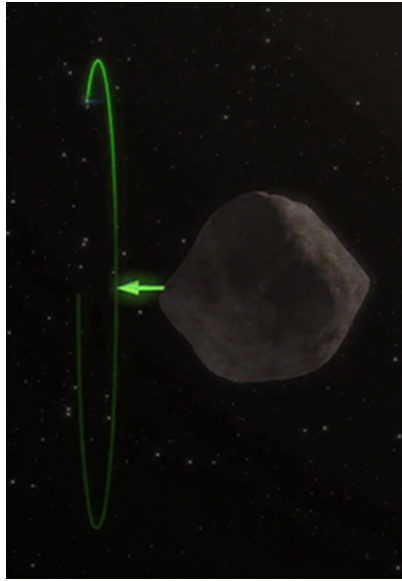


FIGURE 3: Illustration of the gravity tractor method.<sup>37</sup> The spacecraft's orbit is represented by the elliptical path. The net gravitational effect on the NEO is represented by the arrow.

## B. Legal Background

### 1. Responsibility Versus Liability

In international law, responsibility and liability are not synonymous. Responsibility is directed toward a state's fulfillment of its international obligations.<sup>38</sup> If a state commits an act or omission that is attributable to it

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gravitational force on the NEO sufficient to change its orbit, an exceptionally massive spacecraft. See NASA, *supra* note 29, at 2, 21–24.

37. *Asteroid Redirect Mission Planetary Defense Demonstration*, NASA (Mar. 25, 2015), <https://www.nasa.gov/content/asteroid-redirect-mission-planetary-defense-demonstration> [https://perma.cc/CE87-9WJN].

38. See Int'l Law Comm'n, *Draft Articles on Responsibility of States for Internationally Wrongful Acts*, with Commentaries, U.N. Doc. A/56/10, at 32 (art. 1) (2001) ("Every internationally wrongful act of a State entails the international responsibility of that State.").

and is a breach of an international legal obligation of that state, then the state has committed an internationally wrongful act.<sup>39</sup> By contrast, liability focuses exclusively on international compensation. A state may be required to pay compensation—be liable—to another state even though the former has not committed an internationally wrongful act.<sup>40</sup>

For example, Article II of the Convention on International Liability for Damage Caused by Space Objects (Liability Convention) states that “[a] launching State shall be absolutely liable to pay compensation for damage caused by its space object on the surface of the earth or to aircraft in flight.”<sup>41</sup> Article II does not imply that a state commits an internationally wrongful act and so is internationally responsible if its space object causes damage on the surface of the Earth. In other words, a state does not violate an international legal obligation merely by its space object causing damage on the surface of the Earth. Rather, the state is required only to compensate those harmed by such damage. Thus, in this example, the state is internationally liable but not internationally responsible.

Suppose, however, that the state refuses to pay compensation after its space object causes damage on the surface of the Earth. In this case, the state would commit an internationally wrongful act because it breached its international obligation under Article II of the Liability Convention to pay such compensation.<sup>42</sup> Thus, some state actions give rise not to responsibility but only to liability to pay compensation. But if the state refuses to pay that compensation, then the state is internationally responsible because it commits an internationally wrongful act.

If a state commits an internationally wrongful act that injures another state, then the injured state is entitled to reparation.<sup>43</sup> Although the primary purpose of state responsibility is to ensure respect for and adherence to international law—and not to serve as a basis for a claim of compensation<sup>44</sup>—an injured state may justifiably desire reparation for its injury caused by another state’s internationally

39. *Id.* at 34 (art. 2); CURTIS F. J. DOEBBLER, *DICTIONARY OF PUBLIC INTERNATIONAL LAW* 496 (2018).

40. See Frans G. von der Dunk, *Liability Versus Responsibility in Space Law: Misconception or Misconstruction?*, in *PROCEEDINGS OF THE THIRTY-FOURTH COLLOQUIUM ON THE LAW OF OUTER SPACE* 363, 363–65 (1992).

41. Convention on International Liability for Damage Caused by Space Objects art. 2, Mar. 29, 1972, 24 U.S.T. 2389, 961 U.N.T.S. 187 [hereinafter *Liability Convention*].

42. See Statute of the International Court of Justice art. 38, ¶ 1, June 26, 1945, 59 Stat. 1055, 33 U.N.T.S. 993 (establishing international conventions as a source of international law).

43. See Int’l Law Comm’n, *supra* note 38, at 95–110 (arts. 34–39 and cmt.).

44. See *id.* at 87 (ch. 1, cmt. 1) (“[T]he rules and institutions of State responsibility are significant for the maintenance of respect for international law . . .”).

wrongful act. There are many forms that the reparation may take, two of which are restitution and compensation.<sup>45</sup> Conceptually, restitution and compensation are payments made to the injured state by the state that caused the injury.<sup>46</sup> But restitution and compensation—reparations for an internationally wrongful act—are not legally equivalent to liability to pay compensation, which may adhere to a state even if the state does not commit an internationally wrongful act.

There are legally significant differences between restitution and compensation. The responsible state shall attempt first to make restitution—“that is, to re-establish the situation which existed before the [internationally] wrongful act was committed”—to the extent that restitution “is not materially impossible” and “does not involve a burden out of all proportion to the benefit deriving from restitution instead of compensation.”<sup>47</sup> Situations where restitution may be materially impossible include when the property in question has been destroyed or permanently lost, or when a third party has acquired rights to the property.<sup>48</sup> In such a case, the responsible state then has an international obligation to pay compensation “for the damage caused [by its internationally wrongful act], insofar as such damage is not made good by restitution.”<sup>49</sup> Compensation may be appropriate, for example, if a state shoots down another state’s aircraft in violation of an international obligation.<sup>50</sup>

In sum, a state is internationally responsible if it commits an internationally wrongful act: an act or omission that is attributable to the state and that breaches an international legal obligation of that state. If a state commits an internationally wrongful act that injures another state, then the injured state is entitled to reparation—restitution or compensation—for its injury. Compensation as a reparation for an internationally wrongful act is not equivalent to compensation paid by a state that is liable. And a state may be internationally liable to pay compensation to another state even if the former has not committed an internationally wrongful act.

## 2. Principles of Treaty Interpretation

International treaties and conventions are not interpreted in the same manner as statutes or constitutions. For example, the debate over

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45. *Id.* at 96, 98 (arts. 35–36). Other forms of reparation include satisfaction—“an acknowledgement of the breach, an expression of regret, a formal apology or another appropriate modality,” *id.* at 105 (art. 37, ¶ 2)—and interest, *id.* at 107 (art. 38).

46. *See id.* at 96–105 (arts. 35–36 and cmt.).

47. *Id.* at 96 (art. 35).

48. *Id.* at 97–98 (art. 35, cmts. 4, 8–9).

49. *Id.* at 98 (art. 36, ¶ 1).

50. *Id.* at 100 (art. 36, cmt. 8).

whether textualism or purposivism is the optimal method of interpretation is less intense on the international stage when compared to the domestic stage because interpreters—whether tribunals, states, or legal advisors—are required to consider both interpretive approaches.<sup>51</sup> Further, the interpretation of treaties, unlike that of most statutes and constitutions, is performed according to guidelines and general principles established by the Vienna Convention on the Law of Treaties (Vienna Convention). But unlike the interpretation of statutes and constitutions, an exercise in which domestic courts frequently engage, the interpretation of treaties rarely has authoritative or binding guidance from international tribunals.<sup>52</sup> Instead, the most common interpreters of a treaty are states parties themselves. Indeed, a state has a sovereign right to interpret a treaty to which it is a party and need not accept another state's interpretation.<sup>53</sup>

A treaty must be interpreted in “good faith.”<sup>54</sup> The Vienna Convention's drafting history suggests that “good faith” was included “because of the difficulty of dealing with maxims and canons of interpretation, . . . the desire to respect the principle of effectiveness, [and] the recognition of . . . [the] obvious [benevolent] consequence of the

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51. See Vienna Convention on the Law of Treaties art. 31, ¶ 1, May 23, 1969, 1155 U.N.T.S. 331, 8 I.L.M. 679 (“[O]rdinary meaning [shall] be given to the terms of the treaty in their context and in the light of its object and purpose.”).

52. See Martin Ris, *Treaty Interpretation and ICJ Recourse to Travaux Préparatoires: Towards a Proposed Amendment of Articles 31 and 32 of the Vienna Convention on the Law of Treaties*, 14 B.C. INT'L & COMP. L. REV. 111, 111 (1991) (“[T]he practice of treaty interpretation by the International Court of Justice (ICJ) has frequently failed to provide legal certainty, objectivity, and predictability.” (footnote omitted)); see also *id.* at 111 n.4 (“Jurisdiction under article 34 of the Statute of the ICJ only extends to states and is subject to their consent. Hence, the willingness of sovereign states to accept jurisdiction ultimately limits the power of the court.” (citation omitted)).

53. See Ian Johnstone, *Treaty Interpretation: The Authority of Interpretive Communities*, 12 MICH. J. INT'L L. 371, 371–72 (1991) (“[M]ore often than not, the contracting parties themselves have the final say about the meaning of particular provisions of the agreement in question . . . .”); see also Vienna Convention on the Law of Treaties, *supra* note 51, pmbl. (“Having in mind the principles of international law embodied in the Charter of the United Nations, such as the principle[] of . . . the sovereign equality and independence of all States . . . .”). Importantly, although the United States is a signatory—not a party—to the Vienna Convention (because the U.S. Senate has not ratified the Convention), the United States regards the Convention's provisions as customary international law. See *Vienna Convention on the Law of Treaties*, U.S. DEP'T ST., <https://2009-2017.state.gov/s/1/treaty/faqs/70139.htm> [<https://perma.cc/B7K2-A3U9>] (last visited Dec. 29, 2020); see also *Chubb & Son, Inc. v. Asiana Airlines*, 214 F.3d 301, 308 (2d Cir. 2000) (“The United States recognizes the Vienna Convention as a codification of customary international law.”).

54. Vienna Convention on the Law of Treaties, *supra* note 51, art. 31, ¶ 1.

role of good faith as underpinning the law of treaties.”<sup>55</sup> The ordinary meaning of good faith is “[a] state of mind consisting [of] . . . honesty in belief or purpose, . . . faithfulness to one’s duty or obligation, . . . [or] absence of intent to defraud or to seek unconscionable advantage.”<sup>56</sup> Because this notion may be “too general and ill-fitting to help in the context of treaty interpretation,”<sup>57</sup> however, an analysis of instances in which international tribunals have applied the term reveals that “[good faith] signifies an element of *reasonableness* qualifying the dogmatism that can result from purely verbal analysis.”<sup>58</sup> Additionally, “the ordinary meaning [must] be given to the terms of the treaty in their context and in the light of its object and purpose.”<sup>59</sup> As mentioned above, this provision represents a hybrid method of interpretation, instructing interpreters to take account of both the text and its purposes.<sup>60</sup>

The ordinary meaning of a term most commonly refers to its dictionary, prescriptivist definition. Unfortunately, the selection of a particular dictionary definition is often imperfect—and sometimes political—because different dictionaries define words differently, and there are numerous definitions of a single term given within a single dictionary.<sup>61</sup> One potential response is that an interpreter should synthesize all of the different definitions of a term to gauge what the word “has come to mean.”<sup>62</sup> Another potential response is that “ordinary meaning” as used in Article 31 refers to a term’s functionalist, descriptivist definition.<sup>63</sup> In any case, ordinary meaning may be departed from and a “special meaning shall be given to a term if it is established that the parties so intended.”<sup>64</sup>

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55. RICHARD K. GARDINER, *TREATY INTERPRETATION* 169 (2d ed. 2015) (citation omitted).

56. *Good Faith*, BLACK’S LAW DICTIONARY (11th ed. 2019).

57. GARDINER, *supra* note 55, at 170.

58. *Id.* at 171 (emphasis added).

59. Vienna Convention on the Law of Treaties, *supra* note 51, art. 31, ¶ 1.

60. See GARDINER, *supra* note 55, at 185 (“[O]rdinary meaning is the starting point of an interpretation, but only if it is confirmed by investigating the context and object and purpose, and if on examining all other relevant matters (such as whether an absurd result follows from applying a literal interpretation) no contra-indication is found, is the ordinary meaning determinative.”).

61. See Stephen C. Mouritsen, *The Dictionary Is Not a Fortress: Definitional Fallacies and a Corpus-Based Approach to Plain Meaning*, 2010 BYU L. REV. 1915, 1924–25; see also DAVID FOSTER WALLACE, *Authority and American Usage*, in CONSIDER THE LOBSTER AND OTHER ESSAYS 78 (2005) (reviewing Bryan A. Garner’s *A Dictionary of Modern American Usage*).

62. See *MCI Telecomm. Corp. v. Am. Tel. & Tel. Co.*, 512 U.S. 218, 227 (1994) (Scalia, J.).

63. See GARDINER, *supra* note 55, at 186.

64. Vienna Convention on the Law of Treaties, *supra* note 51, art. 31, ¶ 4.



Turning to the purposivism aspect, Article 31 states that “[t]he context for the purpose of the interpretation of a treaty shall comprise, in addition to the text, . . . its preamble and annexes.”<sup>65</sup> Here, it is important that interpreters remember that object and purpose may be found not only in a treaty’s preamble but also in its context and in its textual, substantive provisions.<sup>66</sup> Finally, although Article 31 uses the singular nouns “object and purpose,”<sup>67</sup> and tribunals historically have treated that phrase as a combined concept,<sup>68</sup> interpreters should be mindful that a singular object and purpose may not be found in every treaty. The Appellate Body of the World Trade Organization realistically summarized this approach: “[M]ost treaties have no single, undiluted object and purpose but rather a variety of different, and possibly conflicting, objects and purposes.”<sup>69</sup>

The tools of interpretation discussed so far are the “[g]eneral rule[s] of interpretation.”<sup>70</sup> “Supplementary means of interpretation” are also available “to confirm the meaning resulting from the application of article 31” or “to determine the meaning when the interpretation according to article 31: (a) [l]eaves the meaning ambiguous or obscure; or (b) [l]eads to a result which is manifestly absurd or unreasonable.”<sup>71</sup> Such supplementary means include “the preparatory work of the treaty and the circumstances of its conclusion.”<sup>72</sup>

In sum, the interpretation of international agreements is different from that of statutes and constitutions. A treaty must be interpreted in good faith, which includes an element of reasonableness. Further, a treaty should be interpreted using a hybrid textualist–purposivist approach. Finally, supplementary means of interpretation—a treaty’s drafting history and the circumstances of its conclusion—may be considered to confirm the meaning of a term resulting from an application of the general rules of interpretation, or to determine the meaning of a

65. *Id.* art. 31, ¶ 2.

66. See GARDINER, *supra* note 55, at 216–17.

67. Vienna Convention on the Law of Treaties, *supra* note 51, art. 31, ¶ 1.

68. See GARDINER, *supra* note 55, at 215–16.

69. Appellate Body Report, *United States—Import Prohibition of Certain Shrimp and Shrimp Products*, ¶ 19, WTO Doc. WT/DS58/AB/R (adopted Oct. 12, 1998); see also U.N. Charter art. 1 (directly stating the multiple purposes of the United Nations); Vienna Convention on the Law of Treaties, *supra* note 51, pmb. (listing multiple present-participial phrases, such as “[r]ecognizing,” “[n]oting,” and “[r]ecalling,” which suggests that the Vienna Convention has multiple purposes).

70. Vienna Convention on the Law of Treaties, *supra* note 51, art. 31.

71. *Id.* art. 32.

72. *Id.*

term if the general rules of interpretation render the meaning ambiguous or obscure or lead to a manifestly absurd or unreasonable result.

### III. ANALYSIS

#### A. *Under the Liability Convention*

The Liability Convention creates state liability. If the conditions of the Liability Convention are met, then a nonresponsible state—that is, one that has not breached an international obligation—is internationally liable to and has an international obligation to pay compensation to another state.

Article 2 states that a “launching State shall be absolutely liable to pay compensation for damage caused by its space object on the surface of the earth or to aircraft in flight.”<sup>73</sup> And Article 1 defines a space object to “include[] component parts of a space object as well as its launch vehicle and parts thereof.”<sup>74</sup> Thus, if an NEO, whose orbit is modified by a state’s gravity tractor, is a space object (within the meaning of Articles 1 and 2) that impacts another state, then the former state is liable to the latter state.

One interpretation might rely on the word “includes” in Article 1’s recursive definition to argue that “a space object” is an expansive phrase that includes naturally occurring objects with which the space object gravitationally interacts. As the argument would go, because the gravity tractor itself is a space object (by virtue of its launch by a state inside a launch vehicle), the NEO is also a space object after the gravity tractor gravitationally interacts with it. But, as a starting point, the ordinary meaning of the Article 1 definition suggests that a naturally occurring NEO does not become a state’s space object through nothing more than gravitational interaction with a gravity tractor. The definition focuses on objects launched by a state and contains no language that indicates that gravitational interaction alone can legally transform a natural object into a space object. Additionally, this gravitational-interaction interpretation is overly broad because it would lead to absurd results. A massive object—that is, an object with mass—exerts a gravitational force on every other massive object in the universe, regardless of the physical separation of the two objects.<sup>75</sup> This phenomenon gave rise to theoretical physicist Paul Dirac’s statement: “Pick a flower on

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73. Liability Convention, *supra* note 41, art. 2.

74. *Id.* art. 1, ¶ (d).

75. See BENNETT ET AL., *supra* note 13, at 131 (explaining gravity through Newton’s law of universal gravitation—now accepted by the scientific community as an approximation of gravity); *id.* at 447–55 (explaining gravity through Einstein’s theory of general relativity—now accepted by the scientific community as the leading description of gravity).

earth and you move the farthest star.”<sup>76</sup> Thus, if the Liability Convention’s definition of a space object were to include any object with which a space object gravitationally interacts, then a state’s simple GPS satellite, for example, would include every massive object in the universe because that artificial satellite gravitationally interacts with every such object. This result is manifestly absurd, which indicates that the Liability Convention’s definition of a space object cannot depend solely on gravitational interaction.

Although the NEO is not a space object, a state might still be absolutely liable for the NEO’s impact under one interpretation of causation. The gravity tractor is a space object, and Article 2 imposes liability on a state for any damage caused by its space object on the surface of the Earth. Thus, arguably, the gravity tractor would *cause* the NEO’s impact and the associated damage through its gravitational adjustment of the NEO’s orbit. This argument is plausible. Even though its theory of indirect causation contrasts with the most intuitive example of a space object causing damage within the meaning of Article 2—an artificial satellite itself deorbiting and impacting a state—there is no language in Article 2 that limits causation to direct causation.

Common law states may respond by interpreting Article 2 to implicitly incorporate a requirement of proximate cause. The argument may proceed by claiming that the NEO’s impact is an unforeseeable consequence of orbital adjustment, so the gravity tractor should not be considered to have proximately caused the NEO’s impact. Other states may interpret Article 2 not to include a requirement of proximate cause because, if the drafters of the Liability Convention had intended to limit causation to direct or proximate causes, then they would have inserted a modifier to that effect.<sup>77</sup> Alternatively, states may argue that, even if a requirement of proximate causation was implicitly included in Article II, an NEO’s impact is a foreseeable consequence of attempted orbital modification.

On the whole, the theory of indirect causation would likely prevail. The Liability Convention’s fourteen uses of “cause” and “caused”—including uses in its title and preamble—do not limit causation to

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76. BENJAMIN CROWELL, *NEWTONIAN PHYSICS* 193 (2001) (attributing the quote to Paul Dirac).

77. See Alexandre Senegacnik, *Expressio Unius (Est) Exclusio Alterius*, OXFORD PUB. INT’L L. (Feb. 2018), <https://perma.cc/3ZS2-S9ZL> (“In international law, *expressio unius* is mainly invoked in the context of treaty interpretation . . . .”); cf. *Seneca-Cayuga Tribe of Okla. v. Nat’l Indian Gaming Comm’n*, 327 F.3d 1019, 1034 (10th Cir. 2003) (“[T]he notion [of *expressio unius*] is one of negative implication: the enumeration of certain things in a statute suggests that the legislature had no intent of including things not listed or embraced.” (quoting WILLIAM N. ESKRIDGE, JR., PHILIP P. FRICKEY & ELIZABETH GARRETT, *CASES AND MATERIALS ON LEGISLATION: STATUTES AND THE CREATION OF PUBLIC POLICY* 824 (3d ed. 2001))).

direct causation.<sup>78</sup> Additionally, the objects and purposes of the Liability Convention are broad, “[r]ecognizing the need to elaborate effective international rules . . . to ensure . . . the prompt payment . . . of a full and equitable measure of compensation to victims of such damage [caused by space objects].”<sup>79</sup> Finally, even if proximate cause is an implicit requirement of causation under Article 2, the NEO’s impact is a foreseeable consequence of attempted orbital adjustment: the states through which the risk corridor would pass during an attempted orbital adjustment would be well calculated, and no artificial space object—including a gravity tractor—is infallible.

### B. *Under the Outer Space Treaty*

Articles 3 and 4 of the Outer Space Treaty do not create state liability as the Liability Convention does.<sup>80</sup> Under the Outer Space Treaty, the only way that a state would be internationally obligated to pay compensation to another state is if the former state commits an internationally wrongful act<sup>81</sup> that injures another state, and the injured state then requests restitution or compensation as reparation.<sup>82</sup> To tackle the most thought-provoking aspects of this Note’s inquiry, it assumes that the last two elements are met and that the state’s action is attributable to the state. What remains for analysis is the most challenging part of the first element: whether a state breaches an international obligation.

States parties to the Outer Space Treaty are bound by it—that is, they are under an international obligation to adhere to its provisions.<sup>83</sup> Article 3 states that “States Parties . . . shall carry on activities in the exploration and use of outer space . . . in accordance with international law, including the Charter of the United Nations, in the interest of maintaining international peace and security and promoting international co-operation and understanding.”<sup>84</sup> Whether a state violates

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78. See Liability Convention, *supra* note 41, pmb., arts. 2–7, 11–12.

79. *Id.* pmb.

80. Article 7 of the Outer Space Treaty creates state liability, but this liability is expanded on and more properly addressed by the Liability Convention. See Outer Space Treaty, *supra* note 30, art. 7 (“Each State Party to the Treaty that launches or procures the launching of an object into outer space . . . is internationally liable for damage to another State Party . . .”); *supra* Section III.A.

81. A state commits an internationally wrongful act if that state commits an act or omission that is attributable to it and is a breach of an international obligation of that state. See *supra* note 39 and accompanying text.

82. See *supra* notes 43–46 and accompanying text.

83. See, e.g., Statute of the International Court of Justice, *supra* note 42, art. 38, ¶ 1 (establishing international conventions as a source of international law).

84. Outer Space Treaty, *supra* note 30, art. 3.

Article 3 by redirecting an NEO to impact another state likely turns on the interpretation of “in the interest of maintaining international peace and security.” The ordinary meaning of “interest” is “a feeling that accompanies or causes special attention to something or someone: concern.”<sup>85</sup> But an interest is not unbending. Because an interest is merely a concern to which special attention is directed, it may occasionally yield to other interests. For example, in the United States’ domestic legal system, the government may have a strong governmental interest, such as administrative efficiency, but the pursuit of this interest cannot be absolute. At times, it must yield to other important interests, such as the equal protection of the law.<sup>86</sup> Thus, Article 3’s obligation that a state carry on activities in the exploration and use of outer space in accordance with international law may, in effect, ring somewhat hollow if another sufficiently important interest is involved, such as national or planetary defense.

For example, if astronomers discover an NEO that has been designated a level 10 on the Torino Scale, state *A* would likely act in the interest of maintaining international peace and security if it attempts in good faith to prevent the global climatic catastrophe by diverting the NEO. Even if state *A* fails in this scenario and accidentally redirects the NEO such that it impacts state *B*, it would be difficult to conclude that state *A* failed to act in the interest of international security because preserving the international community itself was an implicit aim of state *A*’s outer space activities.

On the other hand, because Article 3 directly references the U.N. Charter, which has as its primary purpose the maintenance of international peace and security,<sup>87</sup> “interest” in Article 3 may mean an absolute interest from which no derogation is permitted. The counterargument, however, is that few duties in domestic or international law are absolute. With the exception of peremptory norms, there is no international legal duty that approaches the status of absolute. Thus, if a state, acting in good faith, attempts but fails to divert an NEO capable of

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85. *Interest*, MERRIAM-WEBSTER, <https://www.merriam-webster.com/dictionary/interest> [<https://perma.cc/HJ8H-SZA2>] (last visited Dec. 26, 2020).

86. *See, e.g.*, *Frontiero v. Richardson*, 411 U.S. 677, 690 (1973) (plurality opinion) (“[T]here can be no doubt that ‘administrative convenience’ is not a shibboleth . . . . On the contrary, any statutory scheme which draws a sharp line between the sexes, *solely* for the purpose of achieving administrative convenience, . . . involves the ‘very kind of arbitrary legislative choice forbidden by the [Constitution] . . . .’” (final alteration in original) (citations omitted) (quoting *Reed v. Reed*, 404 U.S. 71, 76 (1971))).

87. *See* U.N. Charter art. 1, ¶ 1 (“The Purposes of the United Nations are: To maintain international peace and security . . .”).

causing global destruction, then it likely has not violated Article 3. On the other hand, if a state diverts an NEO that has the ability to cause only regional or localized destruction, or acts in bad faith, then there is a better case to be made that the state has violated Article 3 because it did not appropriately act in the interest of maintaining international peace and security.

Article 4 of the Outer Space Treaty states that “[t]he Moon and other celestial bodies shall be used by all States Parties . . . exclusively for peaceful purposes.”<sup>88</sup> The two critical terms in this provision are “celestial bodies” and “peaceful purposes.” Under the ordinary-meaning approach, an NEO is a celestial body—a naturally occurring physical entity composed of matter.<sup>89</sup> Further, in the field of astronomy, an NEO is *defined* to be a Small Solar System Object that meets certain characteristics, and a Small Solar System Object is in turn defined to be a celestial object.<sup>90</sup> Thus, if “celestial object” in Article 4 is given its technical meaning, then an NEO is a celestial object. There are also strong reasons to conclude that the term as used in Article 4 should be given its technical meaning. For example, the Outer Space Treaty was drafted in the highly technical era of the Space Race.<sup>91</sup> On the other hand, there was little involvement of technical experts in its drafting.<sup>92</sup> This lack of involvement, however, could have been due to diplomats having been the primary individuals needed to reach agreement because the technical terms were already sufficiently defined.

“[E]xclusively for peaceful purposes” is a more difficult phrase to interpret partly because state action often has more than one

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88. Outer Space Treaty, *supra* note 30, art. 4, ¶ 2.

89. See *Celestial Body*, MERRIAM-WEBSTER, <https://www.merriam-webster.com/dictionary/celestial%20body> [<https://perma.cc/6R9R-6ZSU>] (last visited Dec. 27, 2020) (defining a celestial body to be “an aggregation of matter in the universe that constitutes a unit . . . for astronomical study”); see also Ernst Fasan, *Asteroids and Other Celestial Bodies - Some Legal Differences*, 26 J. SPACE L. 33, 35 (1998) (“[W]e know that occasionally little natural objects are approaching our planet, and even fall down on it . . . [T]hey are bodies, most of them very small, moving within the gravitational field of our sun. Thus they (once more) are Celestial Bodies.”).

90. See *supra* notes 7–11 and accompanying text.

91. See, e.g., *Space Race Timeline*, ROYAL MUSEUMS GREENWICH, <https://www.rmg.co.uk/discover/explore/space-race-timeline> [<https://perma.cc/8X9X-NPT9>] (last visited Dec. 27, 2020) (showing that the Space Race lasted until 1975); see also Vienna Convention on the Law of Treaties, *supra* note 51, art. 31, ¶ 4 (“A special meaning shall be given to a term if it is established that the parties so intended.”).

92. See Paul G. Dembling & Daniel M. Arons, *The Evolution of the Outer Space Treaty*, 33 J. AIR L. & COM. 419, 424–29 (1967).



purpose.<sup>93</sup> On one hand, the qualifier “exclusively” adds significant emphasis: it arguably restricts any purpose—regardless of whether the purpose is one of many—to peaceful purposes. Additionally, Article 4’s use of the plural “purposes,” instead of the singular, may suggest that the drafters accounted for the possibility of multipurpose state action and restricted all purposes to those that are exclusively peaceful. On the other hand, “exclusively” modifies the phrase “for peaceful purposes” as a whole, which might suggest that a state need only attempt to pursue peaceful purposes and need not necessarily achieve them.

Another complicating factor is that discerning a purpose of state action depends on how that purpose is characterized. Although a state that acts in bad faith—that is, one that intentionally redirects an NEO such that it impacts another state for no purpose other than to injure that state—clearly does not act exclusively for peaceful purposes, characterizing the purpose(s) of a state that acts in good faith is more difficult and likely political. For example, if state *A* acts in good faith and attempts to divert a globally destructive NEO, it arguably acts with a peaceful purpose to save both its population and Earth from a catastrophic impact. But state *A* could also be characterized as acting not with a peaceful purpose but with a selfish one: saving its own population from direct impact at the expense of any other state along the modified risk corridor.

Ultimately, a state would violate Articles 3 and 4 of the Outer Space Treaty if it acts in bad faith to redirect an NEO such that it impacts another state. By contrast, a state that acts in good faith would likely not violate Article 3 if it attempts to divert an NEO but accidentally causes it to impact another state. The interest of maintaining international peace and security described in Article 3—like most other domestic and international duties—is likely not absolute, and Article 3’s passing reference to the U.N. Charter likely does not elevate this interest to a peremptory norm. As a result, this interest may reasonably yield to other critically important interests, such as the preservation of Earth, its population, and the international community. Similarly, a state that attempts in good faith to redirect the NEO would likely not violate Article 4 if it accidentally causes the NEO to impact another state. But if

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93. *Cf.* *United States v. O’Brien*, 391 U.S. 367, 384 (1968) (Warren, C.J.) (“What motivates one legislator to make a speech about a statute is not necessarily what motivates scores of others to enact it . . .”); ANTONIN SCALIA & BRYAN A. GARNER, *READING LAW: THE INTERPRETATION OF LEGAL TEXTS* 392 (2012) (“[C]ollective intent is pure fiction because dozens if not hundreds of legislators have their own subjective views on the minutiae of bills they are voting on—or perhaps no views at all because they are wholly unaware of the minutiae.”).

the state acts with mixed motives—part peaceful and part nonpeaceful—then the state would likely violate Article 4 because “exclusively peaceful purposes” is best read to restrict all state purposes to those that are exclusively peaceful. Finally, and critically, in interpreting and applying any of the Outer Space Treaty’s provisions, states parties should exercise their utmost efforts to characterize a state’s purpose(s) as objectively and neutrally as possible in order to reach an interpretation and conclusion that best reflects the text, object, and purpose of the Outer Space Treaty.

### C. *Under the U.N. Charter*

Like Articles 3 and 4 of the Outer Space Treaty, the U.N. Charter does not create state liability as the Liability Convention does. Thus, under the U.N. Charter, the only way that a state would be internationally obligated to pay compensation to another state is if the former state commits an internationally wrongful act<sup>94</sup> that injures another state, and the injured state then requests restitution or compensation as reparation.<sup>95</sup> Again, we assume that the last two elements are met and that the state’s action is attributable to the state. What again remains in the inquiry is the most challenging aspect of the first element: whether a state breaches an international obligation.

Members of the United Nations are bound by the U.N. Charter.<sup>96</sup> Except for peremptory norms, the provisions of the U.N. Charter are the most important international obligations of a state because the U.N. Charter establishes that its obligations are supreme to obligations under any other international agreement.<sup>97</sup> Article 2, paragraph 4 of the U.N. Charter requires “[a]ll Members [to] refrain in their international relations from the threat or use of force against the territorial integrity or

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94. A state commits an internationally wrongful act if that state commits an act or omission that is attributable to it and is a breach of an international obligation of that state. *See supra* note 39 and accompanying text.

95. *See supra* notes 43–46 and accompanying text.

96. *See, e.g.*, U.N. Charter art. 2, ¶ 2 (“All Members, in order to ensure to all of them the rights and benefits resulting from membership, shall fulfill in good faith the obligations assumed by them in accordance with the present Charter.”); *see also* Statute of the International Court of Justice, *supra* note 42, art. 38, ¶ 1 (establishing international conventions as a source of international law).

97. U.N. Charter art. 103 (“In the event of a conflict between the obligations of the Members of the United Nations under the present Charter and their obligations under any other international agreement, their obligations under the present Charter shall prevail.”).

political independence of any state.”<sup>98</sup> Thus, the relevant elements of a breach of this provision are (1) a state’s threat or use of force against the territorial integrity or political independence of another state (2) that occurs in the former state’s international relations and is (3) against the territorial integrity of another state. Assuming that the last two elements are met, the most difficult element—the first—becomes dispositive.

The prescriptivist, ordinary meaning of “use” is “the act or practice of employing something.”<sup>99</sup> And the prescriptivist, ordinary meaning of “force” is “violence, compulsion, or constraint exerted upon or against a person or thing.”<sup>100</sup> Taken together, these definitions imply that a use of force is an employment of violence, so an NEO that impacts a state as a result of another state’s deployment of a gravity tractor may constitute a use of force because the impact results in kinetic destruction. As the argument would go, “use” includes indirect use because Article 2, paragraph 4 does not limit uses of force to direct uses. Thus, a state that triggers an event (the deployment of a gravity tractor), which triggers another event (the NEO migrating to a new orbit), which results in the use of force (the NEO impact) may have used force within the literal meaning of Article 2, paragraph 4. But even if the prescriptivist, ordinary meaning of “use of force” is most naturally read to include only direct uses of force, the phrase’s functionalist definition—which suggests that Article 2, paragraph 4 prohibits both direct and indirect uses of force—prevails in light of the treaty’s object and purpose.

The second ordinary meaning of “use of force” is the phrase’s functionalist, descriptivist definition. The functionalist definition of “use of force” is similar, although not identical, to the prescriptivist definition. At the base level, states recognize that state action constitutes a use of force even if the state action is only part of the events leading to the ultimate impartation of force. For example, imagine that a state accuses another state of using force in violation of Article 2, paragraph 4 after the latter launches a targeted strike. Surely part of the reason that that missile reached its target state was because the atmosphere and weather were configured in such a way so as not to disable the missile. In other words, the state’s launch of the missile was but one factor, albeit the

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98. U.N. Charter art. 2, ¶ 4. The provision also includes a disjunctive, catch-all clause: “or in any other manner inconsistent with the Purposes of the United Nations.” *Id.*

99. *Use*, MERRIAM-WEBSTER, <https://www.merriam-webster.com/dictionary/use> [https://perma.cc/V4G3-PP74] (last visited Dec. 28, 2020).

100. *Force*, MERRIAM-WEBSTER, <https://www.merriam-webster.com/dictionary/force> [https://perma.cc/ZRQ3-R8SK] (last visited Dec. 28, 2020).

main factor, that caused an impartation of force on the target state.<sup>101</sup> By extension then, an NEO that impacts a state—and that is caused by another state’s use of a gravity tractor—would likely constitute a use of force under the functionalist, ordinary meaning of Article 2, paragraph 4.

There are limits to this reasoning. A state may not consider another state to use force if the latter’s action contributes negligibly to the ultimate impartation of force. For example, if state *A* accelerates an NEO that will inevitably impact state *B* such that the NEO impacts state *B* sooner that it originally would have, whether state *A* uses force against state *B* would be a more difficult question. On one hand, state *A*’s actions did not change the inevitable NEO impact and impartation of force on state *B*. On the other, state *A* caused the NEO to accelerate and impact state *B* sooner, perhaps resulting in more loss of life or a wider impact crater. Similarly, whether a state that is capable but fails to redirect an NEO may be considered to have used force within the meaning of Article 2, paragraph 4 raises an even more complex question. But these questions are beyond the scope of this Note, which is concerned only with whether a state acting in good or bad faith that redirects an NEO such that the NEO impacts another state may be considered to have used force. And from a functionalist, ordinary meaning

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101. A concrete example is the United States’ January 3, 2020 Baghdad drone strike, which caused the death of Qasem Soleimani. Several states accused the United States of using force in violation of Article 2, paragraph 4 of the U.N. Charter. See Mehrnusch Anssari & Benjamin Nußberger, *Compilation of States’ Reactions to U.S. and Iranian Uses of Force in Iraq in January 2020*, JUST SECURITY (Jan. 22, 2020), <https://www.justsecurity.org/68173/compilation-of-states-reactions-to-u-s-and-iranian-uses-of-force-in-iraq-in-january-2020> [<https://perma.cc/K8FK-D43F>]; see also Agnès Callamard (Special Rapporteur on Extrajudicial, Summary or Arbitrary Executions), *Use of Armed Drones for Targeted Killings*, U.N. Doc. A/HRC/44/38, at 15 (Aug. 15, 2020), <https://undocs.org/en/A/HRC/44/38> [<https://perma.cc/9EBL-STBQ>] (“The targeted killing of General Soleimani and of his companions on 3 January 2020 is the first known incident in which a State invoked self-defence as a justification for an attack against a State actor, in the territory of another State, thus implicating the prohibition of the use of force set out in Article 2 (4) of the Charter.”). The United States—and several other states—did not deny that the strike constituted a use of force but asserted that the United States acted in self-defense by preventing an imminent attack on the United States by Soleimani. See Donald J. Trump, President of the U.S., Remarks by President Trump on the Killing of Qasem Soleimani at Mar-a-Lago (Jan. 3, 2020) (transcript available at <https://perma.cc/LSQ9-9B82>) (“Soleimani was plotting imminent and sinister attacks on American diplomats and military personnel, but we caught him in the act and terminated him.”); see also BBC Politics (@BBCPolitics), TWITTER (Jan. 5, 2020, 4:30 AM), <https://twitter.com/BBCPolitics/status/1213754577268461571> [<https://perma.cc/QJN6-BSQA>] (quoting U.K. Foreign Secretary Dominic Raab as saying, “[The Americans] have the right to exercise self-defence”).

definition of “use of force,” states would likely answer this question in the affirmative.<sup>102</sup>

Applying the Vienna Convention’s requirement to interpret the U.N. Charter in good faith suggests that the functionalist meaning of “use of force” is the best interpretation of the phrase. The requirement that the U.N. Charter must be interpreted in good faith principally means that an interpretation must be reasonable.<sup>103</sup> As the above state practice suggests, one interpretation of Article 2, paragraph 4 the U.N. Charter is that a state uses force when its actions contribute partially to the ultimate impartation of the force. But to be reasonable, this interpretation should be circumscribed to state actions that substantially contribute to the ultimate impartation of force. In other words, a state should not be held internationally responsible for using force against another state if the former’s actions contribute only minimally to the ultimate impartation of force. The Butterfly Effect—the chaos theory that large effects, such as a hurricane forming, result from a combination of many tiny initial conditions, such as a butterfly flapping its wings<sup>104</sup>—has no place in the interpretation of Article 2, paragraph 4. To interpret otherwise would produce manifestly absurd results.<sup>105</sup> But if a state installs a gravity tractor near and manipulates the NEO’s orbit such that the NEO ultimately impacts another state, then the former state can reasonably be said to use force because its actions contribute substantially to the ultimate impartation of force.

The Vienna Convention also requires that the objects and purposes of the U.N. Charter be considered.<sup>106</sup> The U.N. Charter is a rare international agreement because it explicitly establishes its purposes by directly establishing those of the United Nations, which the Charter creates. Although there may be other purposes inferable from its provisions, the U.N. Charter’s explicit purposes are a good starting point for analysis. The first purpose is

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102. Cf. *supra* note 101 and accompanying text.

103. See *supra* notes 57–58 and accompanying text.

104. See generally Edward Lorenz, *The Butterfly Effect*, in *THE CHAOS AVANT-GARDE: MEMORIES OF THE EARLY DAYS OF CHAOS THEORY* 91 (Ralph Abraham & Yoshisuke Ueda eds., 2000).

105. For example, suppose that state *A* launches a missile at and hits state *B*’s ship, which at the moment is in the vicinity of state *C*’s tsunami warning buoys in the Pacific Ocean. State *C* could be considered to have used force simply because it placed buoys in that location. Chaos theory holds that the buoys have an effect on the size of the waves, the amount of water displaced in the vicinity of state *B*’s ship, and the ultimate position of the ship. But to say that state *C* used force against state *B* is absurd.

106. See Vienna Convention on the Law of Treaties, *supra* note 51, art. 31, ¶ 1.

[t]o maintain international peace and security, and to that end: to take effective collective measures for the prevention and removal of threats to the peace, and for the suppression of acts of aggression or other breaches of the peace, and to bring about by peaceful means, and in conformity with the principles of justice and international law, adjustment or settlement of international disputes or situations which might lead to a breach of the peace.<sup>107</sup>

This purpose, particularly its focus on preventing breaches of the peace, suggests that “use of force” should be interpreted broadly. On the other hand, considering the drastic implications of concluding that a state has used force under Article 2, paragraph 4, this purpose may counsel against such a broad reading. The resolution of this interpretive balancing test is informed by the intersection of Article 2, paragraph 4 and Article 51. Article 51 states:

Nothing in the present Charter shall impair the inherent right of individual or collective self-defence if an armed attack occurs against a Member of the United Nations, until the Security Council has taken measures necessary to maintain international peace and security. Measures taken by Members in the exercise of this right of self-defence shall be immediately reported to the Security Council and shall not in any way affect the authority and responsibility of the Security Council under the present Charter to take at any time such action as it deems necessary in order to maintain or restore international peace and security.<sup>108</sup>

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107. U.N. Charter art. 1, ¶ 1.

108. U.N. Charter art. 51. As an aside, a state, hoping to avoid breaching its obligations under the U.N. Charter, may request that the U.N. Security Council authorize its use of a gravity tractor to divert the NEO. *See id.* art. 39 (“The Security Council shall determine the existence of any threat to the peace . . . and shall . . . decide what measures shall be taken in accordance with Articles 41 and 42, to maintain or restore international peace and security.”). Even if the Security Council were to authorize this action—which would likely happen only if the state intended to use its gravity tractor to divert the NEO, rather than attract it in bad faith—this authorization would raise complex international legal questions. For example, Article 42 authorizes the Security Council and the U.N. members acting on its behalf, if the Article’s conditions are met, to “take such action *by air, sea, or land forces* as may be necessary to maintain or restore international peace and security.” *Id.* art. 42 (emphasis added); *see id.* art. 25. But space—where the gravity tractor would be installed and which is commonly accepted to begin at an altitude of 100 kilometers above Earth’s surface, Jonathan C. McDowell, *The Edge of Space: Revisiting the Karman Line*, 151 ACTA ASTRONAUTICA 668, 668 (2018)—is not air, sea, or land, so the Security Council may be



Notably, Article 51 specifies that a state must suffer<sup>109</sup> an “armed attack,” even though Article 2, paragraph 4 prohibits states from “use[s] of force” against the territorial integrity or political independence of another state. The International Court of Justice has recognized a difference between the two terms by suggesting that not every use of force is an armed attack.<sup>110</sup> A frontier incident is a small-scale action—such as a fence-line shooting or a rogue actor—that does not reflect the intent of the state.<sup>111</sup> A frontier incident is thus a use of force prohibited by Article 2, paragraph 4, but it is not an armed attack to which a state may forcibly respond in self-defense. Most states accept this distinction, but the United States considers all uses of force, including frontier incidents, to constitute armed attacks.<sup>112</sup> Regardless, there

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legally unable to authorize such action. I thank Executive Editor Anna Boadwee for raising this point.

109. International scholars and tribunals have interpreted Article 51 not to require a state to actually suffer an armed attack before responding in self-defense. If an armed attack is imminent, then the self-defense right under Article 51 is triggered. *See, e.g.*, Rep. of the High-level Panel on Threats, Challenges and Change, *A More Secure World: Our Shared Responsibility*, ¶ 188, U.N. Doc. A/59/565 (Dec. 2, 2004) (“[A] threatened State, according to long established international law, can take military action as long as the threatened attack is *imminent*, no other means would deflect it and the action is proportionate.”); Sean D. Murphy, *The Doctrine of Preemptive Self-Defense*, 50 VILL. L. REV. 699, 701 (2005) (“For centuries, international law recognized that nations need not suffer an attack before they can lawfully take action to defend themselves against forces that present an imminent danger of attack.”).

110. *See* Military and Paramilitary Activities in and Against Nicaragua (Nicar. v. U.S.), Judgment, 1986 I.C.J. 14, ¶ 191 (June 27) (“[I]t [is] necessary to distinguish the most grave forms of the use of force (those constituting an armed attack) from other less grave forms.”).

111. *See id.* ¶ 195 (distinguishing an armed attack from a “mere frontier incident”). *But see* Murphy, *supra* note 109, at 709 n.31 (arguing that, although the court distinguished the two concepts, it “did not provide a complete definition of what constitute[s] an ‘armed attack’”). The court, however, did provide a few examples. It opined that “assistance to rebels in the form of the provision of weapons or logistical or other support” would not constitute an armed attack. *Nicaragua*, 1986 I.C.J. 14, ¶ 195. By contrast, the court said that an armed attack would occur if a state’s regular armed forces cross an international border, or if a state deploys “armed bands, groups, irregulars or mercenaries, which carry out acts of armed force against another State of such gravity as to amount to (*inter alia*) an actual armed attack conducted by regular forces.” *Id.* (internal quotation marks omitted). The court finally suggested that, in any analysis of whether an armed attack has occurred, the focus should be on the “scale and effects” of the use of force, if any. *See id.*

112. *See, e.g.*, Harold Hongju Koh, Legal Advisor, U.S. Dep’t of State, Remarks at the United States Cyber Command Inter-Agency Legal Conference (Sept. 18, 2012) (transcript available at <https://2009-2017.state.gov/s/1/releases/remarks/197924.htm> [<https://perma.cc/JJF9-4GD4>]) (“[T]he United States has for a long time taken the position that the inherent right of self-defense potentially applies against *any* illegal use of force. In our view, there is no threshold for a use of deadly force to qualify as an ‘armed attack’ that may warrant a forcible response. But that is not to say that any illegal use of force triggers the right to use any and all force in response—such

can be little doubt that most states, including the United States, would interpret a state's purposeful orbital diversion of an NEO to be, at a minimum, a frontier incident, and so a use of force.<sup>113</sup>

Finally, supplementary methods of interpretation, such as the circumstances of the Charter's drafting, confirm this interpretation. The U.N. Charter, including Article 2, paragraph 4, was drafted and adopted immediately after the conclusion of World War II, which followed the dissolution of the League of Nations created after World War I. This context suggests that one of the primary aims of the United Nations and its Charter is to prevent another global conflict.<sup>114</sup> This context also suggests that "use of force" should be interpreted in a manner that would prevent an international dispute from developing into an armed conflict. A state's redirection of an NEO such that it destructively impacts another state may reasonably infuriate the latter—even if the former acts in good faith—to the point of threatening to respond or actually responding with armed conflict. Thus, the circumstances of

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responses must still be *necessary* and of course *proportionate*. We recognize, on the other hand, that some other countries and commentators have drawn a distinction between the 'use of force' and an 'armed attack,' and view 'armed attack'—triggering the right to self-defense—as a subset of uses of force, which passes a higher threshold of gravity.”).

113. Even if a state acts in good faith and accidentally redirects the NEO such that it impacts another state, the former state will likely be considered to have committed a frontier incident and used force under Article 2, paragraph 4. Although the NEO impact does not represent the state's intent—indeed, it acts in good faith and is motivated by self-preservation—the NEO impact would meet or likely exceed the threshold for a fence-line shooting. Just as a state would be considered to have committed at least a frontier incident and use of force if it accidentally launches a nuclear weapon that impacts another state, so too would a state be considered to use force if it accidentally redirects an NEO such that it impacts another state. *Compare* Binzel, *supra* note 4, at 299 (showing, in Figure 2, that the kinetic energy of an NEO impact that is ratable on the Torino Scale ranges from the equivalent of 1 to 10<sup>8</sup> megatons of TNT), *with* Robert S. Norris, *Nuclear Weapon*, BRITANNICA, <https://www.britannica.com/technology/nuclear-weapon> [<https://perma.cc/CWB8-HGAR>] (last visited Apr. 19, 2021) (noting that the atomic bomb dropped by the United States on Hiroshima, Japan on August 6, 1945, released energy equivalent to 15 kilotons of TNT).

114. For example, the five permanent members of the U.N. Security Council were all members of the Allies and victors of World War II: China (originally represented by the Republic of China and currently represented by the People's Republic of China); France (originally represented by the Provisional Government of the French Republic immediately after the liberation of France, later represented by the French Fourth Republic, and currently represented by the French Fifth Republic); Russia (originally represented by the Union of Soviet Socialist Republics and currently represented by the Russian Federation); the United Kingdom of Great Britain and Northern Ireland (originally and currently represented by the same); and the United States of America (originally and currently represented by the same). *See* U.N. Charter art. 23, ¶ 1; *Current Members*, UNITED NATIONS: SECURITY COUNCIL, <https://www.un.org/securitycouncil/content/current-members> [<https://perma.cc/6VH7-6C5M>] (last visited Dec. 30, 2020).

the U.N. Charter's drafting and adoption suggests that "use of force" be interpreted to include such a redirection.

In sum, a state—acting in good or bad faith—that orbitally redirects an NEO such that it impacts another state likely uses force against the territorial integrity of that other state and thus breaches an international obligation under Article 2, paragraph 4 of the U.N. Charter. This interpretation is supported by the functionalist, ordinary meaning of the phrase "use of force." And this interpretation is confirmed by the Charter's object and purpose and in light of supplementary methods of interpretation, including the circumstances of the Charter's drafting and adoption. The redirecting state would thus be internationally obligated to pay restitution or compensation to the injured state as reparation if the injured state requested.<sup>115</sup>

#### IV. CONCLUSION

A state that redirects an NEO by modifying its orbit may be liable to another state principally under three international agreements: the Liability Convention, the Outer Space Treaty, and the U.N. Charter. Under the Liability Convention, a state is absolutely liable for damage caused by its space object. The NEO likely does not legally become a state's space object through nothing more than its gravitational interaction with that state's gravity tractor. But the NEO's impact and the resulting damage would be *caused* by the state's space object—its gravity tractor—because the best interpretation of the Liability Convention's use of "cause" and "caused" includes indirect as well as direct causation. And even if proximate cause is an implicit requirement of causation under the Liability Convention, the NEO's impact is a foreseeable consequence of the state's attempt to modify the NEO's orbit.

Under Articles 3 and 4 of the Outer Space Treaty, a state is liable—not in the sense of the Liability Convention but must pay compensation—to another state if the former state commits an internationally wrongful act (breaches an international obligation) under the Outer Space Treaty that injures another state, and that injured state then requests restitution or compensation as reparation. A state that acts in bad faith violates Articles 3 and 4. But a state that acts in good faith—by attempting to redirect the NEO but accidentally causing it to impact another state—likely does not violate Article 3 because that Article's "interest [in] maintaining international peace and security" is not absolute and may yield to other critically important interests. Similarly, a state that

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115. See *supra* notes 43–46 and accompanying text.

acts in good faith does not violate Article 4 because that state acts “exclusively [with] peaceful purposes.”

Liability under the U.N. Charter is identical to that under the Outer Space Treaty: a state is liable not in the sense of the Liability Convention but must pay compensation to another state if the former state commits an internationally wrongful act under the U.N. Charter that injures another state, and that injured state then requests restitution or compensation as reparation. Although there are competing arguments, this Note concludes that, on balance, a state, acting in good or bad faith, that orbitally redirects an NEO such that it impacts another state likely uses force against the territorial integrity of another state and breaches an international obligation under Article 2, paragraph 4 of the U.N. Charter. The functionalist, ordinary meaning of “use of force” supports this interpretation, which is confirmed by the Charter’s object and purpose and the circumstances of its drafting and adoption.

Any state accused of international wrongdoing may respond with legal justifications—such as consent, self-defense, force majeure, distress, necessity, or compliance with peremptory norms—which, if invoked and if recognized by an injured state and the international community, would preclude a finding of international wrongdoing.<sup>116</sup> Alternatively, an accused state may argue that the current international legal regime is ill-suited to resolve such a novel situation and should be updated or modified to better account for its complexities. Or, finally, an accused state might successfully invoke the maxim: law is not a suicide pact.<sup>117</sup>

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116. See, e.g., U.N. Charter art. 51 (“Nothing in the present Charter shall impair the inherent right of individual or collective self-defence . . .”).

117. See, e.g., Eugene V. Rostow, Opinion, 2. *Law ‘Is Not a Suicide Pact,’* N.Y. TIMES, Nov. 15, 1983, at A35 (“International law, after all, is not a suicide pact.”); cf., e.g., *Kennedy v. Mendoza-Martinez*, 372 U.S. 144, 160 (1963) (“[F]or while the Constitution protects against invasions of individual rights, it is not a suicide pact.”); *Terminiello v. Chicago*, 337 U.S. 1, 37 (1949) (Jackson, J., dissenting) (“There is danger that . . . [the Court] will convert the constitutional Bill of Rights into a suicide pact.”).