

# 1AC

I affirm: The appropriation of outer space by private entities is unjust. I value justice, because the resolution concerns the justness of a state action. The criterion is maximizing well being, prefer because:

**[1] Pleasure and pain are intrinsically valuable. People consistently regard pleasure and pain as good reasons for action. Moen 16** [Ole Martin Moen, Research Fellow in Philosophy at University of Oslo “An Argument for Hedonism” Journal of Value Inquiry (Spr778777u88888888888hyju7=6inger), 50 (2) 2016: 267–281] GI

I think several things should be said in response to Moore's challenge to hedonists. First, I do not think the burden of proof lies on hedonists to explain why the additional values are not intrinsic values. If someone claims that X is intrinsically valuable, this is a substantive, positive claim, and it lies on him or her to explain why we should believe that X is in fact intrinsically valuable. Possibly, this could be done through thought experiments analogous to those employed in the previous section. Second, there is something peculiar about the list of **additional intrinsic values** that counts in hedonism's favor: the listed values have a strong **tendency to be well explained as things that help promote pleasure and avert pain.** To go through Frankena's list, **life** and **consciousness** are necessary presuppositions for pleasure; **activity**, health, and strength **bring about pleasure**; and happiness, beatitude, and contentment are regarded by Frankena himself as “pleasures and satisfactions.” The same is arguably true of beauty, harmony, and “proportion in objects contemplated,” and also of affection, friendship, harmony, and proportion in life, experiences of achievement, adventure and novelty, self-expression, good reputation, honor and esteem. Other things on Frankena's list, such as understanding, wisdom, freedom, peace, and security, although they are perhaps not themselves pleasurable, are important means to achieve a happy life, and as such, they are things that hedonists would value highly. Morally good dispositions and virtues, cooperation, and just distribution of goods and evils, moreover, are things that, on a collective level, contribute a happy society, and thus the traits that would be promoted and cultivated if this were something sought after. To a very large extent, the intrinsic values suggested by pluralists tend to be hedonic instrumental values. Indeed, pluralists' suggested intrinsic values all point toward pleasure, for while the other values are reasonably explainable as a means toward pleasure, pleasure itself is not reasonably explainable as a means toward the other values. Some have noticed this. Moore himself, for example, writes that though his pluralistic theory of intrinsic value is opposed to hedonism, its application would, in practice, look very much like hedonism's: “Hedonists,” he writes “do, in general, recommend a course of conduct which is very similar to that which I should recommend.”<sup>24</sup> Ross writes that “[I]t is quite certain that by promoting virtue and knowledge we shall inevitably produce much more pleasant consciousness. These are, by general agreement, among the surest sources of happiness for their possessors.”<sup>25</sup> Roger Crisp observes that “those goods cited by non-hedonists are goods we often, indeed usually, enjoy.”<sup>26</sup> What Moore and Ross do not seem to notice is that their observations give rise to two reasons to reject pluralism and endorse hedonism. The first reason is that “if the suggested non-hedonic intrinsic values are potentially explainable by appeal to just pleasure and pain (which, following my argument in the previous chapter, we should accept as intrinsically valuable and disvaluable), then—by appeal to Occam's razor—we have at least a pro tanto reason to resist the introduction of any further intrinsic values and disvalues. **It is ontologically more costly to posit a plurality of intrinsic values and disvalues, so in case all values admit of explanation by reference to a single intrinsic value and a single intrinsic disvalue, we have reason to reject more complicated accounts.** The fact that suggested non-hedonic intrinsic values tend to be hedonistic instrumental values does not, however, count in favor of hedonism solely in virtue of being most elegantly explained by hedonism; it also does so in virtue of creating an explanatory challenge for pluralists. The challenge can be phrased as the following question: if the non-hedonic values suggested by pluralists are truly intrinsic values in their own right, then why do they tend to point toward pleasure and away from pain?<sup>27</sup>

**[2] Moral uncertainty means preventing extinction should be our highest priority. Bostrom 12** [(Nick Bostrom, Faculty of Philosophy & Oxford Martin School University of Oxford) “Existential Risk Prevention as Global Priority.” Global Policy, 2012] TDI

These **reflections on moral uncertainty** suggest an alternative, complementary way of looking at existential risk; they also suggest a new way of thinking about the ideal of sustainability. Let me elaborate. **Our present understanding of axiology might well be confused.** We may not now know — at least not in concrete detail — what outcomes would count as a big win for humanity; we might not even yet be able to imagine the best ends of our journey. If we are indeed profoundly **uncertain about our ultimate aims**, then we should **recognize that there is a great option value in preserving** — and ideally improving — our **ability to recognize value and to steer the future accordingly.** Ensuring that there will be a **future version of humanity** with great powers and a propensity to **use them wisely** is plausibly the best way available to us to increase the probability that the future will contain a lot of value. To do this, we must **prevent any existential catastrophe.**

Prefer-

1~ Bindingness— I could put my hand on a hot stove and I'd automatically pull it back before a signal is sent to my brain— Anything else fails to be morally binding because one could always ask "why not?"

2~Degrees of wrongness – only consequentialism can explain why breaking a promise to take someone to the hospital is worse than breaking a promise to play video games – absolutist frameworks fail because you can't weigh between violations of framework That outweighs:

3~ Extinction first under any framework

A~ Future lives — trillions of future lives are lost. They are just as valuable as current ones – anything else says some lives are worth less than others which is genocidal rhetoric

B~ Reversibility — extinction forecloses future improvement; prefer — if we're unsure about which interpretation of the world is true, we should preserve it to figure things out.

## C1: Star Wars

**A new generation of a private space race is well underway.**

**Brehm 15** Brehm, Andrew R. "Private Property in Outer Space: Establishing a Foundation for Future Exploraion." Wis. Int'l LJ 33 (2015): 353.

entrepreneurs and investors alike.' **There is little doubt that the private space race is underway.** Even with much uncertainty surrounding private property rights and international space law, the **discovery of valuable resources in outer space has led to the emergence of various private companies seeking to capitalize in an untapped market.** In 2012, a group of **billionaire investors**, including Google executives Larry Page and Eric Schmidt, Hollywood director James Cameron, and Ross Perot, Jr., announced the launch of Planetary Resources, a private company that **intends to mine resource-rich asteroids.**' In addition to the valuable platinum group elements contained in asteroids, Planetary Resources hopes to mine hydrogen fuels from the asteroids that can be used to launch deeper space expeditions.<sup>5</sup> In January 2013, **Deep Space Industries formed with a similar mission to extract and harvest materials from asteroids,** and an end goal of using the materials to support outer space communities and fuel further exploration.<sup>6</sup> In 2011, Microsoft billionaire Naveen Jain announced the creation of Moon Express, a private space exploration entity that plans to mine for platinum and titanium on the Moon.<sup>7</sup> Additionally, in 2011, venture start-up **Shackleton Energy Company launched**

fund-raising efforts, ultimately seeking to mine the Shackleton Crater in the Moon's south pole for fuels to propel deeper space expeditions.<sup>8</sup> Other private space mining start-ups have followed suit.<sup>9</sup> Each of these private entities has the potential to propel space exploration and technological advances in the pursuit of a deeper understanding of our cosmos.

## **Unchecked Commercial Appropriation causes Space Conflicts.**

**Perez 21** Veronica Delgado-Perez. 12/14/21. Argument | The Commercialization of Space Risks

Launching a Militarized Space Race.

<https://www.theintlscholar.com/periodical/12/14/2020/analysis-commercialization-space-risk-international-law-military-space-race> [Veronica Delgado-Perez is a Staff Writer at The International Scholar.] //

CVHS SR

Fundamentals of the Final Frontier It is a geopolitical imperative to determine what, if any, commercial activities and use of extraterrestrial resources are permitted within the confines of international law. Without clear-cut agreements on what

activity is recognized by international law, the world will undoubtedly see states push the boundaries ever further in an attempt to gain the edge over geopolitical competitors — even more-so in an era of renewed great power competition. Yet to date, there exists no comprehensive treaty or legal reference to commercial

activity in space. However, this should come as no surprise. It has only been since the turn of the century that technology and markets have progressed to the point where commercial space exploration and exploitation has become possible. Only recently have experts and analysts of geopolitics and international law begun to seriously examine questions surrounding the legal framework that would govern extraterrestrial resource-mining and other commercial activities. In the last decade, the United Nations

Committee on the Peaceful Uses of Outer Space (COPUOS) dealt with commercial aspects in outer space.

In one of their last reports, the Committee expressed that the era of the commercial utilization of outer space's resources is intrinsically linked to the escalation of international competition over resources, which could threaten international peace and security. By encouraging the international community to engage in outer space's activities for the

benefit of humankind as a whole, "some delegations" have expressed that states should avoid the promotion of laws and regulations related to the commercialization of outer space, arguing that it should be considered the heritage of all humanity. In that regard, states must then ensure that domestic law on the use of outer space complies with international space law, which means that states should respect the principles outlined in the Outer Space Treaty and ensure that national regulations do not contravene international provisions. Even though the Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, including the Moon and other Celestial Bodies (which entered into force in 1967), refers to the exploration and use of outer space, it does not address questions of a commercial nature, which compromises the ability of states and international actors to address new challenges to extraterrestrial activities. In several provisions, the treaty highlights that these activities may be carried out for peaceful purposes and the benefit of all people, reaffirming that outer space is not subject to national appropriation. Were outer space not considered a global commons, that would imply that the resources and results of commercial exploration may fall within the jurisdiction of a country. It is thus incumbent upon Washington — and its commercial enterprises — to demonstrate how American commercial exploration of space benefits other countries and complies with international space law, or otherwise to adhere to the spirit of past treaties which emphasize the impartiality of outer space until such time as the law is clarified. International Law is Adrift in Space The potential benefits of commercial space exploration cannot be ignored. From an economic standpoint, the space industry would generate a significant economic boon for both states and private companies, due to the abundance and variety of resources — particularly scarce minerals that are difficult to extract on Earth. As one example of the vastness of resources held in outer space, one asteroid has the potential to contain more than the total supply of platinum extracted throughout the history of mankind. It may very well open the door to an advanced era of space navigation, building extraterrestrial infrastructure that facilitates the exploration and use of space's resources, and extra-planetary human habitation.

Inevitably, there are significant drawbacks to the commercialization of space exploration. These can vary, for instance, from the commercial dominance of space's natural resources only by those states with the technical and financial capital to support space missions, to geopolitical competition over extraterrestrial resources that threatens world peace and security, to the potential for the monopolization of extraterrestrial resources by states and private companies. As was the case during the Cold War, the Soviet

Union and the United States began a Space Race in which they struggled to achieve supremacy in space exploration and domination of science. Today, the number of

space powers has increased thanks to continual advancements in flight, combustion, and fueling technologies. In the three decades since the end of the Cold War, technologically advanced countries like China, Japan, and France which previously had no space program have successfully navigated to the top tier of space-faring agencies and programs. In 2018, the U.S. allocated \$41 billion to space programs, followed by China at \$5.8 billion, and Russia at \$3.1 billion. Collectively, the three major space powers control almost 65% of the global industry, showing space powers are monopolizing space and reinforcing the inequality gap between states that do not have sufficient economic and technological capacity to invest. With new actors on the game stage, conflicts of interest may arise. There is a risk that each actor adopts a kind of short-term Realist approach to space policy — one which is driven by self-interest in reaping the greatest benefits of extraterrestrial exploration and commercialization while controlling access to others. If unmitigated, states may choose to militarize outer space to gain a strategic edge over competitors and adversaries. This process has already begun. Under the Trump administration, the Pentagon established the U.S. Space Force as a new branch of the Armed Forces to protect the country and allied interests in space. Already, Delta 4 — one of the U.S. Space Force's missions — conducts strategic and theater missile warnings, manages weapon systems, and provides information to missile defense forces. The measure shows that for the U.S., outer space is not only a domain of scientific exploration but has the potential to become increasingly securitized. With the impending expiration of the Strategic Arms Reduction Treaty (START) between the U.S. and Russia on February 5, 2021, a number of security dilemmas could arise. If the world's two largest nuclear powers do not edge toward extending the treaty, Washington and Moscow risk returning to the era of unrestricted expansion of launch platforms and strategically-deployed nuclear warheads — potentially with the aid of military infrastructure in space. Although President-elect Biden has expressed his interest in negotiating an extension of New START, how Moscow and Washington might proceed remains an open question. Bilateral progress towards a new arms-control regime would require establishing limits on the number and range of long- and mid-range missiles, establishing measures to limit the expansion of traditional missile deployment to space, and banning the deployment of nuclear weapons and weapons of mass destruction in outer space. More than the risk of the securitization of space, state, and private actors could begin to claim exclusive legal rights over the resources they discover. Indeed, the U.S. Commercial Space Launch Competitiveness Act, which came into force in 2015, expressly recognizes the right of U.S. Citizens to possess, own, transport, use, and sell space resources. By this means, domestic law already acknowledges the legal claim to property by individuals, which is prohibited by international law. Under the Outer Space Treaty, states renounced any traditional form of acquisition of territories and agreed not to foray unilaterally into space to extend their national policies on Earth or to exercise any kind of sovereignty over celestial bodies or resources. The absence of a modern international treaty that addresses these issues should be received with grave concern, as there is significant potential for risk to become reality. Existing UN treaties lack the technological context and foresight to address legal questions regarding the potential for commercial exploration and exploitation of outer space or its resources. During the sixties and seventies, when international instruments like the Outer Space treaty were conceived, the principal aim of states was to support and expand the scale of the state's national capacity for operation in space and the development of legal instruments to guide state's international cooperation in the peaceful exploration of outer space. These instruments were never designed to respond to commercial questions over mining or tourism in space, private investment in space activities, or the emergence of non-state private enterprises operating in space. As a result, private enterprises operating in the vacuum of space also float in an unstable legal vacuum which threatens to implode in geopolitical competition. Beyond Stars and States In an increasingly commercial outer space in which there are no set limits to the exploitation of resources or claim to property, states and private companies will inevitably pursue the development of new extraterrestrial industries to suit their geoeconomic interests. If unchecked, the legal protection of outer space as a domain of exploration for the benefit of all humanity would functionally fail. To protect investments and profit from national space industries, states would likely resort to military force to protect and secure private assets. Over time, space would ultimately become a fourth border domain over which states claim, exercise, and defend sovereignty — including through the use of force. The challenge is thus to prevent the circumstances that could lead to space-borne conflict before it is made possible. Notwithstanding, commercial exploration and the use of natural resources need not lead to predation among actors involved in space. The potential rewards — both technological and environmental — that could come from

investment in the harvesting of resources in space **are immense**. International law cannot afford to wait for the security dilemma posed by commercial activity in space to manifest before addressing it but must anticipate and proactively adopt measures to address future issues that govern extraterrestrial human activity. The **only remedy for the lack of legal governance over commercial activity in space is the creation of new international laws** through a comprehensive international treaty on commercial operations in space. The new treaty must **expressly regulate commercial activities** by states and private companies, enshrine an international liability and compensation regime covering damages caused with workable sanction provisions, and reinforce norms that restrict any militarization of outer space. The international community should focus its efforts on establishing a legal regime, with mandatory provisions (rather than non-binding resolutions, observations, commentaries, and conclusions) which generate both international responsibility and provide enforceable sanctions in the event of violations. The effort should be borne out by expanding the scope and strengthening the oversight powers of the United Nations Committee on the Peaceful Uses of Outer Space (COPUOS), rather than creating a new organ with redundant bureaucracy. Beyond the tasks of encouraging space research programs, studying space activities, and addressing legal questions,

## **Commercialization of space makes conflict with China inevitable – monopolies incentivize US power projection and Chinese space militarization, Penter '18:**

Penter, Daniel A. *Preventing Commercial Colonialism and Retaining Sovereignty Over National Policy and Military Strategy in Space*. NATIONAL DEFENSE UNIV NORFOLK VA NORFOLK United States, 2018.

- US space interests become dominated by space monopolies
- monopolies control national interest and increase militarization to project power
- US dev of space makes China conflict inevitable and arms racing

In the next two decades, **the burgeoning U.S. commercial space sector can capture several celestial markets. Commercial space operations exploiting each location or type of market will focus on achieving competitiveness to ensure continued survival.** Due to the unforgiving environment and high technological threshold required for entry into the commercial space market, commercial entities that gain entry will have greater chance of developing a monopoly. When vital national interests intersect with a commercial monopoly, **states will run the risk of ceding sovereignty to commercial entities. The case studies--the English East India Company (EIC), the U.S. opening of the West, and China in Africa--highlight the factors that act for and against commercial entities gaining primacy over national policy.** The indicators of rising commercial primacy over national policy derived from the case studies show that **in pursuit of market domination, commercial entities could gain a monopoly over a vital national interest.** All three cases indicate that legal constraints, the spatial relationship, and ability to project military power define the likelihood for a commercial entity to gain primacy over national policy. During the rise of the EIC, its royal charter was the route to a monopoly that became a vital national interest for England. While in the U.S. case, the quest for market domination in both the fur trade and the buffalo hide market drove government policy despite not having a monopoly. The analysis of **emerging space markets identifies that Rare Earth Minerals (REM), Platinum Group Metals (PGM), and orbital launch capabilities are the most likely to generate monopolies.** As all the commercial entities expected to open the first celestial markets are American, **the space markets will be an item of U.S. national prestige. The likely crash in market value for PGMs and REMs will provide an opportunity for U.S. technology industries that will generate a further economic vital national interest. therefore, the first commercial entities to gain a foothold in the space market will gain significant influence over U.S. national interests.** The case studies show that robust **legal regulation mitigates or prevents the emergence of commercial primacy** over national power. In the case of China in Africa, the globalized legal system is a factor that assists the control of commercial entities. **Contemporary laws for space do not provide a robust framework for regulation** of commercial entities. Moreover, **the U.S. Commercial Space Launch Competitiveness Act 2015 reduces regulation** over U.S. commercial entities until 2023 and provides a legal vehicle for U.S. commercial entities to profit from the extraction and sale of space-based materials. **The reduced regulation will allow more latitude to commercial entities that may develop monopolies that could impact vital national interests. Moreover, in creating the incentives for U.S. commercial entities to open celestial markets,**

**the U.S. Government has left a disparity between U.S. law and international expectations.** The U.S. will likely face legal challenges internationally where it will have to protect commercial monopolies via diplomatic means. **In the EIC case, the findings show that when legislation lags, nations tend to become dependent on monopolized markets.** It also indicates that to prevent loss of primacy over national policy it is necessary to deal with such monopolies aggressively. Potential actions to prevent the emergence of a U.S. dependence upon a monopolized space material market include the development of bilateral space agreements with China, or further U.S. legislation to protect resource markets from crashes. As the limiting of resource markets would go against the intentions of the Space Resource Exploration and Utilization Act, **a bilateral agreement with China may represent a better approach to resolving the wider legal concerns while enabling continued development of space. The three case studies show that states are only able to enforce legal regulation where they can project their authority.** The capability of states to project their authority is due to a combination of spatial considerations and the ability to project military power. The China in Africa case indicates that today, on Earth, spatial considerations are virtually non-existent as near-instantaneous communication coupled with global military reach and globalization enables enforcement of national policy through international organizations. However, the EIC and U.S. cases show that in a remote or dislocated frontier environment, suffering long travel times and communication delays, **the maintenance of national authority requires the projection of military power** Initial consideration of space-based enterprise might indicate that the extreme distances will immediately put commercial entities out of reach of governments. However, this is not the case as commercial operations in orbital space, and near-term asteroid mining will rely on Earth-based ground stations and support while only being a few days travel from terrestrial authorities. On Mars, while communication delays to Earth seem extreme compared to the terrestrial globalized environment, daily communication is still possible. However, the distance presents a completely different calculus as the travel time is akin to that last seen during the Seventeenth Century. Therefore, with spatial dislocation like the situation facing the EIC, it is a given that Mars will be outside of terrestrial national authority. The Moon presents an inflection point between the orbital and Mars scenarios as while it is close enough to Earth to experience only minor communications delays, the commercially monopolized transportation combined with a lack of effective legal framework mean that it will effectively be outside of immediate reach of national authority. The three historical case studies demonstrate that the key to extending the range of national authority to locations dislocated by time, distance, or both is the projection of military power. **Where a military is unable to project sufficient power (U.S.), or is outmatched (India), private and commercial entities will arm themselves to assure protection or enable local rule of law. For orbital commercial activities, while terrestrial military space capabilities are earthward facing, ASAT capabilities could project power into orbit if needed.** Additionally, while the development of an orbital weapons platform would break the Outer Space Treaty, **there is a presumption by China that the U.S. will develop orbital weapons that is leading China to plan a counter-capability. Officials for both the U.S. and China have noted the inevitability of arming space,** which may result in capabilities in orbit that would act to project national power. As there will be no military capability near Mars for some time, it will effectively be outside the reach of state authority once it becomes a colony although that is unlikely before 2060 at the earliest. The Moon, however, is out of reach of weapons based terrestrially, and there is no indication that either the U.S., China or any other countries are planning lunar militarization. That said, for a U.S. commercial entity on the Moon, the dual-use nature of Chinese space enterprise will cause concern. Therefore, **it is virtually inevitable that U.S. commercial entities will justify the pre-positioning of arms or commercial armed forces on the Moon once international competition for resources manifests** in the 2030 timeframe. The findings suggest that despite the Moon's relative proximity to terrestrial authority, it is the most likely location for the emergence of commercial primacy over national policy. The principal causes expected to contribute to commercial primacy are the emergence of international commercial competition on the Moon, coupled with a lack of effective legal regulation, the inability for any nation to project national military power, and the dislocation due to a transportation monopoly. It is unclear how the first commercial diplomatic contacts on the Moon will play out, given the different cultural imperatives of the U.S. and China. The military-civilian dual-use approach by China assures accurate and consolidated representation of its national interests, while the commercially driven U.S. approach will prevent U.S. oversight and create flexibility for commercial entities. The U.S. cultural preference for land ownership demonstrated in its opening of the West, **if manifested in space, is likely to conflict both with international agreements and with Chinese interests.** Despite the variety of differing potential scenarios and outcomes, **there are few routes open to the U.S. to avoid what will become an inevitable armed civilian confrontation with China once a U.S. commercial outpost shares the Moon with other commercial entities.** The two available diplomatic options are to start early discussions with China to develop a bilateral space agreement, or to appoint a U.S. Government representative to a lunar outpost as per the U.S. approach to the West. **Without international cooperation, the only option remaining to the U.S. is to project state authority over commercial entities operating on the Moon by developing a military capability that can operate at lunar ranges That goes nuclear – space is fragile and offense dominant, so even small incidents escalate**

## Space War causes Nuclear War.

**Gallagher 15** "Antisatellite warfare without nuclear risk: A mirage"

<http://thebulletin.org/space-weapons-and-risk-nuclear-exchanges8346> (interim director of the Center for International and Security Studies in Maryland, previous Executive Director of the Clinton Administration's CTBT Treaty Committee, an arms control specialist at the State Dept., and a faculty member at Wesleyan)//Elmer

In recent decades, however, as space-based reconnaissance, communication, and targeting capabilities have become integral elements of modern military operations, strategists and policy makers have explored whether carrying out antisatellite attacks could confer major military advantages without increasing the risk of nuclear war. In theory, the answer might be yes. In practice, it is almost certainly no. Hying threats. No country has ever deliberately and destructively attacked a satellite belonging to another country (though nations have sometimes interfered with satellites' radio transmissions). But the United States, Russia, and China have all tested advanced kinetic antisatellite weapons, and the United States has demonstrated that it can modify a missile-defense interceptor for use in antisatellite mode. Any nation that can launch nuclear weapons on medium-range ballistic missiles has the latent capability to attack satellites in low Earth orbit. Because the United States depends heavily on space for its terrestrial military superiority, some US strategists have predicted that potential adversaries will try to neutralize US advantages by attacking satellites. They have also recommended that the US military do everything it can to protect its own space assets while maintaining a capability to disable or destroy satellites that adversaries use for intelligence, communication, navigation, or targeting. Analysis of this sort often exaggerates both potential adversaries' ability to destroy US space assets and the military advantages that either side would gain from antisatellite attacks. Nonetheless, some observers are once again advancing worst-case scenarios to support arguments for offensive counterspace capabilities. In some other countries, interest in space warfare may be increasing because of these arguments. If any nation, for whatever reason, launched an attack strictly avoid any direct public discussion of the consequences of nuclear war. They do so by arguing that nuclear weapons are not intended to be used, but only to deter. Remarkably, the leaders of the Nuclear Weapon States have chosen to ignore the authoritative, long-standing scientific research done by the climatologists, research that predicts virtually any nuclear war, fought with even a fraction of the operational and deployed nuclear arsenals, will leave the Earth essentially uninhabitable.



## C2: Space Debris

**Low earth orbit is currently congested with space debris and on track to increase with more corporate appropriation – causes debris cascades. David 21'** (Leonard David, April 14,

2021, "Space Junk Removal is Not Going Smoothly",  
<https://www.scientificamerican.com/article/space-junk-removal-is-not-going-smoothly/>)

A Space Age "tragedy of the commons" is unfolding right under our nose—or, really, right over our head—and no consensus yet exists on how to stop it. For more than a half-century, humans have been hurling objects into low-Earth orbit in ever growing numbers. And with few meaningful limitations on further launches into that increasingly congested realm, the prevailing attitude has been persistently permissive: in orbit, it seems, there is always room for one more. After so many decades of the buildup of high-speed clutter in the form of spent rocket stages, stray bolts and paint chips, solid-rocket-motor slag, dead or dying satellites and the scattered fragments from antisatellite tests—all of which could individually damage or destroy other assets—low-Earth orbit is finally on the verge of becoming too crowded for comfort. And the problem is now poised to get much worse because of the rise of satellite "mega constellations" requiring thousands of spacecraft, such as SpaceX's Starlink, a broadband Internet network. Starlink is but one of many similar projects: Another mega constellation from a company called OneWeb is already being deployed. And Amazon's Project Kuiper is seeking to create a mega constellation of up to 3,200 satellites in the near future. As the congestion has grown, so too have close calls between orbiting assets. The International Space Station, for instance, regularly tweaks its orbit to avoid potentially hazardous debris. Worse yet, there has been an uptick in the threat of full-on collisions that generate menacing refuse that exacerbates the already bad situation. Consider the February 2009 run-in between a dead Russian Cosmos satellite and a commercial Iridium spacecraft, which produced an enormous amount of debris. Finding ways to remove at least some of all that space junk should be a top global priority, says Donald Kessler, a retired NASA senior scientist for orbital debris research. In the late 1970s he foretold the possibility of a scenario that has been dubbed the Kessler syndrome: as the density of space rubbish increases, a cascading, self-sustaining runaway cycle of debris-generating collisions can arise that might ultimately make low-Earth orbit too hazardous to support most space activities.

**OST ambiguity fails to address space debris allowing corporations to increase congestion in LEO – SpaceX proves Stockwell '20:**

**Stockwell, Samuel.** "Legal "Black Holes" in Outer Space: The Regulation of Private Space Companies." *E-International Relations* 20 (2020).

Yet the proliferation of these commercial satellite plans also pose significant environmental issues. Article IX of the OST asserts that: "States shall pursue activities of outer space in a manner that avoids any harmful contamination or adverse environmental changes on Earth" (UN, 1967). However, the use of terms like 'harmful' or 'adverse change' underscores the lack of specificity over what exactly constitutes environmental damage, or for whom it must refrain from harming. There is also a failure to address the explicit problem of space debris since the discourse is primarily concentrated on chemical effluent pollution, undermining attempts to facilitate the removal of floating wreckage (Gupta, 2016: 26). The inability of the OST to properly promote environmental considerations in space has been mirrored in the NewSpace community, where there has been a woeful lack of ecological consideration: "The hundreds of articles and books on outer



space resource development seldom mention that such actions may adversely affect the environment in ways that will potentially disadvantage their enterprises and the humans that will be required to implement them” (Kramer, 2017: 136). Such images evoke the types of difficulties that private firms have encountered on Earth reconciling capital with the environment in a way that doesn’t damage profit margins (Magdoff & Foster, 2011: 61-66). Yet in doing so, this neglect is only likely to result in the proliferation of extra-terrestrial debris that the UN OST failed to address. Indeed, despite its vastness there is only a narrow region of orbital space that is either useable or beneficial for prolonged human missions (Brearley, 2005: 2), meaning that the increase in space debris from these massive commercial satellite constellations will likely be at the detriment of developing nations who have yet fostered spacefaring capabilities. Elon Musk’s SpaceX company has already caused complications for Earth-bound astrologists. The brightness of his recent ‘Starlink’ satellite constellation system in comparison to other satellites has been obscuring telescopic images (see Grush, 2020). More concerning, Starlink may be much more visible during twilight hours which could be problematic in identifying potentially hazardous asteroids in a timely manner (The Verge, 2020). In this sense, whilst private space entrepreneurs are able to increase their profitability from being able to establish constellations, such endeavours are spoiling the scientific work of researchers on Earth that may complicate the monitoring of Earthbased asteroid impacts.

## **Clustering makes the risk of collisions uniquely high and the risk is understated**

Dr. Darren **McKnight 17**, Ph.D., Technical Director for Integrity Applications, Previously Senior Vice President and Director of Science and Technology Strategy at Science Applications International Corporation, “Proposed Series of Orbital Debris Remediation Activities,” 3rd International Conference and Exhibition on Satellite & Space Missions, 5/13/2017, <https://iaaweb.org/iaa/Scientific%20Activity/debrisminutes03166.pdf> [graphics omitted]

In the future, this population will be added to primarily from collisions between large objects in orbit as the number of LNT produced is proportional to the mass involved in a collision (or explosion).<sup>2</sup> Cataloged debris produced from a catastrophic collision will be liberated at about 1-3 fragments per kilogram of mass involved while LNT production is around 10-40 fragments per kilogram of mass involved. The Iridium/Cosmos collision involved a total mass of 2,000kg and produced over 3,000 trackable fragments and likely 10,000-15,000 LNT debris. The Feng-Yun purposeful collision yielded over 2,200 trackable fragments and likely over 30,000 LNT from only ~850kg of mass involved. While it is important to prevent these types of events from occurring in the future, the consequence of a collision (based on number of LNT produced) will be proportional to the mass involved in the collision. The term “mass involved” implies a good coupling of the impactor mass with the target mass. For a large fragment (e.g., several kilograms) striking a typical payload (that is densely built) in its main satellite body (vice striking a solar array or other appendage) at hypervelocity speeds (i.e., above 6km/s) will result in all the mass being “involved” in the debris. However, a large fragment striking a derelict rocket body, due to the way that the mass is concentrated at the ends of a rocket body, will likely not result in all of the mass being “involved” in the liberated debris. However, it is likely that when two large derelicts, either rocket bodies or payloads, collide with each other, then all of the mass will be involved due to the likely direct physical interaction between the mass. The table below summarizes the mass involvement scenarios which highlight why the massive-on-massive collisions are the focus of our analyses. Therefore, it is best to prevent the collision of the most massive objects with each other (higher consequence) and the ones that are the most likely (higher probability) since risk is probability multiplied by consequence. Our ability to model and predict the rate of collisions is based empirically upon only one catastrophic accidental collision event and a model developed on the kinetic theory of gases (KTG). However, clusters of massive objects that have identical inclinations plus similar and overlapping apogees/perigees may indeed have a greater probability of collision than predicted by the KTG-based algorithms as they are not randomly distributed and their orbital element evolution (e.g., change in right ascension of ascending node and argument of perigee) is also similar. It is hypothesized that these similarities could result in resonances of collision dynamics that may lead to larger probability of collision values than predicted with current algorithms. The not well-known fact is that many of the most massive objects are in tightly clumped clusters that will likely

produce greater probability of collision than estimated by the KTG approach (see attached paper) and with the much larger consequence (i.e., creation of catalogued LNT fragments). The attached paper that studied this possibility shows some initial indications that this may indeed be true but much more analysis is needed to provide this conclusively. This table of clusters represents well over 50% of the total derelict mass in LEO. However, no one is currently monitoring these potential events. It is proposed that it would be a prudent risk management approach for space flight safety to monitor and characterize this inter-cluster collision risk. The Massive Collision Monitoring Activity (MCMA) is proposed whereby the encounters between members of these clusters are constantly monitored and close encounter information collected, plotted, analyzed, and shared. This would provide a rich research base for scientists and a predictive service for spacefaring countries. I am currently executing a subset of this proposed activity in an ad hoc fashion in conjunction with JSpOC. I have been monitoring the interaction dynamics between the SL-16 population in the 820- 865km altitude region for the last nine months.

## **Satellites are key to environmental monitoring – debris collapses it and causes climate extinction**

Ben **Biggs 18**, PhD Researcher in Computer Vision and Deep Learning at the University of Cambridge, “How Satellites Can Protect Planet Earth From Disaster”, HowItWorks Daily, 12/22/2018, <https://www.howitworksdaily.com/how-satellites-can-protect-planet-earth-from-disaster/>

It might not look it, but our planet is a fragile place. A delicate balance of pressure, temperature and gases keeps us alive, as our atmosphere lets in enough heat for us to thrive – but not too much that we get too toasty. For many years our planet has looked after itself with ease. Now, with humans on the scene, things are changing more than ever, from climate change to mass deforestation. If our planet is going to survive long into the future it’s going to need our help. Fortunately, we’ve got plenty of missions that are working for the benefit of our world already. Using observation satellites in orbit, scientists have been monitoring Earth for decades, watching how the planet pulsates and changes over time. From orbit we can watch how species migrate, identify and predict environmental changes and even fix problems. A great example of this was the global effort to repair a hole in the ozone above the Antarctic back in 1987. Two years prior, scientists had discovered that chemicals known as chlorofluorocarbons (CFCs) – produced by fridges and aerosols, among other things – were causing the hole to grow. As a result countries around the world agreed to phase out the use of CFC as part of the Montreal Protocol. In early 2018, NASA announced that its Aura satellite had watched the hole successfully close, with it expected to fully repair as early as 2060. It was proof that we could work together to change the planet for the better. Aura is part of a broader NASA project called the Earth Observing System (EOS). This programme, which began in 1997, has seen NASA launch missions and instruments into orbit. This has included the groundbreaking Landsat series of satellites, which have provided surface images of the whole globe. Then there’s the Terra mission that launched in 2009 and studies clouds, sea ice and more from orbit. Most of these satellites are in polar orbits, which means they orbit the planet from top to bottom so that it rotates underneath and gives them a global view. Planning for the EOS began back in the 1980s, with NASA keen to regularly fly instruments for at least 15 years. “Human activity has altered the condition of the Earth by reconfiguring the landscape, by changing the composition of the global atmosphere, and by stressing the biosphere in countless ways,” they noted in a handbook in 1993. “There are strong indications that natural change is being accelerated by human intervention.” More than two dozen missions have been launched as part of the EOS to date. Among the programme’s many accomplishments, scientists watched as an ice shelf collapsed on the Antarctic Peninsula in 2002 using the Terra satellite. The same satellite, along with the Aqua satellite launched in 2002, has provided a global view of how the vegetation cycle changes over the course of a year and the effect the climate has on it. Those same two satellites have also allowed us to see how summer sea ice in the Arctic is decreasing, which means that more of the Sun’s light is being absorbed rather than being reflected, raising global temperatures. The EOS has helped in other ways too, such as enabling scientists to keep a close eye on the levels of toxic gases like carbon monoxide being emitted from massive fires in the atmosphere. This allows people on the ground to be alerted to these dangers, and they can in turn be advised to limit their outdoor activity to protect their health. The EOS is even helping to track and monitor rare animals, such as chameleons in Madagascar. Here, scientists have been able to use satellite imagery, combined with known habitats of the animals, to map out where they are likely to be living. It would take survey teams on the ground thousands of years to replicate this information without satellites. It’s not just NASA that has been keeping a close eye on the planet. The European Space Agency (ESA) runs the Copernicus project, billed as the world’s largest single Earth observation campaign. Previously known as the Global Monitoring for Environment and Security (GMES) programme, it began with the launch of the Sentinel-1A satellite in April 2014. This radar imaging satellite provides images both day and night and during all weather conditions, and these

are being used to map sea ice, track oil spills and more. This has been followed by half a dozen more missions, with the latest – Sentinel-3B – launching on 25 April 2018. This mission is focusing on monitoring the behaviour and health of the oceans, but it has a wide range of abilities. It flies in formation with its predecessor, Sentinel-3A, and together the two of them can provide global data for Earth across an entire day. The satellites can measure the temperature over oceans, as well as the colour and height of the sea. They can also monitor wildfires from space, check the health of vegetation and map the way that land is being used around the world. And there are more Sentinel satellites on the way. In the coming years we'll see the Sentinel-4 and Sentinel-5 missions launch, studying the composition of our planet's atmosphere, while Sentinel-6 will measure global sea surface height for ocean and climate studies. "Copernicus will help shape the future of our planet for the benefit of all," said the ESA, also noting that it is the "most ambitious Earth observation programme to date," one that will provide accurate and timely data on the environment, climate change and more. All of this data is vital for directing climate policy and other human activities on Earth. By observing our planet around the clock from space we can see the direct effect that humans are having on it. These are not the only climate-monitoring missions run by NASA and the ESA. The former has a number of other missions, including the Deep Space Climate Observatory, which observes the sunlit side of Earth. The latter has eight missions on the books in its Earth Explorer programme, including a mission to study how Earth's gravity field varies over the surface of the planet, called the Gravity field and steady-state Ocean Circulation Explorer (GOCE), which ended in 2013. In 2016, countries of the world came together to sign the Paris Climate Agreement, a global effort to reduce carbon emissions to prevent the global average temperature rising by two degrees Celsius above pre-industrial levels. While the US later reneged from this agreement, it was proof that with enough level-headed minds, minds that can see the data from missions showing how the planet is changing, we can take action. Humans continue to have a major effect on the planet, for better or worse, and monitoring that change is vital to our planet's survival.