# 1NC vs Lexington AS

## 1

#### Interpretation: “appropriation of outer space” by private entities refers to the exercise of exclusive control of space.

TIMOTHY JUSTIN TRAPP, JD Candidate @ UIUC Law, ’13, TAKING UP SPACE BY ANY OTHER MEANS: COMING TO TERMS WITH THE NONAPPROPRIATION ARTICLE OF THE OUTER SPACE TREATY UNIVERSITY OF ILLINOIS LAW REVIEW [Vol. 2013 No. 4]

The issues presented in relation to the nonappropriation article of the Outer Space Treaty should be clear.214 The ITU has, quite blatantly, created something akin to “property interests in outer space.”215 It allows nations to exclude others from their orbital slots, even when the nation is not currently using that slot.216 This is directly in line with at least one definition of outer-space appropriation.217 [\*\*Start Footnote 217\*\*Id. at 236 (“Appropriation of outer space, therefore, is ‘the exercise of exclusive control or exclusive use’ with a sense of permanence, which limits other nations’ access to it.”) (quoting Milton L. Smith, The Role of the ITU in the Development of Space Law, 17 ANNALS AIR & SPACE L. 157, 165 (1992)). \*\*End Footnote 217\*\*]The ITU even allows nations with unused slots to devise them to other entities, creating a market for the property rights set up by this regulation.218 In some aspects, this seems to effect exactly what those signatory nations of the Bogotá Declaration were trying to accomplish, albeit through different means.219

#### Private appropriation of extracted space resources is distinct from appropriation “of” outer space. Despite longstanding permission of appropriation of extracted resources, sovereign claims are still universally prohibited.

Abigail D. Pershing, J.D. Candidate @ Yale, B.A. UChicago,’19, "Interpreting the Outer Space Treaty's Non-Appropriation Principle: Customary International Law from 1967 to Today," Yale Journal of International Law 44, no. 1

II. THE FIRST SHIFT IN CUSTOMARY INTERNATIONAL LAW’S INTERPRETATION OF THE NON-APPROPRIATION PRINCIPLE Since the drafting of the Outer Space Treaty, several States have chosen to reinterpret the non-appropriation principle as narrower in scope than its drafters originally intended. This reinterpretation has gone largely unchallenged and has in fact been widely adopted by space-faring nations. In turn, this has had the effect of changing customary international law relating to the non-appropriation principle. Shifting away from its original blanket application in 1967, States have carved out an exception to the non-appropriation principle, allowing appropriation of extracted space resources.53 This Part examines this shift in the context of the two branches of the United Nation’s customary international law standard: State practice and opinio juris. A. State Practice The earliest hint of a change in customary international law relating to the interpretation of the non-appropriation clause came in 1969, when the United States first sent astronauts to the moon. As part of his historic journey, astronaut Neil Armstrong collected moonrocks that he brought back with him to Earth and promptly handed off to the National Aeronautics and Space Administration (NASA) as U.S. property.54 Later, the USSR similarly claimed lunar material as government property, some of which was eventually sold to private citizens. 55 These first instances of space resource appropriation did not draw much attention, but they presented a distinct shift marking the beginning of a new period in State practice. Having previously been limited by their technological capabilities, States could now establish new practices with respect to celestial bodies. This was the beginning of a pattern of appropriation that slowly unfolded over the next few decades and has since solidified into the general and consistent State practice necessary to establish the existence of customary international law. Currently, the U.S. government owns 842 pounds of lunar material.56 There is little question that NASA and the U.S. government consider this material, as well as other space materials collected by American astronauts, to be government property.57 In fact, NASA explicitly endorses U.S. property rights over these moon rocks, stating that “[l]unar material retrieved from the Moon during the Apollo Program is U.S. government property.”5 The U.S. delegation’s reaction to the language of the 1979 Moon Agreement further cemented this interpretation that appropriation of extracted resources is a permissible exception to the non-appropriation clause of Article II. Although the United States is not a party to the Moon Agreement, it did participate in the negotiations.59 The Moon Agreement states in relevant part: Neither the surface nor the subsurface of the moon, nor any part thereof or natural resources in place, shall become property of any State, international intergovernmental or nongovernmental organization, national organization or nongovernmental entity or of any natural person.60 In response to this language, the U.S. delegation made a statement laying out the American view that the words “in place” imply that private property rights apply to extracted resources61—a comment that went completely unchallenged. That all States seemed to accept this point, even those bound by the Moon Agreement, is further evidence of a shift in customary international law.62 B. Opinio Juris: Domestic Legislation Domestic law, both in the United States and abroad, provides further evidence of the shift in customary international law surrounding the issue of nonappropriation as it relates to extracted space resources. Domestic U.S. space law is codified at Section 51 of the U.S. Code and has been regularly modified to expand private actors’ rights in space.63 Beginning in 1984, the Commercial Space Launch Act provided that “the United States should encourage private sector launches and associated services.”64 The goal of the 1984 Act was to support commercial space launches by private companies and individuals.65 It did not, however, specifically discuss commercial exploitation of space. The first such mention of commercial use of space appeared in 2004, with the Commercial Space Launch Amendments Act.66 This Act specifically aimed at regulating space tourism but did not explicitly guarantee any private rights in space.67 The most significant change in U.S. space law came with the passage of the Spurring Private Aerospace Competitiveness and Entrepreneurship (SPACE) Act in 2015. As incorporated into Section 51 of the Code, this Act provides: A United States citizen engaged in commercial recovery of an asteroid resource or a space resource under this chapter shall be entitled to any asteroid resource or space resource obtained, including to possess, own, transport, use, and sell the asteroid resource or space resource obtained in accordance with applicable law, including the international obligations of the United States.68 Whereas the idea that private corporations might go into space may have seemed far-fetched to the drafters of the Outer Space Treaty, the SPACE Act of 2015 was the first instance of a government recognizing such a trend and officially supporting private companies’ commercial rights to space resources under law. With the new 2015 amendment to Section 51 in place, U.S. companies can now rest assured that any profits they reap from space mining are firmly legal—at least within U.S. jurisdictions. Although the United States was the first country to officially reinterpret the non-appropriation principle, other countries are following suit. On July 20, 2017, Luxembourg passed a law entitled On the Exploration and Utilization of Space Resources with a vote of fifty-five to two.69 The law took effect on August 1, 2017.70 Article 1 of the new law states simply that “[s]pace resources can be appropriated,” and Article 3 expressly grants private companies permission to explore and use space resources for commercial purposes.71 Official commentary on the law establishes that its goal is to provide companies with legal certainty regarding ownership over space materials—a goal that the commentators regard as legal under the Outer Space Treaty despite the non-appropriation principle.72 The next country to enact similar legislation may be the United Arab Emirates (UAE). According to the UAE Space Agency director general, Mohammed Al Ahbabi, the UAE is currently in the process of drafting a space law covering both human space exploration and commercial activities such as mining.73 To further this goal, in 2017 the UAE set up the Space Agency Working Group on Space Policy and Law to specify the procedures, mechanisms, and other standards of the space sector, including an appropriate legal framework.74 C. Opinio Juris: Legal Scholarship Other major space powers are also considering similar laws in the future, including Japan, China, and Australia. 75 Senior officials within China’s space program have explicitly stated that the country’s goal is to explore outer space and to take advantage of outer space resources.76 The general international trend clearly points in this direction in anticipation of a potential “space gold rush.” 7 Mirroring the shift in State practice and domestic laws, the legal community has also changed its approach to the interpretation of the nonappropriation principle. Whereas at the time of the ratification of the Outer Space Treaty the majority of legal scholars tended to apply the non-appropriation principle broadly, most legal scholars now view appropriation of extracted materials as permissible.78 Brandon Gruner underscores that this new view is historically distinct from prior legal interpretation, noting that modern interpretations of the Outer Space Treaty’s non-appropriation principle differ from those of the Treaty’s authors.79 In contrast to earlier legal theory that denied the possibility of appropriation of any space resources, scholars now widely accept that extracting space resources from celestial bodies is a “use” permitted by the Outer Space Treaty and that extracted materials become the property of the entity that performed the extraction.80 Stressing the fact that the Treaty does not explicitly prohibit appropriating resources from outer space, other authors conclude that the use of extracted space resources is permitted, meaning that the new SPACE Act is a plausible interpretation of the Outer Space Treaty.81 However, scholars have been careful to cabin the extent to which they accept the legality of appropriation. For instance, although Thomas Gangale and Marilyn Dudley-Rowley acknowledge the legality of private appropriation of extracted space resources, they nonetheless emphasize that “[o]wnership of and the right to use extraterrestrial resources is distinct from ownership of real property” and that any such claim to real property is illegal.82 Lawrence Cooper is also careful to point out this distinction: “[t]he [Outer Space] Treaties recognize sovereignty over property placed into space, property produced in space, and resources removed from their place in space, but ban sovereignty claims by states; international law extends this ban to individuals.”83 Although there remain some scholars who still insist on the illegality of the 2015 U.S. law and State appropriation of space resources generally,84 their dominance has waned since the 1960s. These scholars are now a minority in the face of general acceptance among the legal community that minerals and other space resources, once extracted, may be legally claimed as property. 85 Taken together, the elements described above—statements made in the international arena, de facto appropriation of space resources in the form of moon rocks, the adoption of new national policies permitting appropriation of extracted space resources, and the weight of the international legal community’s opinion— indicate a fundamental shift in customary international law. The Outer Space Treaty’s non-appropriation clause has been redefined via customary international law norms from its broad application to now include a carve-out allowing appropriation of space resources once such resources have been extracted.

#### Violation ­– the aff only bans private resource extraction through asteroid mining, which is limited in scope – that’s distinct from full sovereignty over space

#### Vote neg:

#### Limits – their interp explodes the topic to include affs about using space for any single purpose, like space-based solar power, helium and REMs on the Moon, space tourism, and climate adaptation satellites – this is unpredictable because topic lit is concerned with sovereignty over space and space colonization broadly, privileges the aff by stretching pre-tournament neg prep too thin and precludes nuanced case negs that rigorously test the aff

#### Precision – Justifies the aff arbitrarily doing away with words in the resolution which gives way to affs about anything from public appropriation affs to air space affs and many more which obliterates negative prep.

#### Topicality is a voting issue that should be evaluated through competing interpretations—it tells the negative what they do and do not have to prepare for. Reasonability is arbitrary and unpredictable, inviting a race to the bottom and we’ll win it links to our offense

## 2

#### Currently, nuclear power plants produce radioactive waste because of nuclear fission, Edinformatics 13

(Edinformatics, December 2013, accessed on 12-30-2021, Edinformatics, "What is Helium-3 and why is it so important?", https://www.edinformatics.com/math\_science/what-is-helium-3.html) [Lynbrook MD]

Everyone learns about Helium in school. It is the second element in the periodic table having 2 protons, 2 neutrons and 2 electrons - having an atomic mass of 4. But another form of Helium has been in the news lately and it is called Helium-3. Helium-3, also written as 3He, is a light isotope of helium having 2 protons but only one neutron and an atomic mass of 3. The existence of Helium-3 was first proposed in 1934 by the Australian nuclear physicist Mark Oliphant. Helium-3 was originally thought to be a radioactive isotope until it was found in samples of natural helium,, taken both from the terrestrial atmosphere and from natural gas wells. Other than 1H, helium-3 is the only stable isotope of any element with more protons than neutrons. Its presence is rare on Earth, it is sought after for use in nuclear fusion research, and it is abundant in the moon's soil. Currently all nuclear power plants use a nuclear reaction to produce heat which turn water into steam that then drives a turbine to produce electricity. Nuclear power plants have nuclear fission reactors in which uranium nuclei are split part. This releases energy, but also produces radioactive waste which has to be safety stored, effectively indefinitely. Nuclear fusion effectively makes use of the same energy source that fuels the Sun and other stars, and does not produce the radioactivity and nuclear waste that is the by-product of current nuclear fission power generation. Nuclear fusion makes use of the same energy source that fuels the Sun and other stars. Unlike nuclear fission it does not produce the radioactivity and nuclear waste that is the by-product of current nuclear fission power generation. The fission of one atom of U-235 generates 202.5 MeV = 3.24 × 10−11 J, which translates to 19.54 TJ/mol, or 83.14 TJ/kg. This is around 2.5 million times more than the energy released from burning coal. When 23592U nuclides are bombarded with neutrons, one of the many fission reactions that it can undergo is the following. FISSION REACTION OF URANIUM 235 BOMBRADED BY NEUTRONS: 10n + 23592U → 14156Ba + 9236Kr + 3 10n FUSION REACTION OF TWO HELIUM-3 ATOMS: 32He + 32He ---> 42He+ 211p + 12.86 MeV or 22He + 32He ---> 42He+ 11p + 18.3 MeV FUSION OF DEUTERIUM AND H-3: D(21H) + 32He ---> 42He+ 11p + 18.4 MeV

#### Renewable power, emissions reductions, and carbon capture solutions fail without increasing nuclear power, Poneman 19

(Daniel B. Poneman, 5-24-2019, "We Can't Solve Climate Change without Nuclear Power," Scientific American, <https://blogs.scientificamerican.com/observations/we-cant-solve-climate-change-without-nuclear-power/>) [Lynbrook MD]

Sixty-five years ago, President Eisenhower took the first concrete steps toward implementing his “Atoms for Peace” initiative, presenting Soviet leaders with a detailed outline of the safety and nonproliferation rules that should guide the peaceful development of civilian nuclear energy. Three more years of determined U.S.-led diplomacy culminated in the establishment of the International Atomic Energy Agency, which continues to be pivotal in maintaining, monitoring and enforcing global nonproliferation safeguards—so that, in Ike’s words, “this greatest of destructive forces can be developed into a great boon, for the benefit of all mankind.” The existential threat of nuclear annihilation did not go away when the Cold War ended, and now we face a second existential threat from climate change. In the face of these twin threats, American nuclear leadership is as critical in 2019 as it was in 1954. Nuclear energy is the largest source of carbon-free energy in the U.S. by a huge margin and it has a major role to play in confronting the global climate challenge. But we must also be vigilant about the prospect of nuclear weapons falling into the hands of terrorists or rogue regimes. The threat of nuclear proliferation abroad should not lead us to abandon nuclear energy at home. Indeed, American nuclear leadership has always been critical to guiding the safe, responsible use of civilian nuclear energy around the world. For example, a number of American companies are developing advanced generation-reactor technologies that offer a host of safety and nonproliferation advantages. These advanced designs would have “walk away” safety, meaning they do not need any backup power or external cooling systems in the event of an accident. And since many of the new reactor designs would rarely if ever need to be refueled, the risk of diversion of fuel from uranium-enrichment or plutonium-reprocessing plants to a bomb program would be greatly diminished. The U.S. should lead the way in the development of these reactors so they can be deployed at home and abroad over the next decade. As a ries that adopt the new U.S. reactor designs will also be subject to U.S. nonproliferation requirements, which are second to none. We must also confront the challenge posed by countries like North Korea, which has nuclear weapons, and Iran, which has sought to develop them. There is no substitute for tough diplomacy, backed by a unified international community willing to exercise its leverage—through sanctions or ultimately military means, if necessary—to persuade these nations to give up their weapons in a transparent and verifiable way. Here again, America’s technical expertise in building, operating and fueling reactors informs and strengthens our ability to design enforceable nonproliferation agreements and effective verification measures to detect and respond to violations. American leadership in nuclear technologies is equally important when it comes to the climate challenge. It has been three years since the Paris Climate Agreement and the world is already falling far short of its collective commitments to reduce carbon emissions. Even if all nations achieved 100 percent of the reductions they pledged in Paris, the world would not come anywhere near the goal of limiting temperature rise to 2 degrees Celsius over preindustrial levels, much less the 1.5-degree target that scientists say we must achieve if we are, for example, to save the earth’s coral reefs. Projected increases in renewable power and plans to invest in carbon-capture technologies, efficiency measures, reforestation and other steps are important but will not get us there. That is why the International Energy Agency has concluded that meeting the goal of 2 degrees C will require doubling nuclear power’s contribution to global energy consumption by mid-century.

#### Nuclear Energy is Key, WNA

(World Nuclear Association, How can nuclear combat climate change?, https://world-nuclear.org/nuclear-essentials/how-can-nuclear-combat-climate-change.aspx)

How can nuclear combat climate change?To limit the impacts of climate change, the world must rapidly reduce its dependency on fossil fuels to reduce greenhouse gas emissions. Nuclear energy is low-carbon and can be deployed on a large scale at the timescale required, supplying the world with clean, reliable, and affordable electricity. Nuclear\_energy\_important\_part\_of\_solution.jpgClimate change – an accelerating global problemThe United Nations has identified climate change as "the defining issue of our time", with the central aim of the 2015 Paris Agreement is to keep the rise in global temperatures to well below 2 °C compared to pre-industrial levels, and with the aim to limit the rise to 1.5 °C. This is driven by the scientific consensus that limiting the rise to 1.5 °C would significantly reduce the risks posed by climate change. Despite this, carbon dioxide emissions related to energy continue to rise – reaching 33.1 billion tonnes in 2018, a record high, and have increased by more than 40% since 2000. Concerted international efforts over the past 20 years have increased the amount of electricity generated by wind, solar and other renewable sources, but have failed to displace fossil fuels from the mix. As a matter of fact, in 2017, fossil fuels produced more electricity – in relative and absolute terms – than ever before. In its 2018 report, Global Warming of 1.5 °C, the Intergovernmental Panel on Climate Change (IPCC) warned that we are likely to breach the 1.5 °C threshold by as early as 2030. Fossil versus non-fossil fuel electricity generation in 2000 and 2017 (Source: IEA World Energy Outlook)Nuclear is low-carbonNuclear power plants produce no greenhouse gas emissions during operation, and over the course of its life-cycle, nuclear produces about the same amount of carbon dioxide-equivalent emissions per unit of electricity as wind, and one-third of the emissions per unit of electricity when compared with solar. Average life-cycle carbon dioxide-equivalent emissions for different electricity generators (Source: IPCC)Experts have concluded that in order to achieve the deep decarbonisation required to keep the average rise in global temperatures to below 1.5°C, combating climate change would be much harder, without an increased role for nuclear. Because nuclear power is reliable and can be deployed on a large scale, it can directly replace fossil fuel plant, avoiding the combustion of fossil fuels for electricity generation. The use of nuclear energy today avoids emissions roughly equivalent to removing one-third of all cars from the world’s roads. Nuclear power plants, such as the Diablo Canyon power station in California, provide our societies with reliable and affordable electricity, day in and day out (Photo: Mike Baird)Modern society is becoming more and more dependent on electricity, with demand steadily increasing as transport, domestic heating and industrial processes are increasingly electrified. Whilst electricity is clean at the point of use, its generation currently produces over 40% of all energy-related carbon emissions. Decarbonising the electricity supply, whilst providing affordable and reliable electricity to a growing global population, must be central to any climate change strategy.Nuclear energy has shown that it has the potential to be the catalyst for delivering sustainable energy transitions, long before climate change was on the agenda. France generates over 70% of its electricity from nuclear power – the largest nuclear share of any country globally – and its electricity sector emissions are one-sixth of the European average. In around 15 years, nuclear power went from playing a minor role in the French electricity system to producing the majority of its electricity, showing that nuclear energy can be expanded at the speed required to effectively combat climate change.The French electricity mix 1974-2017 (Source: IEA)Achieving HarmonyAll technologies that can contribute towards solving one of the greatest challenges faced by humankind should be deployed. We cannot afford to wait, as the impacts of climate change will hit the poorest and most vulnerable first and failing to act will have significant humanitarian consequences.The nuclear industry recognises the scale and immediacy of the challenge, and the important role that all low-carbon energy sources must play. Harmony – the industry’s vision for the future of electricity supply – sets a target to build an additional 1000 GWe of nuclear reactors across the world so that nuclear power would provide 25% of electricity by 2050. By achieving Harmony, we can build a new, cleaner and truly sustainable world – enabling us to pass on a cleaner planet to our children.

#### Private Companies are key to find and mine helium-3, Jeffries 14

(Adrianne Jeffries, 2-9-2014, accessed on 12-30-2021, The Verge, "NASA is now accepting applications from companies that want to mine the moon", https://www.theverge.com/2014/2/9/5395684/nasa-begins-hunt-for-private-companies-to-mine-the-moon-catalyst) [Lynbrook MD]

NASA is now working with private companies to take the first steps in exploring the moon for valuable resources like helium 3 and rare earth metals. Initial proposals are due tomorrow for the Lunar Cargo Transportation and Landing by Soft Touchdown program (CATALYST). One or more private companies will win a contract to build prospecting robots, the first step toward mining the moon. The contract will be a "no funds exchanged" Space Agreement Act, which means the government will not be directly funding the effort, but will receive NASA support. Final proposals are due on March 17th, 2014. NASA has not said when it will announce the winner. NASA works with private companies that service the International Space Station, and those partnerships have gone well. Faced with a skeleton budget, the agency is looking for innovative ways to cooperate with the private sector in order to continue research and exploration, as it did recently with a crowdsourcing campaign to improve its asteroid-finding algorithms. That campaign was launched with another private company, Planetary Resources, the billionaire-backed asteroid mining company. Faced with a skeleton budget, the agency is looking for innovative ways to cooperate with the private sector According to the 1967 Outer Space Treaty of the United Nations, countries are prohibited from laying claim to the moon. The possibility of lunar mining and the emergence of private space companies has triggered a debate over lunar property rights, however. "There’s a strong case for developing international law in this area because in 1967 it was not envisaged that anyone other than nation states would be able to explore 1the moon," Ian Crawford, a planetary science professor, told The Telegraph. "Clearly that is changing now and there is a case for developing the outer space treaty to include private organizations that may wish to explore the moon."

#### Tons of helium-3 on the moon, only private companies solve, Almasy 11

(Steve Almasy, 7-21-2011, accessed on 12-30-2021, CNN, "Could the moon provide clean energy for Earth?", http://www.cnn.com/2011/TECH/innovation/07/21/mining.moon.helium3/index.html) [Lynbrook MD]

Gerald Kulcinski has a big problem. The nuclear engineering professor at the University of Wisconsin needs a rare element to fuel his research into a fusion reactor. But the cost of the isotope -- helium-3 -- is rising faster than a rocket headed to space. A few years ago it was $1,000 a gram, this year it is $7,000 and next year, well, he assumes it will be tens of thousands of dollars. There are only about 30 kilograms of 3He on Earth, Kulcinski said. Most helium-3 comes as a byproduct of tritium, used in nuclear weapons, so the exact figure is secret. Governments covet helium-3 because it works well in sensors that detect the presence of nuclear material, such as the ones that scan incoming cargo at the nation's borders and ports. "Worldwide demand is very high, the supply is fixed and going down, and those of us who are trying using helium-3 for research purposes are paying very high prices," said Kulcinski, who is the director of the Fusion Technology Institute. "It'll basically shut off university activity pretty soon because we won't be able to afford it." The Kulcinski team's approach toward creating fusion is unique. Ninety-nine percent of research is geared toward using deuterium and tritium together. But using helium-3 instead of tritium would be much safer and drastically cut the chance of nuclear weapons proliferation. If 3He-3He fusion works, there would be no radioactive waste. A breakthrough would be huge, but the team needs more years and more helium-3. The thing is that there are tons of helium-3 -- on the moon. About 1 million tons, Kulcinski said, adding that we also have a pretty good idea as to where the 3He is on the moon. We would know precisely how many trillions of dollars of the stuff is there if someone goes back to the moon and establishes a base there. "A few years ago we thought we were going back soon but that's all changed now," he said. NASA at a crossroads Apollo 17 astronaut and geologist Harrison Schmitt said the United States is behind in the race to return to the surface of the moon. Schmitt, who is the author of "Return to the Moon," has come to the conclusion that NASA's best days are a part of history and it would be best to start over. The space agency is dysfunctional in many ways as a management entity and the past two presidents have lacked a good space policy or the implementation of one, he said. NASA could watch over our obligations to the International Space Station, he said, but missions to the moon and Mars should be handled by another group. "It's probably time to create a new agency ... that would focus almost entirely on deep space," he said. "The agency has just gotten old and most of the experience is retiring." Next space age has a business model, astronauts say He foresees private companies leading the way to the moon. He thinks the fusion research, rocket building and moon base project can be done for $15-20 billion over two decades. By comparison, another big nuclear fusion project (on Earth), the International Thermonuclear Reactor Project, has a €12.8 billion ($18 billion) budget. The big question for investors would be: Is it worth it when you compare it to the costs of producing other fuels like electricity from coal? Schmitt said yes, because the helium-3 on the moon is worth about $150 million per 100 kilograms. Still, capital operating costs, which would be in the billions, will have to come down, he said. The concalllentration of helium-3 is low, so many tons of regolith -- a combination of lunar soil, dust and other material -- would have to be mined to collect 3He. It's difficult to get investors to put money into any helium-3 project, Schmitt said. "The folks at the University of Wisconsin have gone a long way in the early definition, or let's say, demonstration, of the physics of helium-3 fusion," he said, "but we are a long way and have to go through a (long) process" before they approach the break-even point where investors' interest will be piqued. The real challenge is proving you can burn 3He At their lab in Madison, Wisconsin, Kulcinski and his small team of scientific staff and graduate students have developed a tabletop 3He-powered reactor that can produce a small amount of electricity. They are making progress in producing more energy than when they started more than 25 years ago, but there's still much work to be done. The catch? More energy is used than is produced. As critics often note, the promise of nuclear fusion always seems to be 50 years away. Kulcinski doesn't have an end date, a breakthrough date, in sight. "I have no doubt that we'll be able to do it," he said. "With talented scientists and engineers around the world, if we really concentrated, we could do this. "Our group, I have all the faith in the world in them, but we're a small group, and we could be at this for a very long time." Not the only reason to go to the moon Schmitt and Kulcinski wholeheartedly agree on one thing -- 3He is not the only reason to return to the moon. As Schmitt The main reason to go back is to learn how to live in space and use the moon as a jumping off place for missions to Mars, Kulcinski said. There are other reasons, they said, including other elements available on the moon and using the lunar surface for telescopes. But Schmitt, who has consulted for Kulcinski's project since 1985, and the professor think helium-3 has such potential it makes going back a vital mission. After all, it could potentially power the Earth for thousands of years. "You would go to the moon for long-term clean energy," Kulcinski said, "because this is really an enormous source of energy. There is 10 times more energy there than there ever was in fossil fuel on the Earth." said, "We've only touched the surface of exploring it."

#### Nuclear waste is an existential risk, Morris 15

(Margaret Morris devised the GEO-DMF System for robotically building automated solid rock outer space facilities, which she describes in her book 'Moon Base and Beyond' (Scribal Arts – 2013, "Existential Risk Threatens Human Immortality," Transhumanity, 7-28-2015, https://transhumanity.net/existential-risk-threatens-human-immortality/, Accessed 7-25-2021) [Lynbrook MD]

Deadly environmental pollution has become an existential risk that threatens the prospect not just for human immortality, but for the long-term survival of our species and a great many others. Here we will focus on the nuclear waste aspect of the problem and ways to mitigate it before there is a critical tipping point in our global ecosystem. As philosopher Nick Bostrom said in his 2001 paper titled “Existential Risks,” published in the Journal of Evolution and Technology, “Our future, and whether we will have a future at all, may well be determined by how we deal with these challenges.”1 Unlike many radioactive materials that degrade fairly rapidly, some will remain intensely poisonous for incredibly long periods. Plutonium-240 (Pu-240) has a half-life of 6,560 years. The half-life is the time it takes for radioactive decay to decrease by half. But decay does not occur at an even pace, and radioactive isotopes are dangerous for much longer – typically 10 to 20 times the length of their half-life. Pu-238 has an 88-year half-life, and is used for space vehicles despite the frequency of rocket failures. Any exploding rocket including such cargo spreads pollution far and wide. Pu-239 has a half-life of over 24,000 years, and will remain radioactive for about a half a million years. But the situation is more complicated because as Pu-239 decays it transforms to uranium-235 (U-235), which has a half life of 600 to 700 million years. Iodine-129 has a half-life of 16 million years. Pu-244 has a half-life of 80.8 million years. U-238 has a half-life of 4.5 billion years.2 When taken into the body, isotopes of radioactive plutonium are not fully eliminated and tend to accumulate. They are deadly when sufficiently accumulated. Pu-239 was described by its co-discoverer, chemist Glenn Seaborg, as “fiendishly toxic.” In addition to terrible chemical toxicity, plutonium emits ionizing radiation. Pu-239 emits alpha, beta and gamma particles. Gamma radiation can penetrate the entire body and kill cells. Pu-239 has a robust resonance energy of 0.2 96 electron-volts that can badly damage DNA and produce birth defects that carry over generations.3 The body repairs tissues and DNA, but becomes overwhelmed when plutonium concentrates too heavily. According to a 1975 article in New Scientist Magazine, “But if it is inhaled, 10 micrograms of plutonium-239 is likely to cause fatal lung cancer.”4 Experts estimate that Pu-239 is so noxious that only one pound would be enough to kill everyone on our planetif it were so evenly dispersed in the air that everyone inhaled it.5 Although it occurs in nature in exploding stars, almost all plutonium on Earth is man-made – the product of manufacturing nuclear weapons and energy in nuclear power plants. Of the different forms of nuclear products, deadly Pu-239 is very abundant because it is used to make nuclear weapons and is a by-product of energy production in nuclear reactors. As part of the U.S. weapons program (between 1944 and 1988), 114 tons of Pu-239 was produced in nuclear reactors at the Hanford Works facility, in Washington state, and at the Savannah River Site in South Carolina.6 Large quantities of this u-239 remains at temporary storage facilities at these locations. Hanford stores about 50 million gallons of high-level radioactive nuclear and chemically hazardous wastes in underground storage tanks that were not designed for long-term storage. Roughly a third of these tanks have leaked, so that at least a million gallons of radioactive waste has reached the natural environment. Hanford is the most toxic site in the U.S., and among the most toxic places on Earth. Over 1,000 contaminated sites at Hanford have been identified. Groundwater aquifers are polluted for over 200 square miles beyond Hanford. No less than nine pounds of Pu-239 is used to make a working nuclear bomb. As of 2015, a total of 15,695 nuclear weapons are stockpiled by nine countries.7 Some of these weapons are 35 years old, but have a shelf-life of only 25 years.8 These aging weapons are undergoing corrosion. oxidation and other detrimental changes, and they must constantly be maintained and upgraded to prevent them from becoming an immanent threat to life on Earth. They are primary war targets. The situation emphasizes the need for absolute global peace. As of 2014, about 435 nuclear power plants have been built in 31 countries around the world.9 A great number of radioactive products, including Pu-239, are byproducts of U-235 fission occurring in the fuel rods of those plants with uranium reactors. In addition to being susceptible to natural disasters and accidents, these nuclear plants are all vulnerable to acts of war. They, too, emphasize the need for absolute global peace. Many nuclear power plants are operating beyond their established service lives, and storing their nuclear wastes remains highly problematic. No method for the long-term storage of high-level nuclear products was available when industries began producing them to make commercial energy and weapons. Storage remains very precarious, and there is no realistic way to safeguard those that are long-lived. There are 93 different long-lived radioactive elements that are toxic for a minimum of 17,000 years, and the time scale extends for many billions of years of total decay time for some.10 The U.S. alone stores tens of thousands of tons of spent fuel containing [Plutonium] Pu-239 and other highly radioactive materials from the various reactor cores. The quantity continues to increase worldwide as long as the nuclear plants continue to operate. About 1% of spent nuclear fuel is plutonium, and nuclear power provides about 10 percent of the world’s electricity**.** A uranium reactor will contain about a ton of plutonium. These figures provide a rough idea of the enormity of continual global radioactive waste accumulation. Aside from accidents like the Chernobyl disaster (which contaminated 40% of Europe), dangers include the potential for spontaneous fuel combustion and nuclear meltdownat pools containing spent fuel. The following quote from a National Research Council Panel report provides a rough idea of the growing tonnage build-up of plutonium from commercial nuclear reactors: “New production of commercial reactor plutonium during the first half of the 1990s was about 70 MT [metric tons] per year.”11 At least four to five tons of Pu-239 are known to have been released into the environment during nuclear weapons testing.12 Much of the Pu-239 remains buried underground at the test sites. But some was released into the air during atmospheric tests, and some traveled for many miles by way of groundwater after underground tests. About two-thirds of the plutonium in the atmosphere winds up in the oceans, where it tends to sink to their bottoms and challenges sea life.The polluted sediment is disturbed and redistributed by underwater tsunamis, earthquakes, volcanoes and enormous landslides.

#### Climate change causes extinction, Ruiter 17

(Zach Ruiter, environmental reporter for Now Toronto and Torontoist, citing 15, 364 scientists from 184 countries in ‘World Scientists’ Warning to Humanity: A Second Notice’, 11-22-17, “Are we headed for near-term human extinction?” <https://nowtoronto.com/news/are-we-headed-for-near-term-human-extinction/>)

A “warning to humanity” raising the spectre “of potentially catastrophic climate change... from burning fossil fuels, deforestation and agricultural production – particularly from farming ruminants for meat consumption,” was published in the journal BioScience last week. More than 15,000 scientists from 184 countries endorsed the caution, which comes on the 25th anniversary of a letter released by the Union of Concerned Scientists in 1992, advising that “a great change in our stewardship of the earth and the life on it is required, if vast human misery is to be avoided.” A quarter century on, what gets lost in the dichotomy between climate change believers and deniers is that inaction and avoidance in our daily lives are forms of denial, too. And what most of us are collectively denying is the mountingevidence that pointsto a worst-case scenario unfolding of near-term human extinction. Exponential climate change In 2015, 195 countries signed the Paris Climate Agreement to limit the rise in global temperature to below 2 degrees Celsius to avoid dangerous climate change. But none of the major industrialized countries that signed the agreement are currently on track to meet the non-binding targets. The Trump administration has indicated the United States will withdraw from the agreement entirely. In July, a study in the peer-reviewed journal, Proceedings Of The National Academy Of Sciences Of The United States Of America, claimed “biological annihilation via the ongoing **sixth mass extinction**” is underway. And that “all signs point to ever more powerful assaults on biodiversity in the next two decades, painting a dismal picture of the future of life, including human life,” the study states. According to scientists, the majority of previous mass extinctions in the geologic record were characterized by abrupt warming between 6 to 7 degrees Celsius. As recently as 2009, British government scientists warned of a possible catastrophic **4** degrees Celsius global temperature increase by 2060. As Howard Lee wrote in the Guardian in August, “Geologically fast build-up of greenhouse gas linked to **warming, rising sea-levels**, widespread oxygen-starved **ocean dead zones** and **ocean acidification** are fairly consistent across the mass extinction events, and thosesame symptomsare happening todayas a result of **human-driven climate change**.” Runaway climate change is non-linear. Shifts can be exponential, abrupt and massive due to climate change “feedbacks,” which can amplify and diminish the effects of climate change. Here are five you need to know about: 1. Climate lag Temperature increases lag by about a decade, according to NASA’s Earth Observatory. “Just as a speeding car can take some time to stop after the driver hits the brakes, the earth’s climate systems may take a while to reflect the change in its energy balance.” According to a NASA-led study released in July 2016, “Almost one-fifth of the global warming that has occurred in the past 150 years has been missed by historical records due to quirks in how temperatures were recorded.” Adding the climate lag to the current level of global temperature increase would take us past the 2-degree Paris Agreement climate target within a decade. 2. Ice-free Arcti Dr. Peter Wadhams of the Polar Ocean Physics Group at Cambridge University told The Independent more than a year ago that the central part of the Arctic and the North Pole could be ice-free within one to two years. Not only will melting Arctic sea ice **raise global sea levels**, it will also allow the earth to absorb more heat from the sun because ice reflects the sun’s rays while blue open water absorbs it. One study in the Proceedings Of The National Academy Of Sciences Of The United States Of America estimates the extra heat absorbed by the dark waters of the Arctic in summer would add the equivalent of another 25 per cent to **g**lobal **g**reen**h**ouse **g**a**s** emissions. 3. The 50 gigaton methane “burp” Dr. Natalia Shakhova, of the University of Alaska Fairbanks’ International Arctic Research Center has warned that a 50-gigaton burp, or “pulse,” of methane from thawing Arctic permafrost beneath the East Siberian Arctic Shelf is “highly possible at any time.” Methane is a greenhouse gas much more potent than carbon dioxide. A 50 gigaton burp would be the equivalent of roughly two-thirds of the total carbon dioxide released since the beginning of the industrial era. 4. Accelerated ocean acidification The world’s oceans are carbon sinks that sequester a third of the carbon dioxide released into the atmosphere. The carbon dioxide emitted in addition to that which is produced naturally has changed the chemistry of seawater. The carbon in the oceans converts into carbonic acid, which lowers pH levels and makes the water acidic. As of 2010, the global population of phytoplankton, the microscopic organisms that form the basis of the ocean’s food web, has fallen by about 40 per cent since 1950. Phytoplankton also absorb carbon dioxide and produce **half of the world’s oxygen output.** The accelerating loss of ocean biodiversity and continued overfishing may result in a collapse of all species of wild seafood by 2048, according to a 2006 study published in the journal Science. 5. From global warming to global dimming The Canadian government recently announced plans to phase out coal-fired electricity generation by 2030. But at the same time as warming the planet, pollution from coal power plants, airplanes and other sources of industrial soot, aerosols and sulfates are artificially cooling the planet by filling the atmosphere with reflective particles, a process known as global dimming. Airplanes, for example, release condensation trails (or contrails) that form cloud cover that reflects the sun. The effects of global dimming are best evidenced by a 2 degree Celsius temperature increase in North America after all commercial flights were grounded for three days following the attacks of 9/11. The take-away Out of control climate change means feedback mechanisms may accelerate **beyond any capacity of human control**. The occurrences discussed in this article are five of some 60 known weather-related phenomenon, which can lead to what climate scientist James Hansen has termed the “Venus Syndrome,” where oceans would boil and the surface temperature of earth could reach 462 degrees Celsius. Along the way humans could expect to die in **resource wars,** starvation due to food systems collapse or **lethal heat exposure**. Given all that remains unknown and what is at stake with climate change, is it irresponsible to rule out the possibility of **human extinction** in the coming decades or sooner?

## Case

#### Their climate change evidence says extinction by 2026 but no evidence that we will even have mining by 2026, so either the impact is inevitable or they don’t solve.

#### Scoles 15 talks about asteroid deflection, not asteroid mining, which public companies do, Proves the aff does nothing to solve or extinction inevitable. Vote neg if inevitable cause I proved the aff isn’t needed.

#### Private companies are filling in to solve space debris now and the risk of collision is low---built in safeguard, Winter 19

(Lara, Special Correspondent @ Aljazeera, “Taking out the trash - in space”, 7-17-19, https://www.aljazeera.com/ajimpact/trash-space-190716213037055.html )

Houston, we have a trash problem! And it is not just nasty. It can be fatal. In Low Earth Orbit (LEO), debris ranging from tiny crystals of human urine to small school bus-sized satellites are whizzing anywhere up to 2,000km above the Earth's surface at roughly 8km a second. That is 25 times faster than a bullet shot from a Beretta pistol. And that is a problem for humans who fancy going boldly into space. That debris can blow a hole right through a spacecraft, endangering crews and payloads, and creating more fragments of stuff - for which those who follow must watch out. There is no debate that space junk is a growing threat to the commercial space industry. And it got riskier this year after India blew up a satellite into some 4,000 fragments this past March. But some people are hoping to turn the problem of cleaning up the space junk we humans leave behind into a profitable enterprise. How much trash is floating above our heads? Exactly how much debris is floating in LEO is difficult to estimate. But there is undoubtedly a lot of it. NASA's Orbital Debris Program Office has confirmed there are at least 23,000 fragments larger than 10cm. That is roughly the size of a tennis ball. Meanwhile, the European Space Agency reckons the number of tennis-ball-sized junk objects is actually 34,000. That is in addition to an estimated 900,000 objects ranging in size between 1cm and 10cm, as well as 128 million pieces of debris measuring less than 1cm. To give an idea of the kind of damage those tinier objects could cause, consider that a bullet for a Beretta pistol is 9mm. Those millions of projectiles pose a problem to the global space industry that Morgan Stanley estimates will generate $1 trillion in annual revenues by 2040 - roughly triple what it is worth today. Anywhere from a half to two-thirds of that projected growth hinges on satellite broadband projects. One such project, Elon Musk's SpaceX Starlink, recently launched 60 satellites into LEO - the first of potentially thousands of broadband satellites forming a mega-constellation around the Earth. And SpaceX is not the only company trying to do this. OneWeb Satellites, Telesat and Amazon's Project Kuiper are all vying to create mega-constellations to provide broadband service pole to pole. All of this is expensive to develop. Amazon's Project Kuiper, for example, could cost roughly $10bn. That's why firms like Airbus - as well as investment banks and bootstrapping engineers and scientists - are betting that the business of tracking, netting and even harpooning rubbish in LEO could become as profitable as waste management here on Earth - a business estimated to be worth some $52.9bn annually, according to IBISWorld. Airbus is developing a space debris removal product line not only to address the risk to the coming mega-constellations, but a predicted increase in traffic congestion in LEO. "I know it is a truism, but space is a big place," Matthew Stuttard, head of Advanced Systems - Space Systems Engineering at Airbus UK, told Al Jazeera. "In fact, though there is a lot of debris in terms of numbers, the debris risk is really quite low. The last really big collision was 2009." The collision Stuttard to which is referring was between a derelict Russian state-owned Cosmos 2251 satellite that had been left in orbit for a decade, and a commercial Iridium 33 satellite, which was a member of a highly profitable constellation of 66 satellites providing mobile phone services. On February 11, 2009, they smashed into each other at 10km a second or 22,300 miles per hour, according to the Secure World Foundation. According to international law, if damage has been suffered and fault established, the launching state is liable. Although the parties involved tried to assess this, the fault for the Cosmos-Iridium smash-up was not determined. Stuttard pointed out that because of international guidelines, newer satellites are designed to de-orbit to avoid collisions, but there will always be a failure rate. "Objects at that altitude will stay there if they are not de-orbited successfully for many hundreds of years, eternity really if they are at that altitude," Stuttard said. "There is interest in disposing of commercial satellites from Low Earth Orbit and this is the first time that that has been potentially a commercial activity. So we are responding to the market." With the uptick in satellite launches, and the mega-constellations in the pipeline, the United States Federal Communications Commission (FCC) is currently seeking comment on how to best indemnify the US against the risk posed by any space junk that US commercial operators may leave in orbit. The risk is small, but the crash is catastrophic. So when it does happen it is too late to fix. Europe is on the case, too "In every business, there may be a polluter, so clearly there will always be people who will take advantage of the situation," Guglielmo Aglietti, director of the Surrey Space Centre, told Al Jazeera. "[But] the European Union is taking this problem seriously". The European Commission is approaching it so seriously that it underwrote roughly half of the $17m it cost to launch the proof-of-technology mission RemoveDEBRIS. Deployed from the International Space Station last year, this near-complete mission, led by the Surrey Space Centre, is the product of a seven-member academic-commercial consortium that includes Airbus. The RemoveDEBRIS concept is to net or harpoon dead satellites and large debris, and then tow them either out of orbit or into a graveyard orbit. The spacecraft successfully netted and harpooned test debris in October and February, respectively, and is now in the process of de-orbiting itself. The RemoveDEBRIS consortium is not alone in its quest to get the junk out of the way. Tokyo-based Astroscale has to date raised $132m from Sumitomo Mitsui Trust Investment Co, Ltd, the Innovation Network Corporation of Japan and JAFCO Co, Ltd, a private venture capital firm. "What's their motivation? It's financial. But investors in space do invest for a broader vision: to invest in something that has a higher long-lasting impact. It will not have an immediate one- or two-year ROI [return on investment]," Astroscale's Chief Operating Officer, Chris Blackerby, told Al Jazeera. "We see it as a market that's going to develop." Astroscale plans to launch its two-spacecraft proof-of-technology mission, ELSA-d, next year. Consisting of a "servicer" craft and a "client" craft, the mission will test proximity rendezvous technologies and a magnetic docking mechanism to demonstrate the capability to find and magnetically capture debris.

#### Commercial space solves debris EVEN better by avoiding conflict, Dobos and Prazak 18

(Bohumil Dobos and Jakub Prazak 2018, Institute of Political Studies, Faculty of Social Sciences, Charles University, 12-27-2018, “To Clear or to Eliminate? Active Debris Removal Systems as Antisatellite Weapons”, Space Policy, https://doi.org/10.1016/j.spacepol.2019.01.007)

Given the complicated relationships among the actors like the United States, China, Europe, and Russia, commercialization of the process seems to be a better way forward. Following the development of NewSpace [3,21], it seems highly likely that the private entities will attempt to participate in the newly emerging debris mitigation market as well. This process can be conducted in cooperation with some of the less negatively perceived space agency like the ESA that develops some of the necessary technologies as a part of its Clean Space initiativednamely e.deorbit [5,51]. Commercial actors also do not face the issue of intent as they are profit-oriented unlike the complicated structure of the national interests. The commercialized and cooperative effort together with the presented technological limitations of the utility of the ADR systems as ASAT weapons should ensure that the process of the debris removal will take place without causing unnecessary conflict. The negative perception of the ADR systems can thus be limited by taking several steps: (a) do not develop capacity over the level suggested for an effective debris mitigation as to decrease the technological utility of the ADR systems as weapons, (b) operation of the ADR system should lay in hands of a commercial actor that would be contracted to clear the selected objects either by states or the UN, (c) any technological cooperation with the national space programs should primarily lay in technological development of the systems and not in their management and control dthis cooperation should be coordinated at the UN level, and (d) the ADR systems should not act unexpectedly as to increase the trust of all the spacefaring nations in the sincere intent of the operator.

#### Asteroid mining enables space colonization – even if Earth species goes extinct, we can escape if we mine asteroids

Ravisetti 21

Monisha Ravisetti (science writer @ CNET BA in philosophy NYU), 10-4-2021, "Rare asteroids near Earth may contain precious metals worth $11.65 trillion," CNET, https://www.cnet.com/news/rare-asteroids-near-earth-may-become-targets-for-space-mining/, // HW AW

Scientists just calculated that one of two metallic asteroids floating in Earth's vicinity may contain precious metals worth about $11.65 trillion. The expensive nugget, in fact, could boast more iron, nickel and cobalt than the entirety of our global metal reserves. Called metal-rich near-Earth asteroids, these rare, hefty mineral deposits measure over a mile wide. The one reckoned to be a metal motherlode is labeled 1986 DA, and the other, 2016 ED85. The duo "could be possible targets for asteroid mining in the future," according to the [new analysis published Friday](https://iopscience.iop.org/article/10.3847/PSJ/ac235f) in The Planetary Science Journal. Space mining has gained traction in the scientific community because experts believe the feat could provide [cost-effective metals](https://science.howstuffworks.com/asteroid-mining.htm) for a lunar or Mars-based colony, ultimately extending humanity's reach in exploring space. With a cosmic mine, building materials wouldn't have to withstand the expensive shuttle from Earth to space. Further, the team behind the math suggests these unique floating orbs may shed much-needed light on the authenticity of another metallic treasure NASA is [headed to in 2022](https://www.jpl.nasa.gov/missions/psyche) -- the mysterious shiny space globe known as 16 Psyche. 16 Psyche has its own allure for space mining enthusiasts. An artist's illustration shows what asteroid 16 Psyche might look like. Maxar/ASU/P.Rubin/NASA/JPL-Caltech Instead of trees, oceans or stretches of soil, the bizarre body is thought to consist of hills and valleys made of pure metal. Scientists contend it's the remaining core of an ancient rocky planet that was once destroyed. Interestingly, Earth's covered-up core looks awfully similar. Aptly dubbed "mini Psyches," the valuable smaller asteroids described in the new study are presumably pieces that have broken off from a similar naked center, though the research team notes they don't think these fragments are offshoots of 16 Psyche in particular. Still, 16 Psyche has become a rather hot topic of discussion among [scientists](https://earthsky.org/space/asteroid-psyche-metal-or-rubble-pile/) and even the [public](https://www.forbes.com/sites/jamiecartereurope/2020/12/05/a-bizarre-trillion-dollar-asteroid-worth-more-than-our-planet-is-now-aligned-with-the-earth-and-sun/?sh=689f08431c9a) -- it's suspected to hold minerals worth $10,000 quadrillion. Let that sink in. The exorbitant figure, however, has generated [considerable doubt](https://www.cnet.com/news/10000-quadrillion-asteroid-psyche-may-not-be-as-valuable-as-first-thought/) because scientists can't be sure what 16 Psyche is made of until a spacecraft inspects it. It's too far away for precise spectrum analysis, a scientific method that leverages electromagnetic emission and absorption signals to learn about objects' compositions. Until such an examination can happen, something NASA's mission intends to perform, researchers have to consider the option that it's merely some sort of rubble. That's what makes data from the "mini Psyches" indispensable -- they may offer a first look at their namesake's features. Proximity to our home planet deems it much easier for scientists to capture the rocks' spectral info from Earth. "It is rewarding that we have discovered these 'mini Psyches' so close to the Earth," Vishnu Reddy, associate professor at the University of Arizona's Lunar and Planetary Laboratory and principal investigator of the NASA grant that funded the work, said [in a statement](https://www.eurekalert.org/news-releases/930288). Sifting through the collected data, researchers found the orbiting blocks are made of 85% metal, such as iron and nickel, and only 15% silicate, which is basically regular rock. As such, some ambiguity about 16 Psyche might soon be alleviated thanks to the baby versions of it -- including whether it'll add to the crew of treasure troves for future space miners. Regardless, while the trio of metallic hunks definitely seem to hint at our sci-fi fantasies of space mining inching toward reality, one thing is absolutely certain: They're a pretty hard-core squad.

#### Only asteroid mining can provide us with the research and understanding to prevent extinction

Elvis 21 [Martin Elvis is a senior astrophysicist at the Center for Astrophysics | Harvard & Smithsonian. He is the author of Asteroids: How Love, Fear, and Greed Will Determine Our Future in Space (2021). “Riches in space.” Aeon. July 2, 2021. <https://aeon.co/essays/asteroid-mining-could-pay-for-space-exploration-and-adventure>] HW AL

If knowledge or greed isn’t motivation enough to set your sights on the asteroids, then the one thing virtually all people agree on is that having humanity wiped off the face of Earth would be bad, at least for us. Of all the multiple threats to humanity’s existence, the only one that we can definitely eliminate is that of a large asteroid slamming into our home planet and killing us off, together with most other species, following the lead of the dinosaurs who were made extinct by an asteroid slamming into the ocean. There’s a T-shirt popular among space cadets that has the slogan ‘Asteroids are nature’s way of saying “How’s that space programme coming along?”’ If we can find all the killer asteroids, then we can divert them to render them harmless. Best to play it safe. There are several searches underway for undiscovered, potentially dangerous asteroids. Thanks to the first big survey, Spaceguard, 90 per cent of the dinosaur-killer-sized asteroids out there have already been found. None of them pose any danger for the next century at least. That still leaves an uneasily large number of about 100 extinction-event-sized rocks out there that we haven’t found yet. Smaller, city-killer asteroids are much less well-surveyed for. To remedy this concern, two new surveys will begin in the next few years, and they will both be more or less done by 2030. They are the Vera C Rubin Observatory ‘Legacy Survey of Space and Time’, which will start scanning the whole sky every few nights from 2023 onwards. Its mission has been complicated by the mushrooming constellations of thousands of internet satellites now being launched by several companies, with SpaceX being the most visible. Hopefully a solution will be found. The Vera C Rubin Observatory, on a mountain in Chile, will record its image using normal visible light. For asteroids, that light is reflected sunlight. But many asteroids are pitch black, reflecting only a few percent of the sunlight pouring on to their surfaces. How do you find those dark asteroids? The answer is to use the long wavelength – infrared – light they emit because they’re warm: their ‘black body radiation’. NASA is building a special mission just for this purpose. Developed by a team lead by Amy Mainzer, now of the University of Arizona, Tucson, it’s called the Near-Earth Object Surveillance Mission. Starting around 2025, it will scan the sky repeatedly for five years looking for moving objects that are bright in infrared light, and has wavelengths some 10 to 20 times longer than we can see with our eyes. The team’s tagline is ‘Finding Asteroids Before They Find Us.’ Good idea! This will be the first time that humanity has deliberately changed the orbit of any celestial body An advantage of using the black body radiation is that it also tells us quite accurately how big each asteroid is. That helps in assessing their threat, as well giving us a first guess at how much they might yield in resources. Combining the two surveys will indicate how much sunlight each asteroid reflects – its ‘albedo’ – and that’s a clue to what they’re made of. We want to know that because a metal asteroid of a given size is more dangerous than one made of rock, and is more difficult to push out of the way. The composition also helps us explore all two dozen types of asteroid out there, the better to decipher the history of our solar system. As a side product, the surveys will pin down their potential value. By 2030, we’ll have better rockets than we have today. Several are set to fly within five years. They’ll let us reach many more asteroids with more massive payloads to deflect them, study them or mine them. Also by 2030, several more asteroids will have been visited by our exploration spacecraft. JAXA, the Japanese space agency, and NASA each had recent missions to return samples from carbonaceous asteroids. The Japanese Hayabusa2 went to the spinning-top-shaped asteroid named Ryugu, and NASA’s OSIRIS-REx went to the asteroid called Bennu. Such carbonaceous asteroids are the least changed, we believe, from the time of their formation at the beginning of the solar system’s formation. They are called carbonaceous because they are chockfull of organic (carbon-containing) molecules; many of them also contain quite a lot of water. There are more missions planned to more distant asteroids such as Psyche, a metal asteroid in the Main Belt, and to the Trojan asteroids trailing Jupiter’s orbit. OSIRIS-REx samples and leaves asteroid Bennu. Courtesy of NASA **Every time we visit an asteroid, it surprises us.** Bennu was found to be throwing rocks off its surface as it spun around its axis, and when OSIRIS-REx put down its outstretched arm to grab a sample off the surface, the arm sank half a metre into the asteroid; it stopped going deeper only when the retrorockets fired to stop it. That’s really not how rubble behaves on Earth! The more we know about asteroids, the more confident we can be that we can deflect their path away from Earth. A NASA mission called DART will make a high-speed impact on the small moon of the asteroid Didymos in late 2022 to see if we can slow down a dangerous asteroid to stop it causing devastation on Earth. (Don’t worry: the target was chosen to be a safe one for us.) This will be the first time that humanity has deliberately changed the orbit of any celestial body. It isn’t likely to be the last. Once all the good-sized accessible asteroids have been found, their orbits mapped, their sizes known, and at least a good clue found as to what they’re made of, the barriers to mining them will be much lower. **After visiting a half dozen asteroids up close, we’ll have learned a great deal about their origins, how to deflect them should one be headed our way, and how to handle them.** That will put us in a good place to begin to extract their resources. I predict this will happen right around 2030, when demand for in-space materials should be picking up. **The stars seem to be aligning for mining the asteroids. Mining will expand our capabilities in space, especially making it easier to deflect a dangerous asteroid.** In a virtuous cycle, those new capabilities will lead us on to greater exploration of the many worlds in our solar system and, with bigger, better telescopes, to the Universe beyond. It should be fun.

#### Collision risk is infinitesimally small

Fange 17 Daniel Von Fange 17, Web Application Engineer, Founder and Owner of LeanCoder, Full Stack, Polyglot Web Developer, “Kessler Syndrome is Over Hyped”, 5/21/2017, http://braino.org/essays/kessler\_syndrome\_is\_over\_hyped/

The orbital area around earth can be broken down into four regions. Low LEO - Up to about 400km. Things that orbit here burn up in the earth’s atmosphere quickly - between a few months to two years. The space station operates at the high end of this range. It loses about a kilometer of altitude a month and if not pushed higher every few months, would soon burn up. For all practical purposes, Low LEO doesn’t matter for Kessler Syndrome. If Low LEO was ever full of space junk, we’d just wait a year and a half, and the problem would be over. High LEO - 400km to 2000km. This where most heavy satellites and most space junk orbits. The air is thin enough here that satellites only go down slowly, and they have a much farther distance to fall. It can take 50 years for stuff here to get down. This is where Kessler Syndrome could be an issue. Mid Orbit - GPS satellites and other navigation satellites travel here in lonely, long lives. The volume of space is so huge, and the number of satellites so few, that we don’t need to worry about Kessler here. GEO - If you put a satellite far enough out from earth, the speed that the satellite travels around the earth will match the speed of the surface of the earth rotating under it. From the ground, the satellite will appear to hang motionless. Usually the geostationary orbit is used by big weather satellites and big TV broadcasting satellites. (This apparent motionlessness is why satellite TV dishes can be mounted pointing in a fixed direction. You can find approximate south just by looking around at the dishes in your northern hemisphere neighborhood.) For Kessler purposes, GEO orbit is roughly a ring 384,400 km around. However, all the satellites here are moving the same direction at the same speed - debris doesn’t get free velocity from the speed of the satellites. Also, it’s quite expensive to get a satellite here, and so there aren’t many, only about one satellite per 1000km of the ring. Kessler is not a problem here. How bad could Kessler Syndrome in High LEO be? Let’s imagine a worst case scenario. An evil alien intelligence chops up everything in High LEO, turning it into 1cm cubes of death orbiting at 1000km, spread as evenly across the surface of this sphere as orbital mechanics would allow. Is humanity cut off from space? I’m guessing the world has launched about 10,000 tons of satellites total. For guessing purposes, I’ll assume 2,500 tons of satellites and junk currently in High LEO. If satellites are made of aluminum, with a density of 2.70 g/cm3, then that’s 839,985,870 1cm cubes. A sphere for an orbit of 1,000km has a surface area of 682,752,000 square KM. So there would be one cube of junk per .81 square KM. If a rocket traveled through that, its odds of hitting that cube are tiny - less than 1 in 10,000.

#### No Russia war—no motivation for Russian aggression.

Trenin 18 [Dmitri Trenin is director of the Carnegie Moscow Center. Fears of World War III are overblown. July 20, 2018. https://www.politico.eu/article/donald-trump-vladimir-putin-nato-crimea-fears-of-world-war-iii-are-overblown/]

Europeans fretted about the end of NATO. But seen from Moscow, the military alliance still appears to be very much alive. Trump's harsh words to his allies on spending haven't changed that. Russia is all too aware that the alliance is focused on its eastern flank, and not only rhetorically. Since it rediscovered Russia as a threat in 2014, there have been new deployments, a higher degree of mobility, and more military exercises along the Russian border, from the Barents to the Black Seas. Hardly a boon for Russia. It was clear at last week's NATO summit that allies agree on the need to upgrade the bloc’s military efforts. Germany, Italy, France, the U.S. — they all agree members’ defense spending should go up. Whether by 2 percent of GDP as agreed in Wales, or by 4 percent as now demanded by Trump, is, of course, important. However, with Russia’s GDP often likened to that of Spain, or the state of New York, either figure is considered significant in Moscow, given that the money will be spent with Russia in mind. NATO allies also worry about Trump’s comment this week that it is problematic for the U.S. to come to the defense of smaller NATO allies such as Montenegro. But let’s not forget that at the height of the Cold War it was never 100 percent certain what the U.S. would do in case of an attack on West Germany. Former Chancellor Helmut Schmidt would not have asked for U.S. medium-range missiles in Europe in the 1970s had he had full confidence in NATO's largest member. Nor is NATO enlargement off the table completely. Macedonia has just crossed a major hurdle in its push for membership. Predictions that Trump would recognize Crimea at the Helsinki meeting were also overblown. There was never any question of the U.S. accepting Crimea’s status as part of Russia, or Washington leaning on Kiev to fulfill its side of the Minsk II accords. In Helsinki, Trump and Putin simply acknowledged the issue, and moved on. The U.S. continues to support both Ukraine and Georgia in their conflicts with Russia and to promote their eventual membership in NATO, which most in the West privately regard as increasingly dangerous. NATO is still very much exerting pressure on Russia. It's considered more of an annoyance than an immediate threat in Moscow, but also keeps the country in permanent "war mode" vis-à-vis the U.S. Because Moscow is focused on Washington, this means Europeans usually get a pass. As for Russia’s own intentions, two things are clear. There is no interest in Moscow in attacking the Baltic states or Poland. These countries are as safe now as they were before 2014. Suggestions otherwise simply point to the deep wounds in both nations' psyche, which will not be healed for many decades. Should Ukraine's leaders decide to repeat Mikheil Saakashvili’s mistake in 2008 and launch a major offensive to retake Donbas — however unlikely — the Russian response could indeed be devastating and lead to Ukraine's loss of sovereignty, as Putin recently stated. But does this mean Russia will move on Ukraine unprovoked? Most certainly not. Putin's main concerns are largely domestic. He has an ambitious program that logically calls for more economic ties with the West. To move forward, he is looking to ease tensions with the EU and the U.S. What Putin wanted to get out of Helsinki was mainly to start a dialogue with Washington. Those hopes are now visibly going up in smoke. It is safe to bet that Russia will continue to face the same opposition from a coalition of U.S. and EU interests. The first détente in the hybrid war between Russia and the West was indeed nipped in the bud by Trump's behavior and the vehemence of his domestic critics. So be it. Moscow will not capitulate, and will indeed push back. But it's not likely to take the form of an aggressive, overt military attack. Fears of new wars are far from accurate.