# AFF – Cosmic Quarry Colonialism

## 1AC

### AC – Advocacy

#### Thus, resolved: The appropriation of outer space by private entities is unjust.

### 1AC – Cosmic Colonialism

#### Advantage 1 is Cosmic Colonialism.

#### Private appropriation of outer space expands corporate colonialism.

Shammas and Holen 19 [(Victor L, a sociologist working at the Department of Sociology and Human Geography, University of Oslo; Tomas B., independent scholar in Oslo, Norway) “One giant leap for capitalistkind: private enterprise in outer space,” 1-29-2019, pg. 3-5] TDI

The 2010s may very well be remembered as the ‘Age of NewSpace', the decade when outer space was turned into a capitalist space, when private corporations pushed the price of launches, satellites, and space infrastructure downwards, exerting what industry insiders call the ‘SpaceX effect' (Henry, 2018), centered on the technological achievement of ‘reusability', recovering used rocket boosters for additional launches, promising to drastically reduce the price of going to space (Morring, 2016). As one report observes, ‘Not only has the number of private companies engaged in space exploration grown remarkably in recent years, these companies are quickly besting their government-sponsored competitors' (Houser, 2017). What the rockets, shuttles, ships, and landing pods will carry beneath their payload fairing or in their cargo hold, however, along with supplies and satellites, is the capitalist worldview, a particular ideology—just as Robinson Crusoe, in Marx’s ironic retelling in Capital, ‘having saved a watch, ledger, ink and pen from the shipwreck… soon begins, like a good Englishman, to keep a set of books' (Marx, 1976, p. 170), brings with him English political economy—'Freedom, Equality, Property and Bentham', as Marx (1976, p. 280) says elsewhere— to his desert island.

In early 2018, astronomers across the world learned that a New Zealand start-up, Rocket Lab, which aimed to launch thousands of miniature satellites into orbit around Earth (so-called ‘smallsats'), had planned to launch a giant, shining ‘disco ball'—the ‘Humanity Star'—into orbit around Earth. It was an elaborate marketing stunt masked by humanistic idealism. ‘No matter where you are in the world, or what is happening in your life', said Rocket Lab CEO Peter Beck, ‘everyone will be able to see the Humanity Star in the night sky' (Amos, 2018). Many astronomers expressed outrage at these plans, fearing that the light from the Human Star would threaten their ability to carry out scientific observations. But while these astronomers were incensed by the idea of a bright geodesic object disrupting their ability to carry out observations, concerns with the effects of the arrival of capitalistkind on their ability to collect data were non-existent. The astronomical community was angered by the idea of a material, concrete, visible object polluting “pure” scientific data, but it paid less attention to the (invisible and abstract) recuperation of the night sky as it was brought into the fold of capitalism.

In an interview, Beck was quizzed about the Humanity Star and asked by a reporter about the difficulties of generating profits in space (Tucker, 2018). To this Beck replied, ‘It has always been a government domain, but we’re witnessing the democratization of it…[I]t [is] turning into a commercially dominated domain'. Beck established an equivalence established between the dissolution of space as the rightful domain of states and the advent of profitmaking ventures as signs of ‘democratization'. In space, according to Beck’s logic, democratization involves the disappearance of the state and the rise of capital. The argument, of course, is impeccably post-statist: on this account, states are monolithic, conservative Leviathans beyond the reach of popular control; corporations, on the other hand, are in principle representatives of the everyman: in the age of the start-up, any humble citizen could in theory become an agent of disruption, a force for change, an explorer of space, and a potential member of the cadre of capitalistkind. Following this logic, the question for the entrepreneurs of NewSpace is how to monetize outer space, which means turning space into a space for capital; their question is how they can deplanetarize capital and universalize it, literally speaking, that is, turn the Universe into a universe for capital. In this light, Peter Beck’s distortion of democratic ideals appears eminently sensible, equating democratization with monetization, that is, capital liberated from its earthly tethers.

Emblematic of this capitalist turn in space was the founding of Moon Express in 2011, composed of a ‘team of prominent Silicon Valley entrepreneurs…shooting for the moon with a new private venture aimed at scouring the lunar surface for precious metals and rare metallic elements' (Hennigan, 2011). Following Google’s Lunar XPRIZE—an intertwining of Silicon Valley and NewSpace’s capitalistkind—which promised a $20 million prize for the first private company to land a spacecraft on the Moon, travel 500 meters, and transmit high-definition images back to Earth, all by March 2018,9 Moon Express claimed that it would be capable of landing on the lunar surface and earn the cash prize. Their stated goal was twofold: first, to mine rare resource like Helium-3 (a steadily dwindling scarce resources on Earth), gold, platinum group metals, and water, and, second, to carry out scientific work that would ‘help researchers develop human space colonies for future generations' (Ioannou, 2017). The ordering is telling: first profits, then humanity. These were the hollow, insubstantial promises of a venture-capitalized NewSpace enterprise: in early 2018, Google announced that none of the five teams competing for the Lunar XPRIZE, including Moon Express, would reach their stated objectives by the 31 March deadline and they were taking their money back (Grush, 2018). In this sense, it was typical for NewSpace in its formative years: a corporate field populated by (overly exuberant) private enterprises who promised more than they could deliver. But the belief in NewSpace is real enough. In a tome bursting with the optimism of NewSpace, Wohlforth and Hendrix claim that ‘the commercial spaceflight industry is transforming our sense of possibility. Using Silicon Valley’s money and innovative confidence, it will soon bring mass space products to the market' (2016, p. 7).

The trope of humanity plays a key role in the rhetoric of the adherents of NewSpace. To fulfill the objectives of NewSpace, including profit maximization and the exploitation of celestial bodies, the symbolic figure of a shared humanity serves a useful purpose, camouflaging the conquest of space by capitalism with a dream of humanity boldly venturing forth into the dark unknown, thereby also providing the legitimacy and enthusiasm needed to support bolster the legitimacy of NewSpace. So long as the stargazers and SpaceX watchers are permitted their fill of ‘collective effervescence', to use Durkheim’s (1995, p. 228) concept, capitalist entrepreneurs will be able to pursue their business interests more or less as they please. The spectacle of outer space is crucial in this regard.

Crucially, however, and despite this spectacle, SpaceX’s technology might not necessarily be more sophisticated than its competitors or predecessors. Some industry insiders have rebuffed some of the more the spectacular claims of NewSpace’s proponents, arguing that launch vehicle reusability requires a (perhaps prohibitively) expensive refurbishing of the rocket engines involved in launches: ‘The economics will depend on how many times a booster can be flown, and how much the individual expense will be to refurbish the booster…each time' (Chang, 2017). Reusability may be a technological dead-end because of the inherently stressful effects of a rocket launch on the launch vehicle’s components, with extreme limitations on reusability beyond second-use as well as added risks of malfunctions that customers and insurers are likely to wish to avoid. Furthermore, the Falcon Heavy still has not matched the power and payload capacity of NASA’s Saturn V, a product of 1960s military-industrial engineering and Fordist state spending programs. What SpaceX and other NewSpace corporations do with great ingenuity, however, is to manage the spectacle of outer space, producing outpourings of public fervor, aided by a widespread adherence to the ‘Californian Ideology' (Barbrook and Cameron, 1996), or post-statist techno-utopianism, in many postindustrialized societies.

The very centrality of these maneuvers has initiated a new phase in the history of capitalist relations, that of ‘charismatic accumulation'—certainly not in the sense of any ‘objective' or inherent charismatic authority, but with a form of illusio, to speak with Bourdieu, vested in the members of capitalistkind by their uncanny ability to spin mythologizing self-narratives. This has always been part of the capitalist game, from Henry Ford and onwards, but the charismatic mission gains a special potency in the grandiose designs of NewSpace’s entrepreneurs. Every SpaceX launch is a quasi-religious spectacle, observed by millions capable of producing a real sense of wonder in a condition of (legitimizing) collective effervescence.

Outer space necessarily reduces inter-human difference to a common denominator or a shared species-being. An important leitmotiv in many Hollywood science fiction movies, including Arrival (2016), is that a first encounter with an alien species of intelligent beings tends to flatten all human difference (including ethnoracial and national categories), thereby restoring humankind to its proper universality (see also Novoa, 2016). Ambassadors of Earth as a whole, not representatives of particular nations, step forth to meet alien emissaries. But even in the absence of such an encounter, the search for habitable domains (or rather, profitable locales) beyond Earth will necessarily forge a shared conception of the human condition, initiated with the Pale Blue Dot photograph in 1990. Typical of this sentiment are the words of the astronomer Carl Sagan, who famously observed of this photograph: ‘On it everyone you love, everyone you know, everyone you ever heard of, every human being who ever was, lived out their lives'.

This naïvely humanistic vision has been one of the dominant tropes in the discourse on space since the 1950s, and it remains strong today, as with the claims of the United Nations Office for Outer Space Affairs (UNOOSA) that their task is to ‘uphold the vision of a more equitable future for all humankind through shared achievements in space'. This representational tendency mobilizes humanism to generate enthusiasm about space-related activities. But such representations are increasingly being recuperated by capitalist enterprise, so that it is not humankind but its modulation by space capitalists that will launch into the dark unknown. It is not humankind but capitalistkind that ventures forth. In early 2018, NASA was set to request $150 million in its 2019 budget to ‘enable the development and maturation of commercial entities and capabilities which will ensure that commercial successors to the ISS…are operational when they are needed', only one of many signs that space is becoming a space for capitalism. According to one estimate, the value of just one single asteroid would be more than $20 trillion in rare earth and platinum-group metals (Lewis, 1996), a precious prize indeed for profit-hungry corporations.10 Even the UNOOSA spoke vociferously in favor of the commercialization of space, appealing variously to the ‘industry and private sector' and elevating the ‘space economy' to a central pillar in its Space2030 Agenda (including the ‘use of resources that create and provide value and benefits to the world population in the course of exploring, understanding and utilizing space'), even as the UN agency falls back on a humanistic, almost social-democratic vision of the equitable distribution of benefits (and profits) from space mining, exploration, and colonization (UNOOSA, 2018).

We find evidence of this strategic humanism in all manner of pronouncements from NewSpace entrepreneurs. To take but one example: Naveen Jain, the chairman and co-founder of MoonEx, a lunar commercialization firm, has claimed that ‘from an entrepreneur’s perspective, the moon has never truly been explored'. The moon, Jain has claimed, ‘could hold resources that benefit Earth and all humanity' (Hennigan, 2011). We should note the recourse to the trope of all of humanity by this NewSpace entrepreneur, mimicked in the 1979 Moon Agreement, a UN treaty, which also held that the Moon’s resources are ‘the common heritage of mankind' (Tronchetti, 2013, p. 13).11 In a purely factual sense, of course, Jain is wrong: Google Moon offers high-resolution images of the lunar surface,12 and the moon has already been explored, in the sense of being mapped, albeit rudimentarily and with room for further data collection. Crucially, however, these cartographic techniques have not been put to capitalist uses: mapping minerals, for instance, or producing detailed schemata that might one day turn the Moon into a ‘gas station' for commercial space ventures, as Wilbur Ross, Trump’s Secretary of Commerce, has proposed (Bryan, 2018). What is lacking, in short, are capitalist maps of the Moon, i.e., a cartography for capital. But as Klinger (2017: 199) notes, even though no one is ‘actively mining the Moon' at present, at least ‘six national space programs, fifty private firms, and one graduate engineering program, are intent on figuring out how to do so'; furthermore, Klinger draws attention to mapping efforts that have revealed high an abundance of rare earth metals, thorium, and iron in the Moon’s ‘Mare Procellarum KREEP' region (Klinger, 2017, p. 203).

We have already noted that it is not humanity, conceived as species-being, a Gattungswesen, that makes its way into space. The term Gattungswesen, of course, has a long intellectual pedigree, harking back to Hegel, Feuerbach, Marx, and others. The term can ‘be naturally applied both to the individual human being and to the common nature or essence which resides in every individual man and woman', Allan Wood (2004, p. 17) writes, as well as ‘to the entire human race, referring to humanity as a single collective entity or else to the essential property which characterizes this entity and makes it a single distinctive thing in its own right'. Significantly, the adherents of NewSpace often resort to the idea of humanity in its broad universality (e.g., Musk, 2017), but this denies and distorts the modulation of humanity by its imbrication with the project of global (and post-global, i.e., space-bound) capitalism. It is precisely the sort of false universality implied in the humanism of the supporters of NewSpace that Marx subjected to a scathing critique in the sixth of his Theses on Feuerbach. Here Marx noted that the human essence is not made up of some ‘abstraction inherent in each single individual' (1998, p. 570). Instead, humans are defined by the ‘ensemble of social relations' in which they are enmeshed. Under NewSpace, it is not humanity, plain and simple, that ventures forth, but a specific set of capitalist entrepreneurs, carrying a particular ideological payload, alongside their satellites, instruments, and supplies, a point noted by other sociologists of outer space, or ‘astrosociologists' (Dickens and Ormrod, 2007a, 2007b).

#### Corporate colonialism necessitates mass launch.

Shammas and Holen 19 [Victor L, a sociologist working at the Department of Sociology and Human Geography, University of Oslo; Tomas B., independent scholar in Oslo, Norway) “Capitalism and Outer Space: Replies to an Interlocutor” Dr. Victor Lund Shammas Blog, https://www.victorshammas.com/blog/2019/12/17/capitalism-and-outer-space, 12/18/2019] RM

When speaking of viability, one aspect that gets underplayed are the significant ecological effects of launching into space. For instance, SpaceX is developing the idea of Earth-to-Earth space flight, which might entail moving passengers from any point on Earth to any other point within, say, half an hour. What would be the ecological consequences of burning tremendous amounts of rocket fuel to escape Earth’s gravity well, just so that a London-based billionaire could get to Sydney in 30 minutes? There is something perverse about the idea that all the rest of us are being enjoined to cut back on flying, even as Musk and his cronies tinker away to make life easy for the hyper-rich.

Of course, this would be just one more step in a general tendency under capitalism that the geographer David Harvey calls time-space compression: The speed at which capital circulates increases and along with it life also accelerates. Both space and time are compressed by new technologies. One unfortunate consequence of Earth-to-Earth space flight, if it is ever realized, would be its damaging effects on our already CO2-saturated atmosphere. But perhaps more worrying, according to some rocket engineers, is the trail of soot and alumina left in the wake of rockets that could accumulate in the stratosphere and deplete our fragile ozone layer. The United Nations’ 2018 Quadrennial Global Ozone Assessment is the first annual UN report to take this threat seriously. Ironically, as Musk dreams of shuttling humans off Earth to Mars as a species-preserving measure, he could be co-responsible for accelerating the very destruction of Earth that he purportedly fears.

In a radically decarbonized future, heavy caps on emissions might be enough to shutter the space industry - or at least seriously rein it in. This might not be a bad thing, because as a report from the non-profit Aerospace Corporation recently noted, emissions from rockets “inherently impact the stratosphere in a way that no other industrial activity does.” Reaching space on a grand scale might entail tearing open and ripping apart our own atmosphere in the process. This is why we may need to rethink our future in space—perhaps even holding off from launching too many rockets into space—precisely in order to preserve life here on Earth.

#### That depletes the ozone layer, open the floodgates for existential UV floods, and leaves residual black carbon.

Grush 17 [Loren Grush, Loren Grush is a science reporter for The Verge, the technology and culture brand from Vox Media, where she specializes in all things space—from distant stars and planets to human space flight and the commercial space race. The daughter of two NASA engineers, she grew up surrounded by space shuttles and rocket scientists—literally. She is also the host of Space Craft, an original online video series that examines what it takes to send people to space. Before joining The Verge, Loren published stories in Popular Science, The New York Times, Nautilus Magazine, Digital Trends, Fox News, and ABC News.) “Why it’s time to study how rocket emissions change the atmosphere: Get the data now before the problem gets worse” The Verge, May 31, 2018] RM

Every time a rocket launches, it produces a plume of exhaust in its wake that leaves a mark on the environment. These plumes are filled with materials that can collect in the air over time, potentially altering the atmosphere in dangerous ways. It’s a phenomenon that’s not well-understood, and some scientists say we need to start studying these emissions now before the number of rocket launches increases significantly.

It’s not the gas in these plumes that’s most concerning. Some rockets do produce heat-trapping greenhouse gases, like carbon dioxide, but those emissions are negligible, according to experts. “The rocket business could grow by a factor of 1,000 and the carbon dioxide and water vapor emissions would still be small compared to other industrial sources,” Martin Ross, a senior project engineer at the Aerospace Corporation who studies the effects of rockets on the atmosphere, tells The Verge.

Instead, it’s tiny particles that are produced inside the trail that we need to watch out for, Ross says. Small pieces of soot and a chemical called alumina are created in the wakes of rocket launches. They then get injected into the stratosphere, the layer of Earth’s atmosphere that begins six miles up and ends around 32 miles high. Research shows that this material may build up in the stratosphere over time and slowly lead to the depletion of a layer of oxygen known as the ozone. The ozone acts like a big shield, protecting Earth against the Sun’s harmful ultraviolet radiation. However, the magnitude of this ozone depletion isn’t totally known, says Ross.

“IT’S A CALL FOR MORE RESEARCH IN THIS AREA TO KNOW EXACTLY WHAT WE’RE PUTTING INTO THE UPPER ATMOSPHERE AND IN WHAT QUANTITIES.”

That’s why he and others at the Aerospace Corporation, a nonprofit that provides research and guidance on space missions, are calling for more studies. They say it’s especially important now since the private space industry is at the early stages of a launch revolution. Currently, the number of launches each year is relatively small, around 80 to 90, so the aerospace industry’s impact on the atmosphere is not much of a concern. But in a new paper published in April, Ross and his colleague Jim Vedda argue that as launches increase, policymakers will eventually want to know what kind of damage these vehicles are causing to the environment and if regulations are necessary. When that time comes, it will be better to have as much data as possible to make the best decisions.

“It’s a call for more research in this area to know exactly what we’re putting into the upper atmosphere and in what quantities,” Vedda, a senior policy analyst at the Aerospace Corporation, tells The Verge. “So when the debates start, we have the good hard data that says, ‘Here’s a well-defined model of what’s actually happening.’”

So far, the research we have about these emissions mostly comes from lab experiments, modeling, and some direct detections of rocket plumes. At the turn of the century, a few high-altitude planes equipped with sensors flew through plumes created by the Space Shuttle and other vehicles to figure out what was inside.

It turns out that all kinds of rockets produce these emissions, but some types of vehicles produce more than others. Rockets that run on solid propellants produce a higher amount of alumina particles, a combination of aluminum and oxygen that is white and reflective. Most orbital rockets don’t run on solid propellants these days, though some launch companies like the United Launch Alliance do add solid rocket boosters to vehicles to give them extra thrust. Meanwhile, rockets that run on liquid kerosene, a type of refined oil, produce more of the dark soot particles, what is known as black carbon. Kerosene is used as a propellant for rockets such as ULA’s Atlas V and SpaceX’s Falcon 9.

ALL KINDS OF ROCKETS PRODUCE THESE EMISSIONS, BUT SOME TYPES OF VEHICLES PRODUCE MORE THAN OTHERS

Alumina and black carbon from rockets can stick around in the stratosphere for three to five years, according to Ross. As these materials collect high above the Earth, they can have interesting effects on the air. Black carbon forms a thin layer that intercepts and absorbs the sunlight that hits Earth. “It would act as a thin, black umbrella,” says Ross. That may help keep the lower atmosphere cool, but the intercepted energy from the Sun doesn’t just go away; it gets deposited into the stratosphere, warming it up. This warming ultimately causes chemical reactions that could lead to the depletion of the ozone layer.

The reflective alumina particles can also affect the ozone but in a different way. Whereas the soot acts like a black umbrella, the alumina acts like a white one, reflecting sunlight back into space. However, chemical reactions occur on the surface of these white particles, which, in turn, destroy the ozone layer, Ross says.

Black carbon and alumina have actually been proposed by scientists as possible geoengineering agents or tools for cooling down our warming climate. But while they may keep the lower atmosphere cool, geoengineering agents may have other unwanted side effects, too. They might interact with jet streams, causing droughts or more tropical storms. That’s why many scientists have criticized the idea of geoengineering to combat climate change.

However, rockets are putting these particles into the air no matter what, and this byproduct of ozone loss is particularly concerning for Ross and Vedda. As the ozone diminishes, more of the Sun’s harmful radiation could reach the ground. These UVB rays can cause skin cancer and cataracts. “That’s what we need to understand — the ozone depletion aspect of this because protection of the ozone layer is an international imperative,” says Ross. The 1987 Montreal Protocol, for example, is an international agreement to phase out materials that deplete the ozone.

Right now, Ross estimates that rocket launches around the world inject 10 gigagrams, or 11,000 tons, of soot and alumina particles into the atmosphere each year. But that number could be going up. SpaceX has vowed to increase the number of launches it does each year, and numerous other companies are going to start launching their own vehicles soon. What kind of impact that will have on the atmosphere is unclear. That’s why Ross and Vedda suggest the government and universities invest in a series of research programs, in which scientists collect more data on rocket particles from aircraft and satellites.

“WE WANT TO BE PROACTIVE BEFORE THIS TIPPING POINT OCCURS.”

#### **Ozone collapse causes extinction.**

Simmons 20 [Carla Simmons,, The Science Times, "A Repeat of One of the Biggest Extinctions Caused by Ozone Layer Erosion 359M Years Ago Possible, Warn Scientists | Science Times", May 27, 2020, https://www.sciencetimes.com/articles/25838/20200527/repeat-one-biggest-extinctions-caused-ozone-layer-erosion-359m-years.htm] BD

University of Southampton researchers have delved deeper into an extinction event that occurred about 360 million years ago. According to their research, the ozone layer's breakdown caused by ultraviolet (UV) radiation vanquished much of the Earth's marine life and greenery. Moreover, their discovery led to weighty indications for today's continually warming Earth.

Numerous episodes of mass extinction occurred in the geological past. One of the most notorious ones caused the extinction of dinosaurs about 66 million years ago. Their destruction was believed to have been caused by an asteroid hitting the Earth.

Additionally, two chapters were caused by large-scale volcanic eruptions that created the imbalance of oceans and atmospheres in the planets. Another one happened during the end of Permian Great Dying, which, according to Stanford, wiped out 96% of the Earth's aquatic species.

Scientists have discovered evidence pointing to high levels of UV radiation responsible for collapsing forest ecosystems and killing off water animal species during the Devonian geological period about 359 million years ago.

Their research revealed that warming temperatures after an intense ice age could have caused the ozone to collapse. The researchers suggest that the Earth might possibly reach comparable temperatures, thus might face the same consequences that occurred in the past.

The findings of their study are published in the journal Science Advances. Additionally, the research was partly funded by a grant from the National Geographic Society. It was also regulated in collaboration with The Sedgwick Museum of Earth Sciences at the University of Cambridge.

The team collected various rock samples during expeditions in locations in South America. They formed clues as to what was happening at the edge of the melting Devonian ice sheet, which allowed them to compare between the extinction event close to the pole and near the equator.

The rocks were then dissolved in hydrofluoric acid back in the laboratory. The dissolved rocks released microscopic plant spores, which were preserved for hundreds of millions of years. On microscopic examination, the scientists found many of the spores had bizarrely formed spines on their surface.

According to the researchers, the spikes were due to UV radiation damaging their DNA. Furthermore, they found that many spores had dark pigmented walls. These walls were thought to be a protective 'shield' against the increasing and damaging UV levels.

From their findings, the scientists have concluded that during a time of expeditious global warming, the ozone layer collapsed for a short while. Moreover, the ozone collapse exposed life on Earth to harmful UV radiation levels and, therefore, triggered a mass extinction event. This affected life on land and in shallow water at the Devonian-Carboniferous boundary.

From Climate Change to Climate Emergency

Professor John Marshall, the lead researcher from the University of Southampton's School of Ocean and Earth Science, said that our ozone layer is currently in a state of alteration. He adds that they have seen this pattern in the past, where a stimulant or impetus was unnecessary for the phenomenon to kick in.

He also says that current approximate calculations suggest that the Earth will reach similar global temperatures to those of 360 million years ago. Furthermore, they say it is possible that a similar collapse of the ozone layer could occur again, dangerously exposing surface and shallow sea life to harmful radiation.

#### UV floods supress immune responses and lead to radiation

Lucas et al 14 (R. M. Lucas (National Centre for Epidemiology and Population Health, The Australian National University, Canberra 2601, Australia, Telethon Kids Institute, University of Western Australia, Perth 6008, Australia), M. Norval (Biomedical Sciences, University of Edinburgh Medical School, Edinburgh EH8 9AG, Scotland, UK), R. E. Neale (QIMR Berghofer Medical Research Institute, Brisbane 4029, Australia), A. R. Young (King's College London (KCL), St John's Institute of Dermatology, London SE1 9RT, UK), F. R. de Gruijl (Department of Dermatology, Leiden University Medical Centre, P.O. Box 9600, NL-2300 RC Leiden, The Netherlands), Y. (Akita University Graduate School of Medicine, Akita-shi, Akita Prefecture, Japan, National Institute for Minamata Diseases, Minamata-sh, Kumamoto Prefecture, Japan) and J. C. van der Leun (iEcofys, Kanaalweg 16G, NL-3526 KL Utrecht, The Netherlands), “The consequences for human health of stratospheric ozone depletion in association with other environmental factors”, November 10th, 2014, <https://pubs.rsc.org/en/content/articlehtml/2015/pp/c4pp90033b>) CS

Effects of solar UV radiation on immune function and consequences for disease Mechanisms UV photons penetrate the epidermis and upper dermis162 and are absorbed by chromophores ([Table 2](https://pubs.rsc.org/en/content/articlehtml/2015/pp/c4pp90033b#tab2)), which then **initiate a cascade leading to changes in immune responses**. Table 2 Cutaneous chromophores involved in the initiation of UV-induced changes in immune function (reviewed in [ref. 163](https://pubs.rsc.org/en/content/articlehtml/2015/pp/c4pp90033b#cit163)While much of this information has been gathered from studies in vitro or in rodent models, less is known about humans. However, an action spectrum for the UV-induced suppression of the human immune response to a previously-encountered antigen (termed memory or recall immune responses) has been constructed: it has two peaks, one within the UV-B waveband at 300 nm and one at 370 nm in the UV-A waveband.[164,165](https://pubs.rsc.org/en/content/articlehtml/2015/pp/c4pp90033b#cit164) There is also evidence from studies in both humans and mice that interactive and additive effects between wavebands can occur.[166–168](https://pubs.rsc.org/en/content/articlehtml/2015/pp/c4pp90033b#cit166) Briefly, exposure to UV radiation causes up-regulation of some innate immune responses, **and down-regulation of** some acquired primary and memory **immune responses**, mainly through effects on T cell activity (reviewed in Gibbs & Norval,[163](https://pubs.rsc.org/en/content/articlehtml/2015/pp/c4pp90033b#cit163) Schwarz & Schwarz,[169](https://pubs.rsc.org/en/content/articlehtml/2015/pp/c4pp90033b#cit169) and Ullrich & Byrne[170](https://pubs.rsc.org/en/content/articlehtml/2015/pp/c4pp90033b#cit170)). The up-regulation includes the production of several antimicrobial peptides (AMPs) in the epidermis,[171,172](https://pubs.rsc.org/en/content/articlehtml/2015/pp/c4pp90033b#cit171) possibly through a vitamin D pathway (see below). The AMPs provide immediate protection against a variety of pathogens (bacteria, fungi, and viruses having a viral envelope) and they are also involved in the promotion of cell growth, healing, and angiogenesis. In contrast to these stimulatory functions, exposure to UV radiation induces T regulatory cells (Tregs) and other cell types which contribute to immunosuppression and help to restore cutaneous homeostasis.[172,173](https://pubs.rsc.org/en/content/articlehtml/2015/pp/c4pp90033b#cit172) Mediators such as platelet-activating factor, prostaglandin E2, histamine, and tumour necrosis factor-α are produced locally at the irradiated site. These alter the migration patterns and functions of various populations of immune cells. The end result is the generation of cell subsets with suppressive activity which are thought to remain for the life-time of the individual.[174,175](https://pubs.rsc.org/en/content/articlehtml/2015/pp/c4pp90033b#cit174) The UV-induced alterations in the normal immune response can be beneficial for some human diseases and detrimental for others. Vitamin D, synthesised following exposure of the skin to UV-B radiation, also has positive and negative effects on immune-related diseases. Indeed, it is difficult to distinguish between immunoregulation by vitamin D and other mediators induced by UV radiation,[176–180](https://pubs.rsc.org/en/content/articlehtml/2015/pp/c4pp90033b#cit176) since the downstream effects on immune parameters are similar. For clarity, the effects of UV radiation and those of vitamin D have been assessed separately in the sections below. We first focus on the effects of UV radiation on immunity, and address vitamin D-related effects on immune function in the section specifically on vitamin D. Polymorphic light eruption Polymorphic light eruption (PLE) is the commonest of the photodermatoses, with a prevalence of up to 20%.[181](https://pubs.rsc.org/en/content/articlehtml/2015/pp/c4pp90033b#cit181) PLE manifests as an intermittent itchy red skin eruption which resolves without scarring after a few days to weeks. It occurs 2–3 times more frequently in women than in men, with onset typically in the first three decades of life,[181](https://pubs.rsc.org/en/content/articlehtml/2015/pp/c4pp90033b#cit181) and is found predominantly in those with fair skin, although all skin types can be affected.[181](https://pubs.rsc.org/en/content/articlehtml/2015/pp/c4pp90033b#cit181) A recent study of Indian patients with dark skin phototypes (IV and V) who suffered from various photodermatoses revealed that PLE was the commonest of these, affecting 60% of the group.[182](https://pubs.rsc.org/en/content/articlehtml/2015/pp/c4pp90033b#cit182) The lesions occur most often in the spring and early summer or during a sunny holiday, following the first exposure to a large dose of sunlight. After repeated exposures, the lesions are less likely to occur. This process, called photohardening, is used therapeutically with good results. Recent investigations indicate that key events in photohardening include a decrease in the number of Langerhans cells in the epidermis and recruitment of mast cells into the dermis,[183](https://pubs.rsc.org/en/content/articlehtml/2015/pp/c4pp90033b#cit183) together with changes in systemic cytokine levels.[184](https://pubs.rsc.org/en/content/articlehtml/2015/pp/c4pp90033b#cit184) PLE is immunologically-mediated as a result of a failure to establish the normal suppression of immune responses following exposure to UV radiation. The antigen involved has not been identified but is likely to be novel, induced by the **DNA damaging properties of UV radiation**. Various abnormalities in the cutaneous immune response following UV radiation have been demonstrated in people with PLE compared with controls.[185,186](https://pubs.rsc.org/en/content/articlehtml/2015/pp/c4pp90033b#cit185) This disease therefore illustrates the positive evolutionary advantage of UV-induced immunosuppression in individuals who are not susceptible to PLE and what can happen if it is absent. Asthma **Asthma** comprises a group of diseases that evidence as wheeze, chest tightness, or shortness of breath, occurring as a result of obstruction of the airways and restriction of airflow that is usually reversible. The level of severity, frequency of symptoms, age of onset, main inflammatory phenotypes, and triggers and pathways are variable. This heterogeneity may explain the current lack of consistency in results from studies examining the relationship between UV radiation and the risk of asthma. There are anecdotal accounts that sunny holidays or living at high altitude decrease asthma symptoms. The prevalence of asthma was inversely associated with the intensity of UV radiation,[187](https://pubs.rsc.org/en/content/articlehtml/2015/pp/c4pp90033b#cit187) or past personal exposure to solar UV radiation.[188](https://pubs.rsc.org/en/content/articlehtml/2015/pp/c4pp90033b#cit188) However, in a study where different sub-types of asthma were considered, residence at latitudes closer to the equator (and with greater intensity of UV-B radiation) was associated with an increased risk of having asthma in atopic participants (with a history of allergic responses to specific antigens) but a decreased risk in those without atopy.[189](https://pubs.rsc.org/en/content/articlehtml/2015/pp/c4pp90033b#cit189) These findings highlight the importance of differentiating between subtypes of asthma in examining associations with exposure to UV radiation. Nevertheless, individual-level exposure to UV radiation was not measured (only latitude and ambient UV radiation), so the results could reflect exposure to other latitude-associated factors such as temperature and indoor heating. Infection and vaccination Studies over the past 20 years have shown that **exposure to solar UV radiation suppresses** microbe-specific acquired **immune responses in** animal models of **infection**. This modulation can lead to an **increased microbial load, reactivation from latency, and more severe symptoms, including death** (reviewed in Norval et al.[190](https://pubs.rsc.org/en/content/articlehtml/2015/pp/c4pp90033b#cit190)). A recent study showed that spending 8 or more hours outdoors per week when the UV Index was ≥4 was associated with an increased risk of ocular recurrence of herpes simplex virus (HSV) infection resulting in eruptive lesions.[191](https://pubs.rsc.org/en/content/articlehtml/2015/pp/c4pp90033b#cit191) **UV radiation prior to vaccination** causes a **less effective immune response** in several mouse models (reviewed in Norval & Woods[192](https://pubs.rsc.org/en/content/articlehtml/2015/pp/c4pp90033b#cit192)), but whether exposure to UV radiation adversely affects the course of infections and the efficacy of vaccination in humans remains an open question. Despite the paucity of new information, there remains the possibility that UV-induced immunosuppression could **convert an asymptomatic infection into a symptomatic one**, **reactivate** a range of **persistent infections**, increase the oncogenic potential of microbes, and **reduce the memory immune response,** for example after vaccination, so that it is no longer protective. Autoimmune diseases Many autoimmune diseases are considered to have both environmental and genetic risk factors. Evidence to support the importance of environmental exposures comes from geographical variation (changing incidence with changing latitude), temporal patterns (such as variations in incidence with season or season-of-birth) and results from observational epidemiological studies. Several studies show an inverse association between exposure to UV radiation and immune-mediated diseases, suggesting that the UV may be protective. In many cases, the assumed pathway has been through enhanced synthesis of vitamin D (see section on Vitamin D below). However, this evidence is now being re-evaluated in light of possible alternative pathways, including UV-induced immune modulation and altered susceptibility to relevant viral infections, and non-UV pathways such as changes in the secretion of melatonin (reviewed in Hart et al.[193](https://pubs.rsc.org/en/content/articlehtml/2015/pp/c4pp90033b#cit193)). While there have been suggestions that exposure to UV radiation may be important for conditions such as inflammatory bowel disease (for example, Nerich et al.[194](https://pubs.rsc.org/en/content/articlehtml/2015/pp/c4pp90033b#cit194)), type 1 diabetes,[195](https://pubs.rsc.org/en/content/articlehtml/2015/pp/c4pp90033b#cit195) and rheumatic diseases (including rheumatoid arthritis, systemic lupus erythematosus, dermatomyositis, and others),[196](https://pubs.rsc.org/en/content/articlehtml/2015/pp/c4pp90033b#cit196) the strongest evidence is for multiple sclerosis. Multiple sclerosis. Many studies (but not all) have shown that the prevalence, incidence, or mortality from multiple sclerosis (MS) increases with increasing latitude and decreasing altitude or intensity of ambient UV radiation, in predominantly fair-skinned populations (reviewed in Hewer et al.[197](https://pubs.rsc.org/en/content/articlehtml/2015/pp/c4pp90033b#cit197)). In the US Nurses Health Studies, a latitudinal gradient present in a cohort of female nurses born before 1946 was not apparent in a similar cohort born after 1946.[198](https://pubs.rsc.org/en/content/articlehtml/2015/pp/c4pp90033b#cit198) The findings reflected an increase in incidence in the south in the later cohort (rather than a decrease in the north). One explanation given to explain this change was that increasing sun-protective behaviours in the south had reduced the difference in personal dose of UV between the north and south.[199](https://pubs.rsc.org/en/content/articlehtml/2015/pp/c4pp90033b#cit199) Studies from the northern[200](https://pubs.rsc.org/en/content/articlehtml/2015/pp/c4pp90033b#cit200) and southern[201](https://pubs.rsc.org/en/content/articlehtml/2015/pp/c4pp90033b#cit201) hemispheres show that, compared to the general population, people with MS were more likely to have been born in late spring and less likely to have been born in late autumn. This timing would be consistent with a hypothesis that exposure of the mother to more UV radiation during the late first trimester, when the foetal nervous system is developing and maturing, is protective for the development of MS in later life.[201](https://pubs.rsc.org/en/content/articlehtml/2015/pp/c4pp90033b#cit201) Alternatively, it is also possible that exposures early in infancy, rather than in pregnancy, influence risk, or other factors that vary seasonally could be important. Animal studies suggest that UV-B irradiation can prevent the onset of experimental autoimmune encephalomyelitis, used as a model for MS,[202](https://pubs.rsc.org/en/content/articlehtml/2015/pp/c4pp90033b#cit202) and there is supportive evidence from recent studies in humans.[203,204](https://pubs.rsc.org/en/content/articlehtml/2015/pp/c4pp90033b#cit203) The role of UV-induced immune suppression in skin cancer Cutaneous malignant melanoma. Evidence that the immune response is important for the development of CMM is clearly shown by the increase in incidence following organ transplantation that requires ongoing treatment with immunosuppressive medications.[205](https://pubs.rsc.org/en/content/articlehtml/2015/pp/c4pp90033b#cit205) UV radiation, particularly UV-B, can cause suppression of many aspects of cell-mediated immunity but, until recently, how it influenced the initiation of CMM was unknown. In a transgenic mouse model, the recruitment of macrophages to the skin following UV-B irradiation and their subsequent proliferation were shown to be critical in the survival of melanocytes, including those with UV-induced DNA damage.[206–208](https://pubs.rsc.org/en/content/articlehtml/2015/pp/c4pp90033b#cit206) In addition, inflammation induced by UV radiation increased metastasis of melanoma, with neutrophils being the main drivers of the inflammatory process.[209](https://pubs.rsc.org/en/content/articlehtml/2015/pp/c4pp90033b#cit209) Consistent with these reports from animal models, in patients with metastatic melanoma there was a shorter survival time if metastases contained a high proportion of macrophages.[210](https://pubs.rsc.org/en/content/articlehtml/2015/pp/c4pp90033b#cit210) Non-melanoma skin cancer. Tumours induced by UV radiation are highly antigenic. UV-induced immune suppression plays a critical role in the development of NMSC as evidenced by the dramatically increased incidence in immunosuppressed people, for example, following organ transplantation.[211](https://pubs.rsc.org/en/content/articlehtml/2015/pp/c4pp90033b#cit211) This is especially shown for SCCs in organ transplant recipients receiving immunosuppressive drugs that suppress T cell activity, suggesting that effector T cells are of particular importance in the control of SCC.[212](https://pubs.rsc.org/en/content/articlehtml/2015/pp/c4pp90033b#cit212) Furthermore, Tregs induced by UV irradiation infiltrate SCCs and surround BCCs. Pharmacologically blocking steps in the pathway of UV-induced immunosuppression may be effective in preventing the development of skin cancers and actinic keratoses.[212–214](https://pubs.rsc.org/en/content/articlehtml/2015/pp/c4pp90033b#cit212)

#### That causes viruses to human bacterial genome to damage will ensure the next pandemic is existential

Supriya 4/19 [Lakshmi Supriya got her BSc in Industrial Chemistry from IIT Kharagpur (India) and a Ph.D. in Polymer Science and Engineering from Virginia Tech (USA). She has more than a decade of global industry experience working in the USA, Europe, and India. After her Ph.D., she worked as part of the R&D group in diverse industries starting with semiconductor packaging at Intel, Arizona, where she developed a new elastomeric thermal solution, which has now been commercialized and is used in the core i3 and i5 processors. From there she went on to work at two startups, one managing the microfluidics chip manufacturing lab at a biotechnology company and the other developing polymer formulations for oil extraction from oil sands. She also worked at Saint Gobain North America, developing various material solutions for photovoltaics and processing techniques and new applications for fluoropolymers. Most recently, she managed the Indian R&D team of Enthone (now part of MacDermid) developing electroplating technologies for precious metals.) “Humans versus viruses - Can we avoid extinction in near future?” News Medical Life Sciences, 4/19/21, https://www.news-medical.net/news/20210419/Humans-versus-viruses-Can-we-avoid-extinction-in-near-future.aspx] RM

Expert argues that human-caused changes to the environment can lead to the emergence of pathogens, not only from outside but also from our own microbiome, which can pave the way for large-scale destruction of humans and **even our extinction**.

Whenever there is a change in any system, it will cause other changes to reach a balance or equilibrium, generally at a point different from the original balance. Although this principle was originally posited by the French chemist Henry Le Chatelier for chemical reactions, this theory can be applied to almost anything else.

In an essay published on the online server Preprints\*, Eleftherios P. Diamandis of the University of Toronto and the Mount Sinai Hospital, Toronto, argues that changes caused by humans, to the climate, and everything around us will lead to changes that may have a dramatic impact on human life. Because our ecosystems are so complex, we don’t know how our actions will affect us in the long run, so humans generally disregard them.

Changing our environment

Everything around us is changing, from living organisms to the climate, water, and soil. Some estimates say about half the organisms that existed 50 years ago have already become extinct, and about 80% of the species may become extinct in the future.

As the debate on global warming continues, according to data, the last six years have been the warmest on record. Global warming is melting ice, and sea levels have been increasing. The changing climate is causing more and more wildfires, which are leading to other related damage. At the same time, increased flooding is causing large-scale devastation.

One question that arises is how much environmental damage have humans already done? A recent study compared the natural biomass on Earth to the mass produced by humans and found humans produce a mass equal to their weight every week. This human-made mass is mainly for buildings, roads, and plastic products.

In the early 1900s, human-made mass was about 3% of the global biomass. Today both are about equal. Projections say by 2040, the human-made mass will be triple that of Earth’s biomass. But, slowing down human activity that causes such production may be difficult, given it is considered part of our growth as a civilization.

Emerging pathogens

Although we are made up of human cells, we have almost ten times that of bacteria just in our guts and more on our skin. These microbes not only affect locally but also affect the entire body. There is a balance between the good and bad bacteria, and any change in the environment may cause this balance to shift, especially on the skin, the consequences of which are unknown.

Although most bacteria on and inside of us are harmless, gut bacteria can also have viruses. If viruses don’t kill the bacteria immediately, they can incorporate into the bacterial genome and stay latent for a long time until reactivation by environmental factors, when they can become pathogenic. They can also escape from the gut and enter other organs or the bloodstream. Bacteria can then use these viruses to kill other bacteria or help them evolve to more virulent strains.

An example of the evolution of pathogens is the cause of the current pandemic, the severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2). Several mutations are now known that make the virus more infectious and resistant to immune responses, and strengthening its to enter cells via surface receptors.

The brain

There is evidence that the SARS-CoV-2 can also affect the brain. The virus may enter the brain via the olfactory tract or through the angiotensin-converting enzyme 2 (ACE2) pathway. Viruses can also affect our senses, such as a loss of smell and taste, and there could be other so far unkown neurological effects. The loss of smell seen in COVID-19 could be a new viral syndrome specific to this disease.

Many books and movies have described pandemics caused by pathogens that wipe out large populations and cause severe diseases. In the essay, the author provides a hypothetical scenario where a gut bacteria suddenly starts producing viral proteins. Some virions spread through the body and get transmitted through the human population. After a few months, the virus started causing blindness, and within a year, large populations lost their vision.

Pandemics can cause other diseases that can threaten humanity’s entire existence. **The COVID-19 pandemic brought this possibility to the forefront**. If we continue disturbing the equilibrium between us and the environment, we don’t know what the consequences may be and **the next pandemic could lead us to extinction.**

### 1AC – Detritus

#### Advantage 2 is Detritus

#### Asteroid mining spikes the risk of satellite-dust collisions

Scoles 15 ~~[(Sarah Scoles, freelance science writer, contributor at Wired and Popular Science, author of the books Making Contact and They Are Already Here) "Dust from asteroid mining spells danger for satellites," New Scientist, May 27, 2015, <https://www.newscientist.com/article/mg22630235-100-dust-from-asteroid-mining-spells-danger-for-satellites/>~~] TDI

* Study this is citing – Javier Roa, Space Dynamic Group, Applied Physics Department, Technical University of Madrid. Casey J Handmer, Theoretical Astrophysics, California Institute of Technology. Both PhD Candidates. "Quantifying hazards: asteroid disruption in lunar distant retrograde orbits," arXiv, Cornell University, May 14, 2015, <https://arxiv.org/pdf/1505.03800.pdf>

NASA chose the second option for its [Asteroid Redirect Mission](http://www.nasa.gov/content/what-is-nasa-s-asteroid-redirect-mission/), which aims to [pluck a boulder from an asteroid’s surface](https://www.newscientist.com/article/dn27243-rock-grab-from-asteroid-will-aid-human-mission-to-mars) and relocate it to a stable orbit around the moon. But an asteroid’s gravity is so weak that it’s not hard for surface particles to escape into space. Now a new model warns that debris shed by such transplanted rocks could intrude where many defence and communication satellites live – in geosynchronous orbit.

According to [Casey Handmer](http://www.caseyhandmer.com/) of the California Institute of Technology in Pasadena and Javier Roa of the Technical University of Madrid in Spain, 5 per cent of the escaped debris will end up in regions traversed by satellites. Over 10 years, it would cross geosynchronous orbit 63 times on average. A satellite in the wrong spot at the wrong time will suffer a damaging high-speed collision with that dust.

The study also looks at the "catastrophic disruption" of an asteroid 5 metres across or bigger. Its total break-up into a pile of rubble would increase the risk to satellites by more than 30 per cent ([arxiv.org/abs/1505.03800](http://arxiv.org/abs/1505.03800)).

#### Commercial rocket launches produce space clutter—increased debris could reach a tipping point. AND private companies are impossible to control – only space decolonization solves

Thompson 20 [(Clive, author of Coders: The Making of a New Tribe and the Remaking of the World, a columnist for Wired magazine, and a contributing writer to The New York Times Magazine) “Monetizing the Final Frontier The strange new push for space privatization,” December 3, 2020 <https://newrepublic.com/article/160303/monetizing-final-frontier>] TDI

“Physics tells us that two things can’t occupy the same space at the same time or else bad things happen,” Jah said dryly. Indeed, there’s already been one collision that produced sprawling orbital pollution. In 2009, a satellite owned by the U.S. firm Iridium slammed into a decommissioned Russian government satellite at more than 26,000 mph. The crash produced 2,300 pieces of debris, spraying off in all directions. And debris is a particularly gnarly problem in space, because when it’s traveling at thousands of miles an hour, even a marble-size chunk is like a bullet, capable of rendering a damaged satellite inoperable and unsteerable—the owner can no longer fire its boosters to guide it into a higher or lower orbit. There are currently an estimated 500,000 marble-size chunks up there. Decades of space travel by governments left plenty of refuse, ranging from parts of rocket boosters to stray bits of scientific experiments. One particularly grim vision of the future that haunts astronomers is the “Kessler syndrome,” proposed by the astrophysicist Donald Kessler in 1978. Kessler hypothesized that space clutter could reach a tipping point: One really bad collision could produce so much junk that it would trigger a chain reaction of collisions. This disaster scenario would leave hundreds of satellites eventually destroyed, and create a ring of debris that would make launching any new satellites impossible, forever. “Near space is finite—it’s a finite resource,” Jah said. “So now you have this growing trash problem that isn’t being remediated.... And if we exceed the capacity of the environment to carry all this traffic safely, then it becomes unusable.” That’s why a growing chorus of critics are already making the case that space is the next major environmental area to protect, after the oceans and land on Earth. “People seem to really treat resources in space as being infinite,” said Erika Nesvold, an astrophysicist who’s the cofounder of The JustSpace Alliance. “As we’ve seen, people don’t really intuitively understand exponential growth.” That’s the dilemma in a nutshell: The available room in the sky is limited, but the plans for growth are exponential. SpaceX isn’t the only New Space firm looking to toss up satellites. Satellite and rocket start-ups are now lining up en masse, atop new waves of investment. There are satellites geared up to connect to “the internet of things” so companies can communicate among proprietary networks of household devices. There are floating cameras pointing down—so as to gather “geospatial intelligence,” which is to say data streamed from “the vantage point you get from satellites looking down on Earth and giving us information about our planet,” as the venture capitalist Anderson told me. And new forms of satellite vision are emerging all the time, such as cameras that can see at night, or are specially designed to see agriculture. Experiments abound, and so satellite launches will inevitably multiply in their wake. Part of what makes near-Earth orbit so chaotic is that it is, at the moment, remarkably unregulated—not unlike the internet of the early ’90s. An American firm has to get permission from the Federal Communications Commission to launch a satellite, but once it’s in orbit, there’s no federal agency that can compel it to move out of the path of a collision. Satellite owners generally don’t like to move if they can avoid it, because their satellites have a limited amount of fuel; any movement decreases their usable lifespan. On top of that, there are dozens of nations shooting satellites into low-Earth orbit—but no international body coordinating their flight paths. Last fall, the European Space Agency realized one of SpaceX’s new Starlink satellites was on a dangerously close path to an ESA satellite. SpaceX said it had no plans to move the satellite; so the ESA decided to fire its thrusters and get clear. This high-stakes negotiation was conducted via email. What’s more, space debris is extremely hard to source. If a British satellite slams into yours, you can probably figure out who hit you. But if your satellite is wrecked by a random piece of junk, nobody has any clue where that debris came from. It is, in this way, a neat parallel to the problem of C02, where a ceaseless barrage of tiny commercial decisions creates a sprawling problem—one that’s all but designed to ensure that everyone who caused it can deny responsibility. And damage is asymmetric: A company with a small $60,000 satellite could smash into a wildly expensive one paid for by U.S. taxpayers. “A National Reconnaissance Office satellite is at least a billion dollars, if not more, so they have a lot more to lose if something hits a satellite,” Bhavya Lal, a researcher at the IDA Science and Technology Policy Institute, noted. “As more private activity starts to happen, there’s more chances of that loss of control, too.” One might dismiss all this anxiety as a sort of sci-fi version of hippie environmentalism—except that even the administrator of NASA is deeply worried about the chaos and destruction likely to be sown by commercial activity in near-Earth orbit. Jim Bridenstine, the Trump-appointed head of NASA, is as pro-market as one can be. He praises SpaceX every chance he gets; he talks about privatizing the space station. But when I asked him about the looming danger of space debris, during a press-conference call, he conceded that it’s a huge, unresolved issue.

“More satellites mean more risk,” he said. “And we as a nation have not yet caught up to the risk that currently exists in space.” In September, a few months after Bridenstine and I spoke, the space station had to fire its thrusters for 150 seconds to [move out of the way](https://blogs.nasa.gov/spacestation/2020/09/22/station-boosts-orbit-to-avoid-space-debris/) of dangerously approaching space junk, while the crew huddled in a Soyuz capsule in case the station’s hull was breached and they had to flee to Earth.

Apart from the fate of the station, one could ask who cares if a commercial stampede blights Earth’s orbit, and wrecks anyone’s ability to keep satellites aloft? Maybe it’ll just hurt a bunch of investors. And maybe we need less surveillance from deathless orbiting eyes, not more.

There are, though, plenty of civically significant reasons to keep low-Earth orbit usable. Satellite monitoring isn’t solely a spy activity—these days, it has become a powerful tool for climate scientists to figure out how the oceans are warming, and to puzzle out our adaptations to climate change. Other nonprofit concerns use satellites to monitor injustices on Earth: Global Forest Watch, for example, takes data from the 140-satellite array of the firm Planet and uses it to help [bust illegal deforestation](https://www.planet.com/pulse/planet-ksat-and-airbus-awarded-first-ever-global-contract-to-combat-deforestation/).

So it’d certainly be good to keep low-Earth orbit from becoming a junkyard. But there’s no ready consensus on how to do that. Some government regulation could help: Bridenstine wants Congress to pass a bill funding a department in charge of “compelling somebody to maneuver if it’s necessary.” Moriba Jah would like a federal law requiring space firms to openly publish the location of their satellites. (Some, like Planet, already do, but most, as Jah has found, make it very difficult for others to pin down the exact locations of their satellites.) “You can’t enforce anything unless you know what’s happening,” Jah said, and a name-and-shame system could help: “Once people can assign a first and last name, it’s like, OK, these assholes aren’t complying.” Better tech might also assist; the U.S. firm [LeoLabs](https://www.leolabs.space/" \t "_blank) is building a radar-dish array that can track pieces of space junk as small as a few centimeters. Others are working on as-yet-untested ways of actually cleaning up orbital junk, possibly by pushing it down to burn up on reentry.

“Sometimes I think that we might need to have some terrible collision event happening for the world to kind of come together and take it seriously.”

New Space firms themselves, however, want to be left alone to deal with this problem. Most I spoke to argued—quite against the weight of industrial history—that the free market would self-regulate, since each firm wants orbits clean enough to make money in. But even some ardent champions of the new commercial boom worry things may get worse before anyone snaps to attention. “Sometimes I think that we might need to have some terrible collision event happening for the world to kind of come together and take it seriously,” Lal told me.

Satellites are the big commercial opportunity in space right now, though there are plenty of others in various states of gestation. Each one raises a handful of intriguing possibilities for a commercial boom, and its own blizzard of questions for earthbound society. One rough rule of thumb for sizing them up might go something like this: The farther out you go from Earth, the weirder the questions become.

The most proximal market, according to investors, is probably the development of [manufacturing in near-Earth orbit](https://www.space.com/40552-space-based-manufacturing-just-getting-started.html), on space stations. Microgravity, it turns out, makes it possible to create materials that can’t easily be pulled together on Earth. The range of product lines for off-planet factories runs from specially shaped contact lenses (designed to correct deep vision problems) to optical fibers capable of carrying more data than cables made on Earth. One firm, [Nanoracks](https://nanoracks.com/" \t "_blank), currently contracts out room for commercial start-ups on the International Space Station. Its early client list boasts a diverse array of for-profit activities—everything from running science experiments to launching small, inexpensive “[Cubesats](https://www.nasa.gov/mission_pages/cubesats/overview" \t "_blank)” that can fit in your hand and mostly do remote sensing (like monitoring the atmosphere) for research or industry. In the long run, Nanoracks aims to launch its own space station to offer complex manufacturing capabilities that wouldn’t currently fit in the International Space Station’s limited confines.

“There’s a lot of work you can do, a lot of research and a lot of exciting things when you’re not connected to a gigantic, humongous modular space station that has different gravity tensions, different forces acting on it, disturbing the microgravity,” Nanoracks CEO Jeffrey Manber noted.

The next generation of space stations will probably be built—like Manber’s hoped-for one—mostly by private interests. Such installations will continue to do plenty of work for governments. Manber would rather make a fully robotic space station—it’s far more profitable for New Space moguls not to shoulder the, ahem, astronomical costs of keeping people alive in outer space—but he anticipates that a major early customer would likely be NASA, and one of NASA’s main scientific areas of study is how humans react to living in space. Any for-profit space station NASA’s contracting agents would bring on would thus likely need to host a crew.

Beyond the space station beckons another old NASA stomping ground—the moon, which has become newly lucrative. After the last Apollo visit in 1972, NASA and Congress abandoned the moon; reaching it had been a quest to beat the Soviets, and, that race won, public support for the incredible expense evaporated. But over the last decade, moon activity has rebooted. Trump [announced](https://www.theatlantic.com/science/archive/2019/03/trump-nasa-moon-2024/585880/) the goal of returning NASA astronauts to the lunar surface; India [tried and failed](https://www.npr.org/2019/11/26/782890646/2-months-after-failed-moon-landing-india-admits-its-craft-crashed) to put a lander down; and last year, [China succeeded](https://www.space.com/42981-china-moon-far-side-panorama-chang-e-4.html). NASA is currently planning to build a lunar [Gateway](https://www.nasa.gov/gateway), a space station orbiting the moon, to assist in regular traffic back and forth; SpaceX has a $7 billion contract for launching its components.

What, exactly, made the moon sexy again? The [discovery of water](http://news.bbc.co.uk/2/hi/science/nature/8544635.stm). Beginning in the late aughts, moon probes have found that craters in the lunar poles contain water ice—some 600 million tons of it, according to one estimate. This instantly changed the moon’s geopolitical and economic import, because water is an enormously precious commodity in space. It’s crucial for life—not just as a fluid, but broken into its constituent molecular parts: oxygen that lets you breathe, and hydrogen for fuel. One scientist’s rough estimate found that the amount of water on the moon could power one space shuttle launch every day for 2,200 years. Several companies announced their eventual goal would be to create landing craft that could reach the moon and mine the water. One such concern, [the Moon Express](https://www.theverge.com/2017/7/12/15958164/moon-express-robot-landers-private-mining-outpost), pitches its mission in a heady compound of colonialist new frontier rhetoric—equal parts Star Trek and Rudyard Kipling: “The Moon is Earth’s 8th continent,” the firm announces on its website.

But even assuming the wet new lunar frontier can be tamed—for all the space-booster rhetoric, it’s still a very spec-ulative prospect, both logistically and economically—there’s a whole host of untested questions about property rights in the great beyond. Space law, it turns out, is very ambiguous about who’s empowered to exploit space resources, and to what geopolitical-cum-commercial ends. There’s an [Outer Space Treaty](https://2009-2017.state.gov/t/isn/5181.htm), signed in 1967 by most major industrial countries, which seeks to establish space as a shared resource for humanity. It lets corporations engage in commercial activities on other celestial bodies—but neither they nor countries can claim property rights; and whatever a corporation does in space, its host country is on the hook for. There is also a Moon Treaty, created in 1979, that bans property rights on the moon and requires equitable use of lunar resources by all nations. But the Moon Treaty is [mostly toothless](https://www.thespacereview.com/article/1954/1); no country that has launched humans into space ever signed it.

The force of those treaties was never certain. But now that there’s possible money at hand, individual countries are openly defying the treaties—writing laws under their own steam to allow property rights in the heavens. In 2015, Obama signed the [SPACE Act](https://psmag.com/social-justice/outer-space-treaties-didnt-anticipate-the-privatization-of-space-travel-can-they-be-enforced), which explicitly gives U.S. firms the rights to any resources they mine from a celestial body. The Trump administration is [actively pushing](https://www.theguardian.com/science/2020/may/05/trump-mining-moon-us-artemis-accords) for firms to mine the moon. Other countries courting New Space firms—[hello, Luxembourg](https://www.technologyreview.com/2019/11/26/131822/why-its-now-the-perfect-time-to-start-a-small-space-agency/)—are following suit.

History, of course, would suggest that treaties crumble when serious money comes into play. Western settlers signed treaties with indigenous people in the Americas, then ignored them, as Lucianne Walkowicz, an astronomer at the [Adler Planetarium](https://www.adlerplanetarium.org/) and another cofounder of the JustSpace Alliance, noted.

“In many cases,” she told me, “treaties are good until somebody discovers something that they want.” She’s a fan of the Outer Space Treaty, finding it “a very, like, hopeful, peaceful, almost Star Trek-esque view of what space is.” She hopes it proves stronger than it looks.

Historically, however, law tends to follow the facts on the ground rather than shape them. When a new geography for commerce opens, whoever shows up first to exploit the resources sets the norm—and then law is written to validate the first movers. “‘First come, first serve’ is essentially what’s going to happen when people start to do things on the moon,” Peter Ward, author of [The Consequential Frontier](https://www.penguinrandomhouse.com/books/610858/the-consequential-frontier-by-peter-ward/), said.

Yet before the great water rush on the moon starts in earnest, one key point is worth pausing over: The supply of ice on the moon is limited. The estimated water reserves up there may be eye-popping at first glance, but they’re not that big. They likely add up to “three to five cubic kilometers of water, based on the studies that have come up,” said James Schwartz, a philosopher who also studies the ethics of space exploration. “Not a lot of water compared to even moderate- or small-size lakes on Earth.” It wouldn’t be that hard for a concerted explosion of commercial activity to chew through it all.

That may sound far-fetched, but, as all these space ethicists note, to the eyes of nineteenth-century explorers and industrialists, our planet seemed limitless, too—and it only took another century-plus of rapid commercial activity to tear through a diminishing store of finite resources. The environmental implications of exhausting the moon seem ludicrously sci-fi and far-off right now, and they’ll remain so for a long time—until, abruptly, they’re not. As with low-Earth orbit, outer space becomes much smaller and more cramped when you start thinking at commercial scale.

In any event, the moon is chiefly envisioned as a way-station project among the most ambitious cohort of space privatizers. A settled moon colony would serve as the push-off point for the main event, commercially speaking, for New Space entrepreneurs: mining the asteroid belt.

Asteroids are almost comically rich in precious materials. The asteroid Ryugu, for example, has about $82 billion in nickel and iron, according to the “[Asterank](https://www.asterank.com/" \t "_blank)” asteroid-value–ranking project. Another, Bennu, boasts a cool $669 million worth of iron and hydrogen. “You could totally collapse the gold and platinum market on Earth by mining asteroids,” joked Jacob Haqq Misra, a senior research investigator with the [Blue Marble Space Institute of Science](https://www.bmsis.org/), a nonprofit that encourages space exploration.

But there’s a hitch: Nobody has much of an idea how you’d actually mine an asteroid. Despite what you’ve seen in lumbering sci-fi epics like Armageddon, merely grabbing hold of a comparatively small, city-block–size object in microgravity is a forbidding physics puzzle—to say nothing of actually refining whatever you find.

One thing’s clear, however: In order to reach an asteroid, you’d need a lot of fuel for robotic probes. (Oxygen, too, if you’re bringing along a human crew.) This would likely be too expensive to do from Earth, given its gravity. The moon, on the other hand, is a sweet spot to base one’s commercial mining endeavors: enough gravity so humans can live in a base and assemble a rotating corps of mining robots, but sufficiently little gravity that launching mining probes at asteroids is easy.

“It takes so much energy to escape Earth’s orbit, by the time you do that, you’re basically halfway to anywhere in the universe,” Anderson said. “The moon as a launchpad—there’s a lot of commercial value there.”

Some New Space firms harbor still greater plans, in line with the classic “civilizing mission” that animated so many colonial land rushes in recent terrestrial history. Jeff Bezos wants to build space stations that rotate fast enough to simulate Earth gravity—and large enough to host entire cities full of residents. It’s a vision he built from a youth steeped in sci-fi. At Princeton, he took a class with Gerard O’Neill, a physicist who’d been [arguing since the 1960s](https://www.bloomberg.com/news/articles/2019-05-13/why-jeff-bezos-s-space-habitats-already-feel-stale) that humanity had to slip the surly bonds of Earth in order to survive over the long haul. O’Neill argued that living in space and mining asteroids represented the only path forward for the human race to continue growing and prospering without laying waste to planet Earth. He laid it out as a simple proposition of geology: If you were to mine the entire Earth down half a mile, leaving it a honeycombed crater, you’d still only get 1 percent of the metals and substances from the three biggest asteroids.

Bezos has eagerly endorsed the space-colony vision. In the short term, Bezos’s plans are the standard-issue vision for the New Space entrepreneur: building rockets and spacecraft that NASA will hire in order to resume landing astronauts on the moon. But in the long run—decades hence—building space colonies is, as he has argued, the only mission he can find big enough to devote his life and riches toward. “The only way that I can see to deploy this much financial resource,” Bezos [told Business Insider](https://www.businessinsider.com/jeff-bezos-interview-axel-springer-ceo-amazon-trump-blue-origin-family-regulation-washington-post-2018-4), “is by converting my Amazon winnings into space travel.”

The unexpected costs of Bezos-style space exploitation are, as yet, a little distant—decades, at least. But if there’s one thing we’ve learned from observing the human and environmental wreckage of the industrial era, it’s that history is like space travel: The path you set at the beginning is critical. Changing course later on is much harder. So it behooves us to plan now. Are there ways to avoid the worst possible outcomes in space? How is commercial life in space going to unfold?

The world’s small community of space ethicists has, in recent years, been increasingly pondering this, and they’ve come to some unsettling conclusions. First off, they note, the big winners in space will likely be ... the big winners on Earth. “I think it’s going to benefit the wealthy people that are running these mining firms,” Schwartz said bluntly. There are, as New Space investors today will tell you, winner-take-all dynamics. Bezos built a supply chain that is helping Amazon gradually dominate the world. Space will probably have room for only a few winners. So in order to envision the future contours of space conquest, it’s probably a safe bet to take all the harms of monopoly we see on this planet and project them on to a literally cosmic scale.

And that leads, in turn, to a corollary prophecy: Human rights in space are likely to be execrable, if they’re left up to the private sector.

Consider that anyone working in space will be reliant upon their employer for the most basic stuff of life. That’s not just food and water, but breathable oxygen, on a minute-by-minute basis. Plenty of science fiction has, over the years, war-gamed the bleak implications of these precarious situations. In Ridley Scott’s [Alien](https://www.imdb.com/title/tt0078748/) (1979), the employees of “The Company” are sent unwittingly to encounter a vicious alien life-form, with The Company hoping it would get a profitable specimen out of this. More recently, the TV show [The Expanse](https://www.imdb.com/title/tt3230854/) depicts the lives of asteroid miners as an outright form of slavery. One could, again, regard this as the typical pessimism of left-wing creative types—until one ponders workers’ rights on Earth as they exist now. Employees in Amazon’s warehouses are already [peeing into bottles](https://www.theverge.com/2018/4/16/17243026/amazon-warehouse-jobs-worker-conditions-bathroom-breaks) and [collapsing from heat exhaustion](https://www.businessinsider.com/amazon-warehouse-2011-9) in their attempt to satisfy their employer’s relentless work quotas; imagine if the company also controlled their breathable air.

Charles Cockell is a professor of astrobiology at the University of Edinburgh who’s written at length about the question of freedom in space settlements. He’s generally a libertarian, so he’s concerned about concentrations of power in both governments and private-sector firms in space.

“The controls on freedom of movement on the moon or Mars are worse than in North Korea,” he told me. “You can’t just walk out of a settlement.” Control of oxygen, he predicted, will empower the worst instincts of authoritarians of any stripe. “It will attract the coercively inclined and petty officialdom like all these things do…. It will attract people who crave power. You have to assume that that will lead to tyranny.”

These thought experiments don’t all conclude in grim dead-ends, however. There’s a whole arm of space ethics and philosophy devoted to asking the questions: Could the prospect of settling space positively serve society and justice? Could it offer up new ways of thinking about how we organize civic relations?

Coping with scarcity in space might impel settlers to reconsider some of the basic tent­poles of Western society. One is prison: On Mars, jailing someone would cost billions. A settlement would, as the astrophysicist and ethicist Nesvold noted, wonder, “Is it even worth it?” They’d be far more liable to consider styles of justice that don’t involve locking people up. The same goes for environmental thinking. Water and air will be so precious to space settlers that “the people who are living in space are going to be much more concerned about resource conservation,” Schwartz said. “It could be the attitudes that we get there are ones that are helpful to send back [to Earth].”

The idea of space as a fresh slate for political thinking is enticing. But it’s hemmed in by the very nature of the market forces currently reaching for the skies. Would any private-sector firms heading to space agree to limit their power when they’re beyond Earth’s grasp? Nesvold and Lucianne Walkowicz think it’s possible. There is, they believe, a window of opportunity right now, while commercial space activity is still ramping up, to convince everyone in New Space—from the firms to their early (and crucial) governmental clients—to take space ethics seriously. They’ve been pursuing two tracks of inquiry along these lines: first, talking directly to New Space companies about the political, social, and environmental aspects of space exploitation. (The smaller firms, Nesvold noted, are often eager to talk; the big ones—the SpaceXs and Blue Origins—not so much.) Walkowicz has also been holding public events to get everyday citizens to discuss, as she put it, “becoming interplanetary.”

“I think making the infrastructure of getting to spaceflight cheaper and more sustainable, reusable, all of that stuff is great—I love watching rocket launches as much as the next person,” Walkowicz told me. But she wants a much broader cross-section of the public to have a voice on how space is used. As she frames things, it’s a simple matter of public accountability: For all the self-mythologizing among New Space titans about the new, scrappy, and libertarian cast of modern space exploration, it’s still NASA—and by extension, the people’s treasury—that’s projected to supply the biggest revenue stream for much New Space activity today, and in the near future. In other words, we the people are paying for many of these rocket launches, and the huge outlays that will help bankroll the hard stuff, like future human colonies on the moon.

So the public ought to have more input on how the projected settlement and exploitation of outer space actually happens. Walkowicz and Nesvold want to create a bigger sample of people informed about the stakes in the new space race, people who’d lobby Congress to help lay down the new American road rules for space—from keeping orbits clean to the question of who gets to ride on those taxpayer-funded rockets in the first place.

Space, in other words, needs to be “decolonized.” That’s a coinage gaining currency among some space thinkers, including Lindy Elkins-Tanton. She’s a planetary scientist with one foot in the world of New Space, and another in the world of space ethics. She’s the head of the NASA [“Psyche” project](https://www.jpl.nasa.gov/missions/psyche/), which is launching a probe next year to explore the metallic asteroid Psyche. On the one hand, she is herself benefiting directly from the lower costs that New Space has created, so she’s generally a fan of commercial interests making space more viable. Her probe will launch on a SpaceX rocket, and it’s so much cheaper than NASA’s older launches that it makes her science far more affordable. (“I’m sure I’m not supposed to tell you, but I’ll tell you: It’s a lot of money,” she said.)

Yet as Elkins-Tanton noted, the story of new frontiers being settled is the history of colonization, fueled by moneyed interests. Whether it was Europeans heading to North America or Africa or parts of Asia, it was generally huge state interests putting up the money for risk-taking explorers—with the explorers getting rich, the states amassing power, the new frontiers becoming gradually stripped of resources, and their indigenous populations either killed or impoverished.

“Decolonization,” as she and other New Space ethicists put it, would be a different route. It’d be the act of exploring space with that history in mind, and working deliberately in concert to avoid its brutalities. What would that mean? Elkins-Tanton argued, like Walkowicz and Nesvold, that any voyages to space need to have much greater democratic participation. For years, she’s been organizing annual projects that bring together a disparate array of thinkers—astrophysicists, artists, indigenous scholars—to plan for things such as how a Mars colony might exist without becoming a human rights nightmare.

#### Private space companies vastly outpace the public sector and avoid regulation which makes it a uniquely dangerous industry

**Rauenzahn et al, 20** (The Regulatory Review, 6-6-2020, accessed on 1-14-2022, The Regulatory Review, "Regulating Commercial Space Activity | The Regulatory Review", https://www.theregreview.org/2020/06/06/saturday-seminar-regulating-commercial-space-activity/)azhang

Scholars address possible strategies to regulate an emerging commercial space industry. After much anticipation, the United States launched a manned rocket ship for the first time in almost a decade. The launch marked a new era of space travel as Elon Musk’s SpaceX became the first private company to transport astronauts to space. But the transformation of spaceflight from a public endeavor to a commercial industry raises questions about how to regulate the activities of private entities in space. In 2014, the National Aeronautics and Space Administration (NASA) outsourced the task of transporting its astronauts, granting billion-dollar contracts to SpaceX and Boeing in a program called Commercial Crew. NASA astronauts Doug Hurley and Bob Behnken became the first crew to enter space under this public-private program. Over the next few decades, NASA plans to rely on this commercial partnership to pursue even more ambitious goals: returning to the moon and sending astronauts to Mars. But private companies have their own aspirations for outer space. Musk hopes to use SpaceX to start a human colony on Mars. Amazon’s Jeff Bezos also has his sights set on space colonization, and firms such as Bigelow Aerospace and Axiom Space plan to develop their own space stations. Some investors see opportunities in space tourism and mining. But these for-profit goals raise serious concerns about who can claim ownership of space resources and what law will govern private activity in uncharted frontiers. International space law is governed by a 1967 agreement known as the Outer Space Treaty⁠. The treaty allows all nations to use and explore the moon and celestial bodies, prohibits claims of sovereignty, and it requires nations to oversee the activities of private space companies. But existing space law has not kept up with the growth in the private sector, and the United States lacks a comprehensive regulatory regime. In anticipation of a growing commercial space industry, some experts and scholars call for more robust regulation. This week’s Saturday Seminar focuses on possible legal frameworks for governing commercial activity in outer space.

#### Space dust wrecks satellites and debris exponentially spirals

Intagliata 17 ~~[(Christopher Intagliata, MA Journalism from NYU, Editor for NPRs All Things Considered, Reporter/Host for Scientific American’s 60 Second Science) "The Sneaky Danger of Space Dust," Scientific American, May 11, 2017, <https://www.scientificamerican.com/podcast/episode/the-sneaky-danger-of-space-dust/>~~] TDI

When tiny particles of space debris slam into satellites, the collision could cause the emission of hardware-frying radiation, Christopher Intagliata reports.

Aside from all the satellites, and the space station orbiting the Earth, there's a lot of trash circling the planet, too. Twenty-one thousand [baseball-sized chunks](https://www.scientificamerican.com/article/orbital-debris-space-fence/) of debris, [according to NASA](https://www.orbitaldebris.jsc.nasa.gov/faq.html). But that number's dwarfed by the number of small particles. There's hundreds of millions of those.

"And those smaller particles tend to be going fast. Think of picking up a grain of sand at the beach, and that would be on the large side. But they're going 60 kilometers per second."

Sigrid Close, an applied physicist and astronautical engineer at Stanford University. Close says that whereas mechanical damage—like punctures—is the worry with the bigger chunks, the dust-sized stuff might leave more insidious, invisible marks on satellites—by causing electrical damage.

"We also think this phenomenon can be attributed to some of the failures and anomalies we see on orbit, that right now are basically tagged as 'unknown cause.'"

Close and her colleague Alex Fletcher modeled this phenomenon mathematically, based on plasma physics behavior. And here's what they think happens. First, the dust slams into the spacecraft. Incredibly fast. It vaporizes and ionizes a bit of the ship—and itself. Which generates a cloud of ions and electrons, traveling at different speeds. And then: "It's like a spring action, the electrons are pulled back to the ions, ions are being pushed ahead a little bit. And then the electrons overshoot the ions, so they oscillate, and then they go back out again."

That movement of electrons creates a pulse of electromagnetic radiation, which Close says could be the culprit for some of that electrical damage to satellites. The study is in the journal Physics of Plasmas. ~~[Alex C. Fletcher and Sigrid Close, [Particle-in-cell simulations of an RF emission mechanism associated with hypervelocity impact plasmas](http://aip.scitation.org/doi/full/10.1063/1.4980833)~~]

#### Early warning satellites going dark signals attacks – causes miscalc and goes nuclear

Orwig 16 ~~[(Jessica, MS in science and tech journalism from Texas A&M, BS in astronomy and physics from Ohio State) "Russia says a growing problem in space could be enough to spark a war," Insider,’ January 26, 2016, <https://www.businessinsider.com/russia-says-space-junk-could-spark-war-2016-1>~~] TDI

NASA has already warned that the large amount of space junk around our planet is growing beyond our control, but now a team of Russian scientists has cited another potentially unforeseen consequence of that debris: War.

Scientists estimate that anywhere from 500,000 to 600,000 pieces of human-made space debris between 0.4 and 4 inches in size are currently orbiting the Earth and traveling at speeds over 17,000 miles per hour.

If one of those pieces smashed into a military satellite it "may provoke political or even armed conflict between space-faring nations," Vitaly Adushkin, a researcher for the Institute of Geosphere Dynamics at the Russian Academy of Sciences, reported in a paper set to be published in the peer-reviewed journal Acta Astronautica, which is sponsored by the International Academy of Astronautics.

Say, for example, that a satellite was destroyed or significantly damaged in orbit — something that a 4-inch hunk of space junk could easily do traveling at speeds of 17,500 miles per hour, Adushkin reported. (Even smaller pieces no bigger than size of a pea could cause enough damage to the satellite that it would no longer operate correctly, he notes.)

It would be difficult for anyone to determine whether the event was accidental or deliberate.

This lack of immediate proof could lead to false accusations, heated arguments and, eventually, war, according to Adushkin and his colleagues.

A politically dangerous dilemma

In the report, the Adushkin said that there have already been repeated "sudden failures" of military spacecraft in the last two decades that cannot be explained.

"So, there are two possible explanations," he wrote. The first is "unregistered collisions with space objects." The second is "machinations" ~~[deliberate action~~] of the space adversary.

"This is a politically dangerous dilemma," he added.

But these mysterious failures in the past aren't what concerns Adushkin most.

It's a future threat of what experts call the cascade effect that has Adushkin and other scientists around the world extremely concerned.

The Kessler Syndrome

In 1978, American astrophysicist Donald Kessler predicted that the amount of space debris around Earth would begin to grow exponentially after the turn of the millennium.

Kessler 's predictions rely on the fact that over time, space junk accumulates. We leave most of our defunct satellites in space, and when meteors and other man-made space debris slam into them, you get a cascade of debris.

The cascade effect — also known as the Kessler Syndrome — refers to a critical point wherein the density of space junk grows so large that a single collision could set off a domino effect of increasingly more collisions.

For Kessler, this is a problem because it would "create small debris faster than it can be removed," Kessler said last year. And this cloud of junk could eventually make missions to space too dangerous.

For Adushkin, this would exacerbate the issue of identifying what, or who, could be behind broken satellites.

The future

So far, the US and Russian Space Surveillance Systems have catalogued 170,000 pieces of large space debris (between 4 and 8 inches wide) and are currently tracking them to prevent anymore dilemmas like the ones Adushkin and his colleagues cite in their paper.

But it's not just the large objects that concern Adushkin, who reported that even small objects (less than 1/3 of an inch) could damage satellites to the point they can't function properly.

Using mathematical models, Adushkin and his colleagues calculated what the situtation will be like in 200 years if we continue to leave satellites in space and make no effort to clean up the mess. They estimate we'll have:

1.5 times more fragments greater than 8 inches across

3.2 times more fragments between 4 and 8 inches across

13-20 times more smaller-sized fragments less than 4 inches across

"The number of small-size, non-catalogued objects will grow exponentially in mutual collisions," the researchers reported.

#### Anti-Satellite Weapons and Space Debris Collisions Lead to Arms Race and War – extinction

**Blatt 20** Talia M. Blatt [I am a rising sophomore at Harvard, considering a joint concentration in Social Studies and Integrative Biology with a citation in Chinese. I specialize in East Asian geopolitics and security issues]., 26.MAY.2020, "Anti-Satellite Weapons and the Emerging Space Arms Race," Harvard International Review, https://hir.harvard.edu/anti-satellite-weapons-and-the-emerging-space-arms-race/

Despite their deterrent functions, ASATs are more likely to provoke or exacerbate conflicts than dampen them, especially given the risk they pose to early warning satellites. These satellites are a crucial element of US ballistic missile defense, capable of detecting missiles immediately after launch and tracking their paths. Suppose a US early warning satellite goes dark, or is shut down. Going dark could signal a glitch, but in a world in which other countries have ASATs, it could also signal the beginning of an attack. Without early warning satellites, the United States is much more susceptible to nuclear missiles. Given the strategy of counterforcing—targeting nuclear silos rather than populous cities to prevent a nuclear counterattack—the Americans might believe their nuclear weapons are imminently at risk. It could be twelve hours before the United States regains satellite function, which is too long to wait to put together a nuclear counterattack. The United States, therefore, might move to mobilize a nuclear attack against Russia or China over what might just be a piece of debris shutting off a satellite. Additionally, accidental warfare, or strategic miscalculation, is uniquely likely in space. It is much easier to hold an adversary’s space systems in jeopardy with destructive ASATs than it is to sustainably defend a system, which is expensive and in some cases not technologically feasible because of limitations on satellite movement. Space is therefore considered offense-dominant; offensive tactics like weapons development are prioritized over defensive measures, such as improving GPS or making satellites more resistant to jamming. As a result, countries are left with poorly defended space systems and rely on offensive posturing, which increases the risk that their actions are perceived as aggressive and incentivizes rapid, risky counterattacks because militaries cannot rely on their spaced-based systems after first strikes. There are several hotspots in which ASATs and offensive-dominant systems are particularly relevant. Early warning satellites play a central role in US readiness in the event of a conflict involving North Korea. News of North Korean missile launches comes from these satellites. Given North Korea’s history of nuclear provocations, unflinchingly hostile rhetoric towards the United States and South Korea, and diplomatic opacity, North Korea is always a threatening, unknowable adversary, but recent developments have magnified the risk. With the health of Kim Jong-un potentially in jeopardy, a succession battle or even civil war on the peninsula raises the chances of loose nukes. If the regime is terminal, traditional MAD risk calculus will become moot; with nothing to lose, North Korea would have no reason to hold back its nuclear arsenal. Or China might decide to seize military assets and infrastructure of the regime. If the US does not have its early warning satellites because they have been taken out in an ASAT attack, the US, South Korea, and Japan are all in imminent nuclear peril, while China could be in a position to fundamentally reshape East Asian geopolitics. The South China Sea is another hotspot in which ASATs could risk escalation. China is developing Anti-Access Area Denial (A2/AD) in the South China Sea, a combination of long range radar with air and maritime defense meant to deny US freedom of navigation in the region. Given the disputed nature of territory in the South China Sea, the United States and its allies do not want China to successfully close off the region. But the most effective way to break an A2/AD system would be with anti-satellite weapons. ASATs could neutralize the maritime surveillance China relies upon to deny access to the region and guide cruise missiles. Thus, China is extremely wary of US ASAT development: risks to Beijing’s South China Sea strategy are seen as threats to China itself because of territorial sovereignty claims that are deeply important to the regime and have only become more pronounced under President Xi Jinping. If a Chinese satellite went dark, Beijing might perceive it as a US ASAT designed to undermine the A2/AD approach, and escalate with conventional force. Many of these conflict scenarios start with the loss of satellite function, which may seem unlikely. But ASATs threaten satellites through more than just direct attack. ASAT testing, rather than deployment, risks the exponential accumulation of debris, which endangers satellites and creates a host of other problems. KE-ASATs rely on smashing satellites into thousands of pieces, so each test adds tremendous amounts of space debris. The 2007 Chinese KE-ASAT test alone increased the number of objects in orbit by 20 percent, producing more than two thousand pieces of debris large enough to be tracked and likely thousands more too small to be counted that will remain in orbit for centuries. Even the smallest pieces of debris can do great damage; traveling at more than 15,000 miles per hour, they can crash into other debris in a proliferation known as the Kessler Syndrome. The situation in space could approach a critical mass in which collision cascading occurs even if all launches were halted, choking orbits with debris until all satellites are destroyed and spaceflight rendered impossible. Compared to the negligible debris created during commercial launches, ASAT tests—especially if the arms race continues to escalate and countries with less developed space programs join with cruder designs—may accelerate the debris in space closer and closer to this critical mass. If debris knocks out a satellite, an increasingly likely possibility in a world with ASAT tests, then the aforementioned conflict scenarios become more likely. Conflict aside, ASAT-based debris clouds are terrifying in their own right. Public health, transportation, climate science, and a litany of other crucial infrastructures are dependent on satellites that are now at risk. Satellite GPS is a cornerstone of the modern economy; some pundits believe that the slightest glitch in GPS satellites could shock the stock market and further destabilize an unstable global economy. During the pandemic, satellites are playing a crucial role in geospatial data collection for infectious disease modeling. Essentially, it is hard to imagine a world without satellites, but that is a possible outcome given that there are no reliable methods of withdrawing debris from space.

#### Nuke war causes extinction – it won’t stay limited

Edwards 17 ~~[(Paul N. Edwards, CISAC’s William J. Perry Fellow in International Security at Stanford’s Freeman Spogli Institute for International Studies. Being interviewed by EarthSky/card is only parts of the interview directly from Paul Edwards.) "How nuclear war would affect Earth’s climate," EarthSky, September 8, 2017, earthsky.org/human-world/how-nuclear-war-would-affect-earths-climate~~] TDI

We are not talking enough about the climatic effects of nuclear war.

The "nuclear winter" theory of the mid-1980s played a significant role in the arms reductions of that period. But with the collapse of the Soviet Union and the reduction of U.S. and Russian nuclear arsenals, this aspect of nuclear war has faded from view. That’s not good. In the mid-2000s, climate scientists such as Alan Robock (Rutgers) took another look at nuclear winter theory. This time around, they used much-improved and much more detailed climate models than those available 20 years earlier. They also tested the potential effects of smaller nuclear exchanges.

The result: an exchange involving just 50 nuclear weapons — the kind of thing we might see in an India-Pakistan war, for example — could loft 5 billion kilograms of smoke, soot and dust high into the stratosphere. That’s enough to cool the entire planet by about 2 degrees Fahrenheit (1.25 degrees Celsius) — about where we were during the Little Ice Age of the 17th century. Growing seasons could be shortened enough to create really significant food shortages. So the climatic effects of even a relatively small nuclear war would be planet-wide.

What about a larger-scale conflict?

A U.S.-Russia war currently seems unlikely, but if it were to occur, hundreds or even thousands of nuclear weapons might be launched. The climatic consequences would be catastrophic: global average temperatures would drop as much as 12 degrees Fahrenheit (7 degrees Celsius) for up to several years — temperatures last seen during the great ice ages. Meanwhile, smoke and dust circulating in the stratosphere would darken the atmosphere enough to inhibit photosynthesis, causing disastrous crop failures, widespread famine and massive ecological disruption.

The effect would be similar to that of the giant meteor believed to be responsible for the extinction of the dinosaurs. This time, we would be the dinosaurs.

Many people are concerned about North Korea’s advancing missile capabilities. Is nuclear war likely in your opinion?

At this writing, I think we are closer to a nuclear war than we have been since the early 1960s. In the North Korea case, both Kim Jong-un and President Trump are bullies inclined to escalate confrontations. President Trump lacks impulse control, and there are precious few checks on his ability to initiate a nuclear strike. We have to hope that our generals, both inside and outside the White House, can rein him in.

North Korea would most certainly "lose" a nuclear war with the United States. But many millions would die, including hundreds of thousands of Americans currently living in South Korea and Japan (probable North Korean targets). Such vast damage would be wrought in Korea, Japan and Pacific island territories (such as Guam) that any "victory" wouldn’t deserve the name. Not only would that region be left with horrible suffering amongst the survivors; it would also immediately face famine and rampant disease. Radioactive fallout from such a war would spread around the world, including to the U.S.

It has been more than 70 years since the last time a nuclear bomb was used in warfare. What would be the effects on the environment and on human health today?

To my knowledge, most of the changes in nuclear weapons technology since the 1950s have focused on making them smaller and lighter, and making delivery systems more accurate, rather than on changing their effects on the environment or on human health. So-called "battlefield" weapons with lower explosive yields are part of some arsenals now — but it’s quite unlikely that any exchange between two nuclear powers would stay limited to these smaller, less destructive bombs.

#### Privatization drive rivalries and exponentially increases debris.

BERNAT 20. Pawel @ Military University of Aviation. 11/4/20. [SAFETY ENGINEERING OF ANTHROPOGENIC OBJECTS, “ORBITAL SATELLITE CONSTELLATIONS AND THE GROWING THREAT OF KESSLER SYNDROME IN THE LOWER EARTH ORBIT,” Volume 4, PDF] Justin

5. Orbital satellite constellations and the growing threat of the Kessler syndrome

Space 2.0 – the new era of space exploration that we witness now in the 21st century means, in words of Buzz Aldrin, “moving human enterprise into space” (Pyle, 2019, p. xiv). The process of commercialization of outer space has already begun and is not limited to private companies providing technologies and services for national or international space agencies, as it was in the past. On the contrary, private companies from the space sector have now matured to carry out their own independent projects.

As for 2020, SpaceX is a company that serves as the best example – it launches satellites to the orbit, both for state and private contractors, it successfully realized two crew missions to the International Space Station, and is in the process of constructing Starlink satellite constellation that will provide high-speed internet access across the planet.

Each satellite weighs around 260 kg, is equipped with an ion propulsion system, autonomous collision avoidance system, and orbits Earth at approximately 540-560 km altitude (Starlink, 2020). At the beginning of November 2020, more than 860 Starlink satellites were orbiting the Earth (Jewett, 2020). Immediate plans include launching 12,000 satellites, but they assume a potential later extension to 42,000 (Henry, 2019a). Of course, SpaceX has employed, at least declaratively, all necessary measures to keep the space clean – the satellites are equipped with the deorbiting system, and in the event of inoperability of the propulsion system (Starlink, 2020). The orbital collisions are, however, inevitable. As it was shown before, the possibility of collisions grows with the number of orbital objects. Bastida Virgili with the team compared (2016, p. 154-155) orbital debris environment development without and with a large hypothetical constellation consisting of merely 1080 satellites, distributed across 20 orbital planes at 1,100 km altitude (Fig. 5).

Chart, line chart

Description automatically generated

Figure 5. Comparison of long term evolution of the number of objects in LEO with and without the constellation (Virgili et al., 2016, p. 155)

It has to be noted that although SpaceX’s Starlink is the only constellation that is being built in orbit, it is not the only one planned. There are at least a few initiatives aiming at the same goal – to construct internet infrastructure at the Earth’s orbit. The planned Kuiper Systems LLC, which is a subsidiary of Amazon and intends to place 3,236 broadband satellites in the LEO, is one of Starlink’s biggest competitors (Henry, 2019b). Now, there is even a rivalry between the two companies because Kuiper’s lowest orbital shell is planned to be 590 km, with a tolerance of 9 km either above or below (Cao, 2020), which is the altitude of Starlink satellites. Moreover, the race for space in orbit is now at the beginning.

The outer space is vast. It increasingly becomes more cluttered with both operational satellites and space debris. The threat of collisions increases and no institution or body has enough power to license, coordinate and regulate what is sent to the orbit. The UNOOSA has not such power. National states decide what the companies from the space industry can launch to space. In the United States, which is most advanced in the area of private constellations, it is the Federal Aviation Administration (FAA) that issues the appropriate approvals. The race to put broadband internet satellites bears similarities to the gold rush – there are no rules, at the global level, apart from first-come, first-served.

#### Models are rigorous—inserted below.

Virgili et al. 16. Bastida, J.C. Dolado, H.G. Lewis, J. Radtke, H. Krag, B. Revelin, C. Cazaux b , C. Colombo, R. Crowther, M. Metz. 4/26/16. [Act Astranautica “Risk to space sustainability from large constellations of satellites,” <https://sci-hub.se/10.1016/j.actaastro.2016.03.034>.] Justin

1.3. Simulation approach and result analysis A Monte Carlo (MC) approach was used to simulate the evolution of the object population over a period of 200 years under different post-mission disposal requirements, with four different tools (MEDEE – Modelling the Evolution of Debris on Earth's Environment [9], LUCA – Long Term Utility for Collision Analysis [10], DAMAGE – Debris Analysis and Monitoring Architecture to the Geosynchronous Environment [11] and DELTA – Debris Environment Long Term Analysis [12]). For analysis purposes, the effective number of objects was used where the contribution to the population by each object was weighted by the proportion of the orbital period spent in LEO. In a first step, four different evolutionary models performed an analysis of two reference scenarios. One scenario considered only the evolution of the background population and non-constellation traffic. The second scenario augmented the first with the addition of the representative constellation, with the requirement that 90% of the constellation satellites achieved post-mission disposal to orbits with remaining lifetimes of 25 years. The manoeuvres performed at the mission end to meet the disposal requirement are assumed to be impulsive (i.e. instantaneous) and result in an eccentric orbit with the apogee near the original (constellation) altitude and the perigee at an altitude such that the effects of atmospheric drag would cause the orbit to decay within 25 years. Two of the models considered an apogee remaining at the operational constellation altitude, while the other two reduced the apogee by 50 km. The purpose of these scenarios is to provide a cross-comparison of the models in terms of their predictions of the total object population, which take into account the effects of the constellation. As the distribution of the MC results for the models is of the same nature and the results are independent, a bootstrapping [20] approach is used to derive the mean, the standard deviation and the confidence levels at 95% of the combined results of all the MC runs from the four models (cf. Fig. 1), although not all the models performed the same number of MC runs (see Table 1). The main source of variation inside a particular model's MC runs included the randomness in collision activity, while the different models used their own solar activity forecast.

#### Aff solves better.

David 21 – Leonard, 4/14/21, Leonard David is author of Moon Rush: The New Space Race (National Geographic, 2019) and Mars: Our Future on the Red Planet (National Geographic, 2016). He has been reporting on the space industry for more than five decades, [“Space Junk Removal Is Not Going Smoothly,” Scientific American, <https://www.scientificamerican.com/article/space-junk-removal-is-not-going-smoothly/>] Justin

“From my perspective, the best solution to dealing with space debris is not to generate it in the first place,” says T. S. Kelso, a scientist at CelesTrak, an analytic group that keeps an eye on Earth-orbiting objects. “Like any environmental issue, it is easier and far less expensive to prevent pollution than to clean it up later. Stop leaving things in orbit after they have completed their mission.” There simply is no “one-size-fits-all solution” to the problem of space junk, Kelso says. Removing large rocket bodies is a significantly different task than removing the equivalent mass of a lot more smaller objects, which are in a wide range of orbits, he observes. Meanwhile innovations by companies such as SpaceX are dramatically lowering launch costs, opening the floodgates for far more satellites to reach low-Earth orbit, where some will inevitably fail and become drifting, debris-generating hazards (unless they are removed by ELSA-d-like space tugs). “Many of these operators are starting to understand the difficulty and complexity of continuing to dodge the growing number of debris.” Space junk ranges from nanoparticles to whole spacecraft such as the European Space Agency’s Envisat, which is the size of a double-decker bus and at the top of everyone's removal hit list, says Alice Gorman, a space archaeologist and space junk expert at Flinders University in Australia. There are also objects such as despin weights, which are solid lumps of metal, and thermal blankets, which are paper-thin. “They’ll cause different types of damage and may need different strategies to remove. There is no way that a one-size-fits-all approach is going to do it,” Gorman says. The most serious risks, she says, come from debris particles between one and 10 centimeters in size. “There’s far more of them than whole defunct spacecraft, and there is a far greater probability of collision,” Gorman says. “While debris this size might not cause a catastrophic breakup, collision with it can certainly damage working satellites and create new debris particles.” Turning her attention to satellite mega constellations, Gorman worries about their effects in a low-Earth orbital environment that is already congested. “We also know that orbital dynamics can be unpredictable,” she says. “I want to see some of these mega constellation operators releasing their long-term modeling for collisions as more and more satellites are launched.” There is no doubt that active orbital debris removal is technically challenging, Gorman says. “However, the big issue is that any successful technology that can remove an existing piece of debris can also be used as an antisatellite weapon,” she says. “This is a whole other can of worms that requires diplomacy and negotiation and, most importantly, trust at the international level.” Indeed, the ability to cozy up to spacecraft in orbit and perform servicing or sabotage has spurred considerable interest from military planners in recent years, says Mariel Borowitz, an associate professor at the Georgia Institute of Technology’s Sam Nunn School of International Affairs. “These rapidly advancing technologies have the potential to be used for peaceful space activities or for warfare in space,” she says. “Given the dual-use nature of their capabilities, it’s impossible to know for sure in advance how they’ll be used on any given day.” TAKING UP SPACE For now, according to Moriba Jah, an orbital debris expert at the University of Texas at Austin, the business case for space debris removal is not monetizable and is more a “PowerPoint talk” than a real marketplace. “I think people are hoping that government basically comes to some common sense to help create and establish a marketplace for industries to engage in these sorts of activities,” Jah says. In order for that to happen, he believes that spacefaring nations have to agree that near-Earth space is an ecosystem like land, air and the ocean. “It’s not infinite, so we need environmental protection,” he says.

### 1AC – Framing

#### Extinction first --- moral uncertainty.

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.

**Pleasure and pain are intrinsically valuable.**

Moen 16 [Ole Martin Moen, Research Fellow in Philosophy at University of Oslo “An Argument for Hedonism” Journal of Value Inquiry (Springer), 50 (2) 2016: 267–281] TDI

Let us start by observing, empirically, that a widely shared judgment about intrinsic value and disvalue is that pleasure is intrinsically valuable and pain is intrinsically disvaluable. On virtually any proposed list of intrinsic values and disvalues (we will look at some of them below), pleasure is included among the intrinsic values and pain among the intrinsic disvalues. This inclusion makes intuitive sense, moreover, for there is something undeniably good about the way pleasure feels and something undeniably bad about the way pain feels, and neither the goodness of pleasure nor the badness of pain seems to be exhausted by the further effects that these experiences might have. “Pleasure” and “pain” are here understood inclusively, as encompassing anything hedonically positive and anything hedonically negative.2 The special value statuses of pleasure and pain are manifested in how we treat these experiences in our everyday reasoning about values. If you tell me that you are heading for the convenience store, I might ask: “What for?” This is a reasonable question, for when you go to the convenience store you usually do so, not merely for the sake of going to the convenience store, but for the sake of achieving something further that you deem to be valuable. You might answer, for example: “To buy soda.” This answer makes sense, for soda is a nice thing and you can get it at the convenience store. I might further inquire, however: “What is buying the soda good for?” This further question can also be a reasonable one, for it need not be obvious why you want the soda. You might answer: “Well, I want it for the pleasure of drinking it.” If I then proceed by asking “But what is the pleasure of drinking the soda good for?” the discussion is likely to reach an awkward end. The reason is that the pleasure is not good for anything further; it is simply that for which going to the convenience store and buying the soda is good.3 As Aristotle observes: “We never ask [a man] what his end is in being pleased, because we assume that pleasure is choice worthy in itself.”4 Presumably, a similar story can be told in the case of pains, for if someone says “This is painful!” we never respond by asking: “And why is that a problem?” We take for granted that if something is painful, we have a sufficient explanation of why it is bad. If we are onto something in our everyday reasoning about values, it seems that pleasure and pain are both places where we reach the end of the line in matters of value.

#### Thus, the standard is maximizing expected well-being – prefer:

#### 1] Actor specificity – Governments must aggregate since every policy benefits some and harms others, which also means side constraints freeze action.

#### 2] **No act-omission distinction—governments are responsible for everything in the public sphere so inaction is implicit authorization of action: they have to yes/no bills, which means everything collapse to aggregation.**