# 1

#### Strong commercial space catalyzes tech innovation – progress at the margins and spinoff tech change global information networks

Joshua Hampson 2017, Security Studies Fellow at the Niskanen Center, 1-25-2017, “The Future of Space Commercialization”, Niskanen Center, https://republicans-science.house.gov/sites/republicans.science.house.gov/files/documents/TheFutureofSpaceCommercializationFinal.pdf

Innovation is generally hard to predict; some new technologies seem to come out of nowhere and others only take off when paired with a new application. It is difficult to predict the future, but it is reasonable to expect that a growing space economy would open opportunities for technological and organizational innovation. In terms of technology, the difficult environment of outer space helps incentivize progress along the margins. Because each object launched into orbit costs a significant amount of money—at the moment between $27,000 and $43,000 per pound, though that will likely drop in the future —each 19 reduction in payload size saves money or means more can be launched. At the same time, the ability to fit more capability into a smaller satellite opens outer space to actors that previously were priced out of the market. This is one of the reasons why small, affordable satellites are increasingly pursued by companies or organizations that cannot afford to launch larger traditional satellites. These small 20 satellites also provide non-traditional launchers, such as engineering students or prototypers, the opportunity to learn about satellite production and test new technologies before working on a full-sized satellite. That expansion of developers, experimenters, and testers cannot but help increase innovation opportunities. Technological developments from outer space have been applied to terrestrial life since the earliest days of space exploration. The National Aeronautics and Space Administration (NASA) maintains a website that lists technologies that have spun off from such research projects. Lightweight 21 nanotubes, useful in protecting astronauts during space exploration, are now being tested for applications in emergency response gear and electrical insulation. The need for certainty about the resiliency of materials used in space led to the development of an analytics tool useful across a range of industries. Temper foam, the material used in memory-foam pillows, was developed for NASA for seat covers. As more companies pursue their own space goals, more innovations will likely come from the commercial sector. Outer space is not just a catalyst for technological development. Satellite constellations and their unique line-of-sight vantage point can provide new perspectives to old industries. Deploying satellites into low-Earth orbit, as Facebook wants to do, can connect large, previously-unreached swathes of 22 humanity to the Internet. Remote sensing technology could change how whole industries operate, such as crop monitoring, herd management, crisis response, and land evaluation, among others. 23 While satellites cannot provide all essential information for some of these industries, they can fill in some useful gaps and work as part of a wider system of tools. Space infrastructure, in helping to change how people connect and perceive Earth, could help spark innovations on the ground as well. These innovations, changes to global networks, and new opportunities could lead to wider economic growth.

#### Fiat means the plan circumvents normal procedures for industry dialogue---that wrecks certainty and confidence, even if the substance of the plan is pro-business

Jeff Foust 18. Editor and publisher of The Space Review, and a senior staff writer with SpaceNews. 11-5-2018. "The Space Review: Turning space policy into space regulation." The Space Review. http://www.thespacereview.com/article/3598/1

More than five months ago, President Trump signed Space Policy Directive (SPD) 2, a policy document directing a series of regulatory reforms related to commercial space activities. That document, largely incorporating recommendations made at a February meeting of the National Space Council, was hailed by the space industry as a key step towards streamlining regulations and cutting red tape. “While many details have yet to be worked out, we are a committed and constructive partner in revising and reducing cumbersome space regulations,” said Frank Slazer, vice president for space and workforce at the Aerospace Industries Association, in a statement after the signing of SPD-2 (see “A step towards a ‘one-stop shop’ for commercial space regulations”, The Space Review, May 29, 2018). Now, though, is the time to work out those details. SPD-2 set schedules for some of those regulatory reform efforts, most notably reforms to launch licensing. The directive requires the Department of Transportation (through the FAA) to develop a formal, public draft of revised regulations for commercial launch and reentry regulations. Those changes, the directive states, would include unifying launch licenses and the use of “performance-based criteria” for licensing versus prescriptive requirements. Industry had long sought streamlining of such regulations, such as the requirement that a vehicle have a separate launch license for each site it operates from. “I think it requires heroics when you make any changes to those launch licenses. When you have to change a launch pad from [Space Launch Complex] 40 to [Launch Complex] 39A or back to 40, you have to basically apply for a new license,” said Gwynne Shotwell, president of SpaceX, at the first National Space Council meeting in October 2017. That’s a reference to the two launch sites the company has several kilometers apart in Florida, but in separate jurisdictions: LC-39A at the Kennedy Space Center and SLC-40 at Cape Canaveral Air Force station. Vice President Mike Pence picked up on that issue at the council’s second meeting in February. “You know, the government’s figured out how to honor driver’s licenses across state lines,” he said. “There’s no reason we can’t do the same for rockets.” While the government and industry might be on the same page when it comes to the broad goals of the regulatory changes, how that gets converted into actual regulations is an ongoing process. It’s one that’s taking place at rapid speed—from a bureaucratic point of view—in order to meet the deadline in SPD-2. “We’re moving at a rocket pace. We’re going as fast as we possibly can,” said Kelvin Coleman, the acting associate administrator for commercial space transportation at the FAA, during an October 31 meeting of the FAA’s Commercial Space Transportation Advisory Committee (COMSTAC) in Washington. A typical “rulemaking” process at the FAA can take four to five years to complete, he said. “It usually takes us a year or two, maybe three, even to get to a draft.” “I think, frankly, after repeated calls for that engagement, it is of concern to me, and to a number of other members, that the FAA has decided not to do that,” said Alexander. Both Coleman and his deputy, Dorothy Reimold, said at the COMSTAC meeting that they intended to stick to the schedule in SPD-2. That would require the formal publication of the draft revised regulations, known as a notice of proposed rulemaking (NPRM), in less than three months. “The target and intent—and we view it not as anything less than an obligation to follow the requirements under SPD-2—is to publish an NPRM on February 1,” said Reimold. That’s created some concerns in industry, though, that the process might actually be going too fast. For example, to support the development of the draft rule, the FAA established an Aviation Rulemaking Committee, or ARC, earlier this year to solicit industry input on how to revise existing launch and reentry regulations. That committee, though, hasn’t been given the opportunity to meet again with the FAA to follow up on its earlier input. “Frankly, as we’ve said many times to individuals and to groups, time has not been on our side,” Reimold said. “We have not been able to bring the ARC back together to have the kind of venue that I think was being sought, not for lack of wanting to but simply because time has not allowed us to do that.” Some on COMSTAC, whose members include representatives of major commercial launch providers and related companies, said they’re [they are] concerned about not knowing more about the development of the proposed rule. They said they’re worried that the FAA might release a draft rule next February with language that doesn’t match the intent of the regulatory reform. “I want to really register a strong concern with how the FAA is approaching the upcoming NPRM,” said Brett Alexander, director of business development for Blue Origin, citing what he said was a “lack of dialogue, insight, transparency and engagement” by the FAA. “I think, frankly, after repeated calls for that engagement, it is of concern to me, and to a number of other members, that the FAA has decided not to do that.” Reimold said there had been “internal discussions” about ways discuss the development of the rule and get additional industry input. “The pace that we’re at right now to pull this off is just extraordinary,” she said. “It frankly just didn't allow any kind of natural opportunities” for discussion. “It is not a lack of good intent or willingness. We’re not trying to hide anything,” she added. “We’re simply trying to get the job done.” “The balance that we have to be careful of here is that we certainly want to get these out as quickly as humanly possible, and we don’t want to do anything that would delay that process,” said Mike Gold, chairman of COMSTAC. “At the same time, we want to get industry feedback in.” Industry—and everyone else—will have a chance to comment once the NPRM is released in February. The details of how long the comment period would be, and how those comments will be incorporated into development of a final rule, haven’t been announced.

#### The government needs to endorse property rights in space – not enforce treaties that prevent private ownership

Jeff Greason and James C. Bennett 19, CTO of Electric Sky and CEO of Agile Aero, and Space Fellow of Economic Policy Centre in London, respectively, 6-5-2019, "The Economics of Space: An Industry Ready to Launch," Reason Foundation, https://reason.org/policy-study/the-economics-of-space/

Given a functioning transportation infrastructure, as the private sector develops space industry, government’s role changes to fostering that industry. What space commerce needs from government is a legal framework in which to operate that defines and defends property rights and research (especially on human health in space) that leads to more diverse space activities. Taking cues from agreements on the way various nations regard the bounty of the seas, government can ensure a sustainable and equitable free market environment. With models from other frontier exploration, government should focus on creating the legal framework to allow commerce and private endeavor to flourish. We cannot imagine how profoundly, comprehensively and quickly technological advancement—when it is commercialized—changes our everyday lives. Every single time, and by orders of magnitude, we underestimate its power to improve ordinary people’s lives once it becomes widely used through commercialization. For example, we cannot each own a jet, but today almost all of us can afford a plane ticket. This is due to the tangible effects of the synergy of technology and commerce. These effects occur so universally that any discussion of new technological frontiers should assume a blind but well-grounded expectation of manifold global rewards if only we have the foresight to encourage its proliferation. Examples from sea, land and air transportation, the Digital Age and countless other endeavors prove that technology combined with commerce triggers comprehensive advancement at a lower cost. America’s future success in space depends on restructuring our approach to accommodate such a vision. Commercialization Creates a Self-Sustaining Space Industry Despite the best current efforts of the private sector in this direction, it’s not yet an industry. Yet, launch companies have managed to create a profitable service focusing on occasional launches of very high-value payloads at very high prices. For example, the geosynchronous orbital position for telecommunications is so valuable that even our current highly inefficient way of accessing it is profitable. SpaceX’s Falcon 9 launch success at one-third the price of a traditional NASA-contracted launch demonstrates the private-sector capability to fulfill many current NASA functions at a fraction of the cost. Such achievement frees up NASA to concentrate on its core research and exploration missions in space and allows the private sector to invest in self-sustaining space-based industry. Developing the industry depends on a certain amount of infrastructure, which can pay for itself by freeing up funds currently used for NASA’s SLS (Space Launch System)/Orion program. This redistribution of current NASA funding is the key to paradigm change, although there are political problems with terminating the current SLS/Orion program in closely contested states in the 2020 presidential elections—states like Alabama and Florida. A compromise solution might be to push for increased spending on commercial service purchase, while SLS proceeds to flight status since the SLS will run out of surplus Shuttle engines by the early 2020s. Moving our funding of space activity from solely the exploration function to a mixture of privately funded commercial industry and publicly funded research is signaled by the private sector’s current capabilities, and the commercial-quality resources already identified in space that the current paradigm prevents us from harnessing. Also, changing to a commercial approach allows for efficiencies such as mass production of equipment and standardized designs that can carry cargo or humans with few modifications—which is much cheaper and more effective than what we do now. No matter how much money Congress sinks into status-quo space activities now, utility will continue to decline, making funding increasingly ineffective, and keeping the U.S. space program confined. The first step in progress is systemic change, beginning with policy change. Every single change that makes space operations more like airline operations bears fruit in lower costs, and those changes, in turn, trigger further reductions in costs.

#### Tech innovation solves every existential threat – cumulative extinction events outweigh the aff

Dylan **Matthews 18**. Co-founder of Vox, citing Nick Beckstead @ Rutgers University. 10-26-2018. "How to help people millions of years from now." Vox. https://www.vox.com/future-perfect/2018/10/26/18023366/far-future-effective-altruism-existential-risk-doing-good

If you care about improving human lives, you should overwhelmingly care about those quadrillions of lives rather than the comparatively small number of people alive today. The 7.6 billion people now living, after all, amount to less than 0.003 percent of the population that will live in the future. It’s reasonable to suggest that those quadrillions of future people have, accordingly, hundreds of thousands of times more moral weight than those of us living here today do. That’s the basic argument behind Nick Beckstead’s 2013 Rutgers philosophy dissertation, “On the overwhelming importance of shaping the far future.” It’s a glorious mindfuck of a thesis, not least because Beckstead shows very convincingly that this is a conclusion any plausible moral view would reach. It’s not just something that weird utilitarians have to deal with. And Beckstead, to his considerable credit, walks the walk on this. He works at the Open Philanthropy Project on grants relating to the far future and runs a charitable fund for donors who want to prioritize the far future. And arguments from him and others have turned “long-termism” into a very vibrant, important strand of the effective altruism community. But what does prioritizing the far future even mean? The most literal thing it could mean is preventing human extinction, to ensure that the species persists as long as possible. For the long-term-focused effective altruists I know, that typically means identifying concrete threats to humanity’s continued existence — like unfriendly artificial intelligence, or a pandemic, or global warming/out of control geoengineering — and engaging in activities to prevent that specific eventuality. But in a set of slides he made in 2013, Beckstead makes a compelling case that while that’s certainly part of what caring about the far future entails, approaches that address specific threats to humanity (which he calls “targeted” approaches to the far future) have to complement “broad” approaches, where instead of trying to predict what’s going to kill us all, you just generally try to keep civilization running as best it can, so that it is, as a whole, well-equipped to deal with potential extinction events in the future, not just in 2030 or 2040 but in 3500 or 95000 or even 37 million. In other words, caring about the far future doesn’t mean just paying attention to low-probability risks of total annihilation; it also means acting on pressing needs now. For example: We’re going to be better prepared to prevent extinction from AI or a supervirus or global warming if society as a whole makes a lot of scientific progress. And a significant bottleneck there is that the vast majority of humanity doesn’t get high-enough-quality education to engage in scientific research, if they want to, which reduces the odds that we have enough trained scientists to come up with the breakthroughs we need as a civilization to survive and thrive. So maybe one of the best things we can do for the far future is to improve school systems — here and now — to harness the group economist Raj Chetty calls “lost Einsteins” (potential innovators who are thwarted by poverty and inequality in rich countries) and, more importantly, the hundreds of millions of kids in developing countries dealing with even worse education systems than those in depressed communities in the rich world. What if living ethically for the far future means living ethically now? Beckstead mentions some other broad, or very broad, ideas (these are all his descriptions): Help make computers faster so that people everywhere can work more efficiently Change intellectual property law so that technological innovation can happen more quickly Advocate for open borders so that people from poorly governed countries can move to better-governed countries and be more productive Meta-research: improve incentives and norms in academic work to better advance human knowledge Improve education Advocate for political party X to make future people have values more like political party X ”If you look at these areas (economic growth and technological progress, access to information, individual capability, social coordination, motives) a lot of everyday good works contribute,” Beckstead writes. “An implication of this is that a lot of everyday good works are good from a broad perspective, even though hardly anyone thinks explicitly in terms of far future standards.” Look at those examples again: It’s just a list of what normal altruistically motivated people, not effective altruism folks, generally do. Charities in the US love talking about the lost opportunities for innovation that poverty creates. Lots of smart people who want to make a difference become scientists, or try to work as teachers or on improving education policy, and lord knows there are plenty of people who become political party operatives out of a conviction that the moral consequences of the party’s platform are good. All of which is to say: Maybe effective altruists aren’t that special, or at least maybe we don’t have access to that many specific and weird conclusions about how best to help the world. If the far future is what matters, and generally trying to make the world work better is among the best ways to help the far future, then effective altruism just becomes plain ol’ do-goodery.\*

# 2

#### CP: The appropriation of outer space by private entities except for mining is unjust

#### Commercial asteroid mining is coming now – lower costs and improving tech make it economically viable – and the legal basis is already in place in multiple countries– that helps acquire water for rocket fuel and rare earth metals

Gilbert 21 alex gilbert, is a complex systems researcher and a PhD student in space resources at the Colorado School of Mines. "Mining in Space Is Coming." Milken Institute Review, April 26, 2021, [www.milkenreview.org/articles/mining-in-space-is-coming](http://www.milkenreview.org/articles/mining-in-space-is-coming). [Quality Control]

Space exploration is back. after decades of disappointment, a combination of better technology, falling costs and a rush of competitive energy from the private sector has put space travel front and center. indeed, many analysts (even some with their feet on the ground) believe that commercial developments in the space industry may be on the cusp of starting the largest resource rush in history: mining on the Moon, Mars and asteroids.

While this may sound fantastical, some baby steps toward the goal have already been taken. Last year, NASA awarded contracts to four companies to extract small amounts of lunar regolith by 2024, effectively beginning the era of commercial space mining. Whether this proves to be the dawn of a gigantic adjunct to mining on earth — and more immediately, a key to unlocking cost-effective space travel — will turn on the answers to a host of questions ranging from what resources can be efficiently.

As every fan of science fiction knows, the resources of the solar system appear virtually unlimited compared to those on Earth. There are whole other planets, dozens of moons, thousands of massive asteroids and millions of small ones that doubtless contain humungous quantities of materials that are scarce and very valuable (back on Earth). Visionaries including Jeff Bezos imagine heavy industry moving to space and Earth becoming a residential area. However, as entrepreneurs look to harness the riches beyond the atmosphere, access to space resources remains tangled in the realities of economics and governance.

Start with the fact that space belongs to no country, complicating traditional methods of resource allocation, property rights and trade. With limited demand for materials in space itself and the need for huge amounts of energy to return materials to Earth, creating a viable industry will turn on major advances in technology, finance and business models.

That said, there’s no grass growing under potential pioneers’ feet. Potential economic, scientific and even security benefits underlie an emerging geopolitical competition to pursue space mining. The United States is rapidly emerging as a front-runner, in part due to its ambitious Artemis Program to lead a multinational consortium back to the Moon. But it is also a leader in creating a legal infrastructure for mineral exploitation. The United States has adopted the world’s first spaceresources law, recognizing the property rights of private companies and individuals to materials gathered in space.

However, the United States is hardly alone. Luxembourg and the United Arab Emirates (you read those right) are racing to codify space-resources laws of their own, hoping to attract investment to their entrepot nations with business-friendly legal frameworks. China reportedly views space-resource development as a national priority, part of a strategy to challenge U.S. economic and security primacy in space. Meanwhile, Russia, Japan, India and the European Space Agency all harbor space-mining ambitions of their own. Governing these emerging interests is an outdated treaty framework from the Cold War. Sooner rather than later, we’ll need new agreements to facilitate private investment and ensure international cooperation.

What’s Out There

Back up for a moment. For the record, space is already being heavily exploited, because space resources include non-material assets such as orbital locations and abundant sunlight that enable satellites to provide services to Earth. Indeed, satellite-based telecommunications and global positioning systems have become indispensable infrastructure underpinning the modern economy. Mining space for materials, of course, is another matter.

In the past several decades, planetary science has confirmed what has long been suspected: celestial bodies are potential sources for dozens of natural materials that, in the right time and place, are incredibly valuable. Of these, water may be the most attractive in the near-term, because — with assistance from solar energy or nuclear fission — H2O can be split into hydrogen and oxygen to make rocket propellant, facilitating in-space refueling. So-called “rare earth” metals are also potential targets of asteroid miners intending to service Earth markets. Consisting of 17 elements, including lanthanum, neodymium, and yttrium, these critical materials (most of which are today mined in China at great environmental cost) are required for electronics. And they loom as bottlenecks in making the transition from fossil fuels to renewables backed up by battery storage.

#### However, the legal framework that strikes the best balance of providing economic incentives for mining while preventing unbeneficial land claims requires a doctrine of appropriation – the plan prevents that

Meyers 15 Meyers, Ross. J.D. candidate at the University of Oregon Law School. "The doctrine of appropriation and asteroid mining: incentivizing the private exploration and development of outer space." Or. Rev. Int'l L. 17 (2015): 183. Italics in original. [Quality Control]

The doctrine of appropriation is a reasonable rule for adjudicating asteroid claims, and it could easily be modified to apply to asteroid mining. In the context of water rights, the doctrine of appropriation requires that the claimant be a landowner in order to claim the right to use a water source. It does not make sense, however, for the international community to grant complete ownership over asteroids toa single entity, so the landowner requirement of the rule should be removed. A similar modification would need to be made to the "beneficial use" language of the doctrine.

In the context of water rights, an appropriator obtains rights only to water that he or she can reasonably put to beneficial use. The metals contained in asteroids have a high level of marketability. For that reason, a mining entity could potentially put any amount of obtained metal to beneficial use, in the sense that the resources can be sold. This, however, would defeat the purpose of the rule, which is to limit such unreasonable claims. To ameliorate this problem, the doctrine of appropriation could be modified to define "beneficial use "constructively by providing that beneficial use is assumed for any resources that have been removed from the asteroid that the mining entity can reasonably hope to transport to market in a return journey. With the astronomical cost of undertaking a trip to such an asteroid, this modification would limit mining entities to only what they can carry back, thereby leaving the untapped resources available to other entities capable of making the same trip. Considering the size and profitability of metal deposits on asteroids, this modification to the doctrine of appropriation would not be overly burdensome to corporate interests. At the same time, it would satisfy the economic imperative of promoting the rapid development of asteroid resources.

By changing the landowner requirement, and qualifying the “beneficial use" language, the doctrine of appropriation would be essentially ready for application to asteroid mining claims. The only other changes necessary would be some additional requirements that are common to other space related provisions, like those found in the Outer Space Treaty of 1968. For example, a reporting requirement or clause guaranteeing asylum for other astronauts. A functional rule might read something like this:

*State parties or private entities may, upon actual possession, lay claim to natural resources found on or below the surface of asteroids. Rights to appropriate are given in order of seniority, starting with the first party to land on the surface of the asteroid and establish control over the resources, be it water, methane, metal, or any other beneficial substances. A party will be said to have established control over a resource once he has mined the substance and removed it from the asteroid. A senior appropriator may use as much of the asteroid's resources as he can take from the asteroid and put to beneficial use, and may continue to enlarge his share until another junior appropriator begins to appropriate resources from source for beneficial use. For the purposes of this Agreement, "beneficial use “refers to the amount of resources that an appropriator has removed from the asteroid that the actor may reasonably hope to bring home in a return voyage. Resources in excess of what an appropriator can reasonably hope to transport to market in a single voyage do not qualify as having a beneficial use, and are therefore not yet claimed. This means that the extraction of metal from an asteroid does not serve to provide ownership if the appropriator plans on letting the resources languish until another voyage is undertaken to secure the resources and bring them back to Earth. Junior appropriators receive rights in the source of resources (the asteroid) as they find it, and may prevent the senior appropriator from enlarging his share to the junior appropriator’s detriment under a no-injury rule. No state party will attempt to hinder other parties from landing on or using the asteroid, and parties will assist other entities on an asteroid, should they need emergency assistance. Mining claims on asteroids will be reported to the Secretary-General of the United Nations, and state parties agree to release the location of the asteroid, and any scientific findings to the United Nations, the general public, and the scientific community. In the event that the asteroid is on a collision course with any other celestial body, all state parties agree to follow the course of action suggested by the United Nations. Should the United Nations decide the asteroid must be destroyed, no state party may claim liability for resources contained within the asteroid, but not yet captured. This provision applies only to asteroids as classified by the scientific community, and does not apply to planets, comets, meteorites, or any other celestial body not mentioned.*

There is no doubt that asteroids may be extremely beneficial to mankind, both as a source of resources and as a jumping-off point to far off locations in space. The human-race has progressed scientifically and technologically to the point that space travel is within commercial reach, and the need for new international laws governing the ownership of space has never been more apparent. The Outer Space Treaty of 1968made great strides in developing rational rules for space and many of its provisions should be maintained in their original form. However, by allowing ownership of asteroids under the doctrine of appropriation, the international community can incentivize the exploration and development of space in a way that reflects the needs of society in general, without vesting an absolute monopoly in a single entity. The doctrine of appropriation helped drive American westward expansion, and its application to space mining would help drive the human race in its expansion into the space, the final frontier.

#### Asteroid mining offsets terrestrial growth that ruins the environment and enables solar power satellites – both solve climate change

Taylor 19 Chris Taylor is a veteran journalist. Previously senior news writer for Time.com a year later. In 2000, he was named San Francisco bureau chief for Time magazine. He has served as senior editor for Business 2.0, West Coast editor for Fortune Small Business and West Coast web editor for Fast Company. Chris is a graduate of Merton College, Oxford and the Columbia University Graduate School of Journalism. "How asteroid mining will save the Earth — and mint trillionaires." Mashable, 2019, mashable.com/feature/asteroid-mining-space-economy. [Quality Control]

The mission is essential, Joyce declares, to save Earth from its major problems. First of all, the fictional billionaire wheels in a fictional Nobel economist to demonstrate the actual truth that the entire global economy is sitting on a mountain of debt. It has to keep growing or it will implode, so we might as well take the majority of the industrial growth off-world where it can’t do any more harm to the biosphere.

Secondly, there’s the climate change fix. Suarez sees asteroid mining as the only way we’re going to build solar power satellites. Which, as you probably know, is a form of uninterrupted solar power collection that is theoretically more effective, inch for inch, than any solar panels on Earth at high noon, but operating 24/7. (In space, basically, it’s always double high noon).

The power collected is beamed back to large receptors on Earth with large, low-power microwaves, which researchers think will be harmless enough to let humans and animals pass through the beam. A space solar power array like the one China is said to be working on could reliably supply 2,000 gigawatts — or over 1,000 times more power than the largest solar farm currently in existence.

“We're looking at a 20-year window to completely replace human civilization's power infrastructure,” Suarez told me, citing the report of the Intergovernmental Panel on Climate Change on the coming catastrophe. Solar satellite technology “has existed since the 1970s. What we were missing is millions of tons of construction materials in orbit. Asteroid mining can place it there.”

The Earth-centric early 21st century can’t really wrap its brain around this, but the idea is not to bring all that building material and precious metals down into our gravity well. Far better to create a whole new commodities exchange in space. You mine the useful stuff of asteroids both near to Earth and far, thousands of them taking less energy to reach than the moon. That’s something else we’re still grasping, how relatively easy it is to ship stuff in zero-G environments.

#### Environmental destruction is profoundly unjust – prioritize environmental justice over primarily human concerns

Cafaro 14 Dr. Philip Cafaro (philip.cafaro@colostate.edu) is Professor of Philosophy at Colorado State University, an affiliated faculty member with CSU's School of Global Environmental Sustainability and Book Review Editor of Elsevier's Biological Conservation journal. His main research interests are in environmental ethics, consumption and population issues, and wild lands preservation. He is the author of Thoreau's Living Ethics and Life on the Brink: Environmentalists Confront Overpopulation, among other books. Dr. Richard B. Primack (primack@bu.edu) is Professor of Biology at Boston University [go terriers!] and Editor-in-Chief of Biological Conservation, an Elsevier journal focusing on the protection of biodiversity. His research concerning the effects of climate change on the plants and animals of Massachusetts is the focus of a new book coming out in March titled Walden Warming: Climate Change Comes to Thoreau's Woods. "Species extinction is a great moral wrong." Elsevier Connect, 12 Feb. 2014, [www.elsevier.com/connect/species-extinction-is-a-great-moral-wrong](http://www.elsevier.com/connect/species-extinction-is-a-great-moral-wrong). [Quality Control]

Extinguishing species through the continued expansion of human economic activities appears to be morally acceptable to Kareiva, Marvier and some other Anthropocene proponents, as long as this destruction does not harm people themselves. But this view is selfish and unjust. Human beings already control more than our fair share of Earth's resources. If increased human population and economic demands threaten to extinguish the polar bear and many other species, then we need to limit our population and economic demands, not make excuses that will just lead to greater ecological damage.

Conservation biologists, with our knowledge and appreciation of other species, are the last people who should be making excuses for their displacement or making light of their extinction. It is particularly inappropriate for Peter Kareiva to do so, given his position as chief scientist at the Nature Conservancy, an organization dedicated to preserving biodiversity. TNC's fundraising rests in part on appeals to a strong and widely shared moral view that other species have a right to continued existence. Much of the conservation value of TNC's easements and land purchases depends on society-wide moral and legal commitments to preserve threatened and endangered species and their habitats. Kareiva and Marvier state that they "do not wish to undermine the ethical motivations for conservation action," or presumably, conservation law. Yet their articles do precisely that, with potentially disastrous implications for practical conservation efforts, particularly in the long term.

To be clear: We do not think there is anything wrong with people looking after our own legitimate needs. This is an important aspect of conservation. Kareiva and Marvier are right to remind us that protecting ecosystem services for human beings is important. They are right that concern for our own wellbeing can sometimes motivate significant biodiversity preservation. We believe that people should preserve other species both for their sakes and for ours.

But it is a mistake to reduce conservation solely to concern for our own well-being, or to assume that it is acceptable to extinguish species that do not benefit humans. Such an overly economistic approach to conservation leads us astray morally. It makes us selfish, which is the last thing we want when the very existence of so many other life forms is at stake. Fairly sharing the lands and waters of Earth with other species is primarily a matter of justice, not economic convenience.

# Case

Vote neg on presumption – they say that appropriation means that taking somehting in a way that is illegal or unfair – colonization, mining, etc are all legal under the OST now, which means that none of it is counted as appropriation.

They also don’t solve for government appropriation -

## Space War

#### No space war – it’s hype and systems are redundant

Johnson-Freese and Hitchens 16 [Dr. Joan Johnson-Freese is a member of the Breaking Defense Board of Contributors, a Professor of National Security Affairs at the Naval War College and author of Space Warfare in the 21st Century: Arming the Heavens. Views expressed are those of the author alone. Theresa Hitchens is a Senior Research Scholar at the Center for International and Security Studies at Maryland (CISSM), and the former Director of the United Nations Institute for Disarmament Research (UNIDIR) in Geneva, Switzerland. Stop The Fearmongering Over War In Space: The Sky’s Not Falling, Part 1. December 27, 2016. https://breakingdefense.com/2016/12/stop-the-fearmongering-over-war-in-space-the-skys-not-falling-part-1/]

In the last two years, we’ve seen rising hysteria over a future war in space. Fanning the flames are not only dire assessments from the US military, but also breathless coverage from a cooperative and credulous press. This reporting doesn’t only muddy public debate over whether we really need expensive systems. It could also become a self-fulfilling prophecy. The irony is that nothing makes the currently slim possibility of war in space more likely than fearmongering over the threat of war in space.

Two television programs in the past two years show how egregious this fearmongering can get. In April 2015, the CBS show 60 Minutes ran a segment called “The Battle Above.” In an interview with General John Hyten, the then-chief of U.S. Air Force Space Command, it came across loud and clear that the United States was being forced to prepare for a battle in space — specifically against China — that it really didn’t want.

It was explained by Hyten and other guests that China is building a considerable amount of hardware and accumulating significant know-how regarding space, all threatening to space assets Americans depend on every day. If viewers weren’t frightened after watching the segment, it wasn’t for lack of trying on the part of CBS.

Using terms like “offensive counterspace” as a 1984 NewSpeak euphemism for “weapons,” it was made clear that the United States had no choice but to spend billions of dollars on offensive counterspace technology to not just thwart the Chinese threat, but control and dominate space. While it didn’t actually distort facts — just omit facts about current U.S. space capabilities — the segment was basically a cost-free commercial for the military-industrial complex.

In retrospect though, “The Battle Above” was pretty good compared to CNN’s recent special, War in Space: The Next Battlefield. The latter might as well have been called Sharknado in Space – because the only far-out weapons technology our potential adversaries don’t have, according to the broadcast, seems to be “sharks with frickin’ laser beams attached to their heads!”

First, CNN needs to hire some fact checkers. Saying “unlike its adversaries, the U.S. has not yet weaponized space” is deeply misleading, like saying “unlike his political opponents, President-Elect Donald Trump has not sprouted wings and flown away”: A few (admittedly alarming) weapons tests aside, no country in the world has yet weaponized space. Contrary to CNN, stock market transactions are not timed nor synchronized through GPS, but a closed system. Cruise missiles can find their targets even without GPS, because they have both GPS and precision inertial measurement units onboard, and IMUs don’t rely on satellite data. Oh, and the British rock group Pink Floyd holds the only claim to the Dark Side of the Moon: There is a “far side” of the Moon — the side always turned away from the Earth — but not a “dark side” — which would be a side always turned away from the Sun.

More nefariously, the segment sensationalized nuggets of truth within a barrage of half-truths, backed by a heavy bass, dramatic soundtrack (and gravelly-voiced reporter Jim Sciutto) and accompanied by sexy and scary visuals.

Make no mistake there are dangers in space, and the United States has the most to lose if space assets are lost. The question is how best to protect them. Here are a few facts CNN omitted.

The Reality

The U.S. has all of the technologies described on the CNN segment and deemed potentially offensive: maneuverable satellites, nano-satellites, lasers, jamming capabilities, robotic arms, ballistic missiles that can be used as anti-satellite weapons, etc. In fact, the United States is more technologically advanced than other countries in both military and commercial space.

That technological superiority scares other countries; just as the U.S. military space community is scared of other countries obtaining those technologies in the future. The U.S. military space budget is more than 10 times greater than that of all the countries in the world combined. That also causes other countries concern.

More unsettling still, the United States has long been leery of treaty-based efforts to constrain a potential arms race in outer space, as supported by nearly every other country in the world for decades. Indeed, under the administration of George W. Bush, the U.S. talking points centered on the mantra “there is no arms race in outer space,” so there is no need for diplomat instruments to constrain one. Now, a decade later, the U.S. military – backed by the Intelligence Community which operates the nation’s spy satellites – seems to be shouting to the rooftops that the United States is in danger of losing the space arms race already begun by its potential adversaries. The underlying assumption — a convenient one for advocates of more military spending — is that now there is nothing that diplomacy can do.

However, it must be remembered that most space-related technologies – with the exception of ballistic missiles and dedicated jammers – have both military and civil/commercial uses; both benign — indeed, helpful — and nefarious uses. For example, giving satellites the ability to maneuver on orbit can allow useful inspections of ailing satellites and possibly even repairs.

Further, the United States is not unable to protect its satellites, as repeated during the CNN broadcast by various interviewees and the host. Many U.S. government-owned satellites, including precious spy satellites, have capabilities to maneuver. Many are hardened against electro-magnetic pulse, sport “shutters” to protect optical “eyes” from solar flares and lasers, and use radio frequency hopping to resist jamming.

Offensive weapons, deployed on the ground to attack satellites, or in space, are not a silver bullet. To the contrary, U.S. deployment of such weapons may actually be detrimental to U.S. and international security in space (as we argued in a recent Atlantic Council publication, Towards a New National Security Space Strategy). Further, there are benefits to efforts started by the Obama Administration to find diplomatic tools to restrain and constrain dangerous military activities in space.

These diplomatic efforts, however, would be undercut by a full-out U.S. pursuit of “space dominance.” This includes dialogue with China, the lack of which Gen. William Shelton, retired commander of Air Force Space Command, lamented in the CNN report.

Given CNN’s “cast,” the spin was not surprising. Starting with Ghost Fleet author Peter Singer set the sensationalist tone, which never altered. The apocalyptic opening, inspired by Ghost Fleet, posited a scenario where all U.S. satellites are taken off-line in nearly one fell swoop. Unless we are talking about an alien invasion, that scenario is nigh on impossible. No potential adversary has such capabilities, nor will they ever likely do so. There is just too much redundancy in the system.

#### No space war – prefer data over political rhetoric

Klimas interviewing Weeden 18 [Brian Weeden, smart space guy. Is the space war threat being hyped? August 3, 2018. https://www.politico.com/story/2018/08/03/space-war-threat-hype-force-760781]

There’s been increasing rhetoric...about the militarization of space and the potential for conflicts on Earth to extend into space. That’s driven in part by reports about anti-satellite testing in Russia and China...The report really grew out of our frustration at the level of publicly available information on this topic.

A lot of what you get are public statements from military leadership or politicians, or sometimes news articles talking about something and it’s really hard to get down to details and...sort through what might be real, what might be hype. Our goal was to dig into the open source material and see what we could determine from a factual standpoint was really going on -- what types of capabilities were being developed and how might they be used in a future conflict.

Ultimately we hoped that would lead to a more informed debate about what U.S. strategy should be to address those threats.

What sort of feedback have you gotten so far?

A lot of the feedback has been either informal or private because a lot of the issues we talk about, people in the government research using classified materials. So it’s difficult for them to give detailed feedback.

In general, the feedback we’ve gotten has been pretty positive. People have said they like the fact that this sort of stuff is being put in the public domain and encouraged us to continue.

Were your findings better or worse than the picture public discourse paints?

In general, it’s a little bit better. A lot of political rhetoric and news stories focus on the most extreme examples, so using kinetic weapons to blow up satellites. While there is research and development going on to develop those capabilities, what we found is there’s yet to be any publicly-known example of them being used.

What is being used and what seems to be of the most utility are the non-kinetic things, like jamming and cyber attacks. The good news is we have yet to see the most destructive kinetic attacks that can cause really harmful long-term damage to the space environment, but unfortunately we are seeing non-kinetic attacks being used, and that’s likely to continue.

#### Mutual dependence on space infrastructure prevents war

Triezenberg 17 [Bonnie Triezenberg is a senior engineer at RAND. Previously, she was the senior technical fellow at the Boeing Company, specializing in agile systems and software development. She received a B.S. in aerospace engineering from the University of Michigan, an M.S. in systems science from the University of California-Los Angeles, and a Ph.D. in policy analysis from the Pardee RAND Graduate School. Deterring Space War. 2017. https://www.rand.org/content/dam/rand/pubs/rgs\_dissertations/RGSD400/RGSD400/RAND\_RGSD400.pdf]

The above discussion suggests that a likely means to achieve deterrence of acts of war in outer space is to increase civilian dependence on space to support day-to-day life—if everyone on earth is equally dependent on space, no one has an incentive to destroy space. Largely by accident, this dependence appears to have, in fact, occurred. The space age was born in an age of affluence and rapid economic expansion; space quickly became a domain of international commerce as well as a domain of national military use. Space assets and the systems they enable have transformed social, infrastructure and information uses perhaps more visibly than they have transformed military uses. In fact, in the current satellite database published by the Union of Concerned Scientists, of the 1461 satellites in orbit 40% support purely commercial ventures, while only 16% have a strictly military use.46 The first commercial broadcast by a satellite in geo-synchronous orbit was of international news between Europe and the United States.47 The first telephony uniting the far flung islands of Indonesia was enabled by satellite48. Those of us who are old enough remember the 1960s “magic” of intercontinental phone calls and international “breaking news” delivered by satellite. Today, most social and infrastructure uses of space are taken for granted - even in remote locales of Africa, people expect to be able to monitor the weather, communicate seamlessly with colleagues and to find their way to new and unfamiliar locations using the GPS in their phones. All of us use space every day.49 These unrestricted economic and social uses of space may be the best deterrent, making everyone on all sides of combat equally dependent on space and heightening the taboo against weaponizing space or threatening space assets with weapons.

## Rocket Launches

#### Timeframe – ozone depletion is super slow and incoherent there’s no brink argument or falsifiable data that explains the brink, 50 years of launches proves resilience

#### Launches inevitable – massive privatization, increasing popularity, other countries thump

Helsinki Times 21 – “Global orbital rocket launches surge by 44% in H1 2021, U.S. leads,” 7/15/2021, https://www.helsinkitimes.fi/business/19596-global-orbital-rocket-launches-surge-by-44-in-h1-2021-u-s-leads.html

Space missions are increasingly becoming popular, with companies moving towards enabling private citizens to have a glimpse of the orbit away from the professional astronauts. The interest in space travel is increasing the number of orbital launches.

Data acquired by Finbold indicates that the global number of orbital rockets launched in 2021 H1 surged 43.9% compared to the first half of 2020.

As of 2021, the orbital rocket launches stood at 59, while last year, the figure was at 41.

In 2021, the United States showed dominance, accounting for about 49% of the launches at 29. China recorded 18 launches, followed by Russia at seven. French space company Arianespace accounts for four orbital launches. The numbers are based on RocketLaunch.live data, which tracks orbital rocket launches worldwide.

Space tourism driving increase in orbital launches

The increase in orbital launches during the period highlights the increasing focus to make space travel a routine. The sector has witnessed the entry of private companies working towards making space travel available for private citizens and not just the professional astronauts of space agencies like NASA.

Worth mentioning is that despite 2020 being a challenging year due to the coronavirus pandemic, several space missions were initiated, with some arriving at their destination in 2021.

The increase in orbital launches also correlates with the entry of private companies into the sector that are jostling to make a name for themselves in space. For instance, Jeff Bezos’ Blue Origin company is expected to have the inaugural space flight with the founder on board on July 20, 2021.

Notably, Virgin Galactic (SPCE) offered a glimpse of space tourism after the company’s aircraft successfully conducted a space mission with founder Sir Richard Branson on board.

Virgin Galactic may begin flying the first paying passengers next year after two more test flights. However, with tickets running into hundreds of thousands of dollars, the space experience remains viable for financially able individuals. But when the companies begin commercial operations, Blue Origin and Virgin Galactic will be direct competitors.

Elsewhere, Elon Musk’s SpaceX is also an active player in the space industry with a reputation for conducting multiple short test flights over the past year. The company’s next step is to reach orbit. Furthermore, competition between private companies is also heating up.

For instance, Arianespace, the world’s first commercial launch company that dominated the market for sending big communications satellites into orbit, is now shifting its focus to smaller satellites. This shift is likely to give companies like SpaceX a run for their money.

#### No ozone impact

**Ridley 14** -- Matthew White Ridley, 5th Viscount Ridley DL FRSL FMedSci, known commonly as Matt Ridley, is a British journalist, businessman and author of popular science books. Since 2013 Ridley has been a Conservative hereditary peer in the House of Lords. “THE OZONE HOLE WAS EXAGGERATED AS A PROBLEM” http://www.rationaloptimist.com/blog/the-ozone-hole-was-exaggerated-as-a-problem.aspx

Serial hyperbole does the environmental movement no favours My recent [Times column](http://www.thetimes.co.uk/tto/opinion/columnists/article4206440.ece) argued that the alleged healing of the ozone layer is exaggerated, but so was the impact of the ozone hole over Antarctica: The ozone layer is healing. Or so said the news last week. Thanks to a treaty signed in Montreal in 1989 to get rid of refrigerant chemicals called chlorofluorocarbons (CFCs), the planet’s stratospheric sunscreen has at last begun thickening again. Planetary disaster has been averted by politics. For reasons I will explain, this news deserves to be taken with a large pinch of salt. You do not have to dig far to find evidence that the ozone hole was never nearly as dangerous as some people said, that it is not necessarily healing yet and that it might not have been caused mainly by CFCs anyway. The timing of the announcement was plainly political: it came on the 25th anniversary of the treaty, and just before a big United Nations climate conference in New York, the aim of which is to push for a climate treaty modelled on the ozone one. Here’s what was actually announced last week, in the words of a Nasa scientist, Paul Newman: “From 2000 to 2013, ozone levels climbed 4 per cent in the key mid-northern latitudes.” That’s a pretty small change and it is in the wrong place. The ozone thinning that worried everybody in the 1980s was over Antarctica. Over northern latitudes, ozone concentration has been falling by about 4 per cent each March before recovering. Over Antarctica, since 1980, the ozone concentration has fallen by [40 or 50 per cent each September](http://bigstory.ap.org/article/scientists-say-ozone-layer-recovering) before the sun rebuilds it. So what’s happening to the Antarctic ozone hole? Thanks to a diligent blogger named Anthony Watts, I came across a press release also from Nasa about nine months ago, which said: “ Two new studies show that signs of recovery are not yet present, and that temperature and winds are still driving any annual changes in ozone hole size.” As recently as 2006, Nasa announced, quoting Paul Newman again, that the Antarctic ozone hole that year was “the largest ever recorded”. The following year a paper in Nature magazine from Markus Rex, a German scientist, presented new evidence that suggested CFCs may be responsible for less than 40 per cent of ozone destruction anyway. Besides, nobody knows for sure how big the ozone hole was each spring before CFCs were invented. All we know is that it varies from year to year. How much damage did the ozone hole ever threaten to do anyway? It is fascinating to go back and read what the usual hyperventilating eco-exaggerators said about ozone thinning in the 1980s. As a result of the extra ultraviolet light coming through the Antarctic ozone hole, southernmost parts of Patagonia and New Zealand see about 12 per cent more UV light than expected. This means that the weak September sunshine, though it feels much the same, has the power to cause sunburn more like that of latitudes a few hundred miles north. Hardly Armageddon. The New York Times reported “an increase in Twilight Zone-type reports of sheep and rabbits with cataracts” in southern Chile. Not to be outdone, Al Gore wrote that “hunters now report finding blind rabbits; fisherman catch blind salmon”. Zoologists briefly blamed the near extinction of many amphibian species on thin ozone. Melanoma in people was also said to be on the rise as a result. This was nonsense. Frogs were dying out because of a fungal disease spread from Africa — nothing to do with ozone. Rabbits and fish blinded by a little extra sunlight proved to be as mythical as unicorns. An eye disease in Chilean sheep was happening outside the ozone-depleted zone and was caused by an infection called pinkeye — nothing to do with UV light. And melanoma incidence in people actually levelled out during the period when the ozone got thinner. Then remember that the ozone hole appears when the sky is dark all day, and over an uninhabited continent. Even if it persists into the Antarctic spring and spills north briefly, the hole allows 50 times less ultraviolet light through than would hit your skin at the equator at sea level (let alone at a high altitude) in the tropics. So it would be bonkers to worry about UV as you sailed round Cape Horn in spring, say, but not when you stopped at the Galapagos: the skin cancer risk is 50 times higher in the latter place. This kind of eco-exaggeration has been going on for 50 years. In the 1960s Rachel Carson said there was an epidemic of childhood cancer caused by DDT; it was not true — DDT had environmental effects but did not cause human cancers. In the 1970s the Sahara desert was said be advancing a mile a year; it was not true — the region south of the Sahara has grown markedly greener and more thickly vegetated in recent decades. In the 1980s acid rain was said to be devastating European forests; not true — any local declines in woodland were caused by pests or local pollution, not by the sulphates and nitrates in rain, which may have contributed to an actual increase in the overall growth rate of European forests during the decade. In the 1990s sperm counts were said to be plummeting thanks to pollution with man-made “endocrine disruptor” chemicals; not true — there was no fall in sperm counts. In the 2000s the Gulf Stream was said to be failing and hurricanes were said to be getting more numerous and worse, thanks to global warming; neither was true, except in a Hollywood studio. The motive for last week’s announcement was to nudge world leaders towards a treaty on climate change by reminding them of how well the ozone treaty worked. But getting the world to agree to cease production of one rare class of chemical, for which substitutes existed, and which only a few companies mainly in rich countries manufactured, was a very different proposition from setting out to decarbonise the whole economy, when each of us depends on burning carbon (and hydrogen) for almost every product, service, meal, comfort and journey in our lives. The true lesson of the ozone story is that taking precautionary action on the basis of dubious evidence and exaggerated claims might be all right if the action does relatively little economic harm. However, loading the entire world economy with costly energy, and new environmental risks based on exaggerated claims about what might in future happen to the climate makes less sense.

## Aliens

#### Space disease is fake

Drew Smith 17. Scientist. 06-16-17. "Would Extraterrestrial Bacteria Be Dangerous To Humans?." Forbes. https://www.forbes.com/sites/quora/2017/06/16/would-extraterrestrial-bacteria-be-dangerous-to-humans/#18d64b377601

The chance that extraterrestrial bacteria would be deadly to humans is zero. Not just very, very small. Zero.

Pathogenesis requires intimacy. This intimacy is attained through millions of years of co-evolution. The need for intimacy is apparent when you look at how bacteria and viruses cause infections and disease.

Infection requires binding to a cell surface. Bacteria (and viruses) bind to human cells through proteins that recognize human proteins and carbohydrates. The structure of these human proteins and carbohydrates is, to a first approximation, arbitrary. There are an almost infinite number of permutations of them that could exist and work just fine. But only one does exist. The chance that an alien bacteria would have evolved to stick to that protein is infinitesimally small.

Even if this alien bacterium were able to stick to a cell surface, this alone would not establish an infection. Infecting bacteria secrete all kinds of toxins and virulence factors. These toxins and factors bind to specific human proteins. They block or modify their activity in ways that degrade cells and tissues, releasing nutrients that the bacteria can feed upon.

Again, the target proteins have fairly arbitrary structures. They are the result of billions of years of evolutionary history and their precise structure - and even their existence - is not at all predictable. The chance that an alien bacterium would have evolved toxins that precisely target them is infinitesimally small.

Pathogenicity is extremely rare on Earth. There are millions, perhaps billions, of species of bacteria. The number of potential human pathogens among them is very small, no more than a couple hundred. And only a couple dozen are able to infect otherwise healthy humans. These are bacteria that have been with us for millions of years, evolving as we evolve, becoming intimately familiar with our proteins, our cells, our immune systems.

This knowledge is stamped into their genomes; it is a diary of their long association with us. It is not a book that could be written in an alien language. Alien bacteria are no more likely to be human pathogens than intelligent aliens are likely to speak Urdu as their native tongue. It just isn’t possible.

#### Aliens don’t exist

#### Fermi paradox.

Boree 18 (Liv Boeree, science communicator and TV host specializing in astrophysics, rationality, and poker. "Why haven’t we found aliens yet?," Vox, 7-3-2018, available at https://www.vox.com/science-and-health/2018/7/3/17522810/aliens-fermi-paradox-drake-equation, accessed 12-10-2019, HKR-cjh)

Where is everybody? In 1950, while working at Los Alamos National Laboratory, physicist Enrico Fermi famously exclaimed to his colleagues over lunch: “Where is everybody?” He had been pondering the surprising lack of evidence of other life outside of our planet. In a universe that had been around for some 14 billion years, and in that time developed more than a billion trillion stars, Fermi reasoned there simply must be other intelligent civilizations out there. So where are they? We still don’t know, and the Fermi paradox has only strengthened with time. Since the 1950s, humans have walked on the moon, sent a probe beyond our solar system, and even sent an electric sports car into orbit around the sun for fun. If we can go from rudimentary wooden tools to these feats of engineering in under a million years, surely there would have been ample opportunity in our 13.8 billion-year-old universe for other civilizations to have progressed to a similar level — and far beyond — already? And then, surely there would be some lingering radio signals or visual clues of their expansion reaching our telescopes.

#### Overwhelming evidence we’re alone and unreachable -- newest models

Bloetscher 18 (Dr. Frederick Bloetscher -- Professor and Associate Dean at Florida Atlantic University& received his Ph.D. from the University of Miami, https://sci-hub.tw/10.1016/j.actaastro.2018.11.033, 23 November 2018, `Using predictive Bayesian Monte Carlo- Markov Chain methods to provide a probablistic solution for the Drake equation, Pgs. 25-28)

No specific answer on the likelihood of intelligent life on another planet communicating with Earth is possible despite attempts to create models that provide such answers. However, using predictive Bayesian methods, a probability distribution can be created to accomplish same. This approach involves the assignment of probability distributions to the underlying factors. When little or no data are available to specify the parameters of these distributions, probability distributions can then be assigned to the prior parameters within the initial distributions to determine the location and scale parameters of the factor distribution. Subjective information may then be used to create these prior distributions until such time as real data is developed or becomes available. Hence subjective data can be incorporated and the prior distributions and adjusted as new data emerges, something other statistical methods cannot do. In addition, as the data increases, the confidence in the underlying distributions increases, another feature lacking in the other methods discussed herein. As a result, the results of predictive Bayesian methods are robust and include factors for both uncertainty and variability.

For the Drake equations, a distribution for N was developed through using the Hierarchical Monte Carlo distributions for the factors of the equation run 10,000 times. Figure 1 shows the results of the probability density function and cumulative density functions each parameter using the priors note in Table 2. Table 3 outlines the probabilities of intelligent, communicative life at given probabilities developed from the Monte Carlo prior data. The mean and standard deviation were then input into the MCMC protocol for the predictive Bayesian method that solved for N. The solution is shown in Figure 2 (red datapoints). Of importance, there is nearly a 20% probability that we are alone in the galaxy. The graph indicates that there is a 95% probability that there are less than 100 communicating civilizations concurrent with Earth, and a 99% that there are 1,000 such civilizations.

Additional scenarios were run to see what differences might be, starting with the factors R and L because they might have a significant impact on the results for N. Reducing R by a factor of 2 (to 10 starts per year) reduced the mean to 1.6 and a 90% probability that we are alone in the galaxy (black datapoints).

The graph indicates that there is a 99% probability that there are less than 100 communicating civilizations concurrent with Earth, and virtually no probability that there are 1,000 such civilizations. Increasing the value of L by a factor of 10 (to 46,000) yielded a mean of 253 (a factor of 10 higher), which translated to a greater likelihood of concurrent civilizations, but still likely less that 10,000 total (blue datapoints). The subjective points noted in Table 1, graphed as a cumulative density function are also shown on Figure 2. Figure 2 shows the pdf and CDF result for the 3 scenarios. Figure 2 shows that there is only a 5 percent chance that the number of civilizations with which we can communicate at this time in the galaxy (N) is less than 1000, and that there is virtually no chance that there are more than 100,000 civilization at any time.

Added scenarios were run that altered variables by up to one magnitude noting that all of these distributions fall between 0 and 1. The results all fell within the range of a one magnitude change to L and R and the graphs mimic those shown on Figure 2. Of interest, the average is the only place were significant changes occur with the Bayesian approach and only L was a significant factor – larger L led to larger likelihood of concurrent civilizations. The distribution may flatten a bit (larger tails and a lesser slope in the middle of the graph), but the overall graphic remains consistent – an artifact of the predictive Bayesian approach. There is a consistently large percentage of results that indicate we are alone in the galaxy when using the averages noted in Table 2, or smaller numbers for these variables are used (See circles on Figure 2). Where the averages increase, large percentages remain showing us to be alone, while the extreme values increase a little (i.e. the 99.9 percentile increases slightly but remains below 1 million civilization unless the magnitudes of L are increased).

5.0 CONCLUSIONS

Despite major progress in the detection of other planets in the galaxy, humans have only scratched the surface of space exploration. The answer to the famous Fermi-paradox (“Where is everybody?”) is also missing because the distances across the galaxy are large and the factors that may be present are largely still uncertain [101, 102]. There is emerging data that can be useful in a probabilistic model to determine the likelihood of life beyond Earth using Predictive Bayesian statistics, which are designed to use limited, uncertain data, to develop results, and that can be updated as more data is collected. The results provide a probability curve of the likelihood of life in the universe that includes both uncertainty and potential variability within the result to provide a means to define the probability of life in the galaxy as well as life within proximity to earth.

It is clear from this analysis that based on the data we know today, and the subjective data of the author referenced herein, large numbers of planets with intelligent, communicative life forms are unlikely in the galaxy, and we are very possibly alone. The result provided an estimate of the number of civilizations concurrent with ours is less than 1000, a number that is smaller than many prior estimates. While the probability of other civilizations is not zero, the results provide some suggestion as to why SETI has not detected any civilizations near Earth. This however does not mean that we are wasting our time with ventures such as SETI. One barrier is that there are a limited number of stars within 25 light years (133 and many are not very bright). Hart [4] notes that 25-50 years might be the limit of reasonable space exploration. The truth is likely that the distance to the next civilization is beyond our communication era. For example, if the next civilization is 1200 years away, our signals will not reach that planet for another 1200 years (3300), and assuming that planet currently has a civilization that can receive our signal and can respond, they would need to survive another 1200 years to respond to us (4500). Who knows what state Earth will be in by the time we receive their signal in 4500. And who will remember we sent a signal? And how will we interpret it? Recall the Greeks were the greatest civilization on Earth 2400 years ago.

#### No phosphorus in Universe means alien life impossible

Paez 18 (Danny Paez -- Innovation staff writer at Inverse summarizing host of studies, “Lack of Cosmic Phosphorus Raises Doubts About Extraterrestrial Life”, https://www.inverse.com/article/43320-low-phosphorous-no-aliens, 5 April 2018)

Bad news Ancient Aliens fans: life in the cosmos might be even rarer than scientists once thought.

It’s all because the universe is lacking one key chemical element for life, phosphorus. The element — abbreviated as P on the periodic table — is a fundamental ingredient that enables cells to store and transfer energy. Without it, we wouldn’t exist and with so little of it floating around in space, the likelihood of finding extraterrestrial life is looking slim.

Astronomers from Cardiff University used the William Herschel Telescope in the Canary Islands to study the universe’s biggest producers of the chemical, supernovae. It turns out even literal P factories don’t produce much of it at all. Lead researcher Jane Greaves and Phil Cigan will present their findings at the European Week of Astronomy and Space Science.

Supernovae are the final stage of a massive stars’ lifespan. Once the stellar mass has used up all of the fuel that keeps it burning it begins to collapse into itself until it becomes so dense it can’t sustain its gravitational force. This result is an explosion that spits out massive clouds of gas, which was once thought to hold a ton of P.

A previous study found that a supernova remnant known as Cassiopeia A (Cas A) contained plenty of phosphorus. But when Greaves and Cigan observed parts of the Crab Nebula they found substantially less P, which suggests only certain supernovae produce a lot of the element. This would mean planets formed far away from P-producing supernovae would have little to no hope of developing life.

#### No intelligent aliens for next 26 million years

Engler and von Wehren 18 (John-Oliver Engler and Henrik von Wehrden -- Faculty of Sustainability @ Leuphana University, ‘Where is everybody?’ An empirical appraisal of occurrence, prevalence and sustainability of technological species in the Universe, https://www.researchgate.net/profile/John-Oliver\_Engler/publication/329311655\_%27Where\_is\_everybody%27\_An\_empirical\_appraisal\_of\_occurrence\_prevalence\_and\_sustainability\_of\_technological\_species\_in\_the\_Universe/links/5c011f62a6fdcc1b8d4b24dc/Where-is-everybody-An-empirical-appraisal-of-occurrence-prevalence-and-sustainability-of-technological-species-in-the-Universe.pdf, 30 November 2018, pgs. 9-11)

Lastly, we multiply by the number NAst as taken from Frank and Sullivan (2016), who refer to Fukugita and Peebles (2004), to obtain the number of technological species on different scales of interest (Table 2). We find that, as an absolute minimum, at least 7 technological species have likely arisen in the history of our galaxy 15 until today, while a number of up to 300 is likely under the most optimistic plausible parameter values. Our estimated range for A is notably narrower than what Maccone (2010) estimates for the number of civilizations currently living in the Milky Way (7453 ≥ A ≥ 0). The difference is due to the large value of 0.2 that Maccone assumes for fi and ft , which leads to a considerably larger value of fbt = 0.02 than 20 the range that we have provided above. For the observable Universe, our estimates mean that at least 500 billion technological species have likely arisen to this day. However, these numbers do not imply anything about the existence of extraterrestrial technological species right now, or that communication with them would be likely. For one, technological species may disappear shortly after they have arisen (Shklovsky and Sagan 1966, Sagan 2015) and even if they were sending signals, a 2017 study by Grimaldi has shown that the chance of us picking up their signals would basically be zero, regardless of how many technological species would actually 5 be transmitting (cf. Grimaldi 2017). A sensitivity analysis of our estimations can be found in Appendix A.

3.2 How long until the next technological species?

It is well possible that mankind is currently the only technological species in the Milky Way galaxy. If this were the case, how long would we have to wait for the 10 occurrence of another technological species in our galaxy? Recent findings suggest that the oldest known system of terrestrial-sized planets is about T = 11.2 · 109 years old (Campante et al. 2015), which is therefore the best possible guess as to how long evolution may already be at work elsewhere in the cosmos and therefore in our galaxy. We combine this number with our results for A from Table 2 to give 15 something like the ‘rate of occurrence’ or ‘birth rate’ λ of technological species in a given sphere of interest, i.e. λ = A T . Results can be found in Table 3.

Processes that have a known rate of occurrence may however be modeled by the Poisson distribution as discussed by Glade, Ballet and Bastien (2012).4 The probability of n events in the time period t with known rate of occurrence λ can be shown to follow

Pn(t) = e −λt(λt) n n! .(8)

Hence, the probability of at least one event in the time period t is

Pn≥1(t) = X∞ n=1 e −λt(λt) n n! = 1 − P0(t)

= 1 − e −λt (9)

and the expected waiting time to the next occurrence of a technological extraterrestrial species as a function of probability Pn≥1 = α becomes

t(α) = − 1 λ ln(1 − α) (10)

In words, if we were alone in our galaxy today, we would have to wait approximately t = 26 million (1 billion) years for a α = 50% chance that another technological species has arisen in our galaxy depending on whether the lowest or highest defensible estimate of ns is assumed in calculations (2.7 · 10−8 ≤ λ ≤ 6.7 · 10−10 10 , cf. Table 3). For α = 90%, these waiting times would be t = 86 million (3.4 billion). The ‘pessimistic’ scenario therefore encompasses waiting times much longer than Earth’s remaining window of habitability, which is determined by the life cycle of the Sun. Figure 1 illustrates the cumulative probability distributions for the re15 spective spheres of interest, as well as the ranges that result from optimistic and pessimistic assumptions on rate of occurrence λ, i.e. we plot equation (9) for the possible extreme values of λ.

#### All ET life trapped too far underground for contact

Clements 18 (Dr. David L Clements -- Astrophysics Group @ Blackett Lab @ Physics Department of Imperial College, “Life Before Fermi – Back to the Solar System”, https://arxiv.org/pdf/1811.06313.pdf, 15 November 2018, pgs. 4-5)

5. Discussion and Conclusions Since we have deemed that water is the essential environment for life, the implication of these numbers is that the icy moons of the outer Solar System can potentially host much larger ecosystems than the one that is present on the Earth. There are certainly other requirements, such as an adequate supply of energy, potentially from radiogenic or tidal heating, but we know such power sources are present from observations of the plumes on Europa and Enceladus.

Secondly, the history of life on Earth now seems to be showing us that life, albeit very simple prokaryotic monocellular life1 , emerged very rapidly once the Earth had become compatible with its existence.

What are the implications of these results for the Fermi Paradox?

If we put the two sets of results together we find the following:

- The rapid emergence of life on Earth suggests that life can emerge wherever there is a compatible environment

- There are large bio-compatible environments inside the icy moons of Solar System gas giants

- The size of the bio-compatible environments inside gas giant moons is much larger, both in sum and, in the case of the large moons like Ganymede and Titan, individually, than the biosphere of Earth

The conclusion of this analysis for our own Solar System is that the interior of the icy moons may be where the bulk of life in the Solar System is to be found. However, this life, intelligent or otherwise, would be locked beneath many kilometres of solid ice, only able to escape into the broader universe through catastrophic geyser eruptions such as those found on Enceladus and Europa.

There are already indications that moons exist around some exoplanets (Kenworthy et al., 2015), and there is no reason to think that moons around gas giant exoplanets should be any different from those seen in the Solar System. There may thus be a very large number of them. Given the discussion here, it could be that the subsurface oceans of gas giant exomoons are in fact the dominant home for life in the Galaxy, with life on Earthlike, terrestrial planets, being the exception rather than the rule. We note that the prospects for identifying more exomoons and for their detailed study in the next few years are very good (Peters & Turner, 2013; Kipping et al., 2009) using data from Kepler or the James Webb Space Telescope.

In the context of the Fermi Paradox, we know that species that live in water can evolve to a high level of intelligence – dolphins and octopuses are good examples (though it should be noted that dolphins are evolutionary returnees to the water). However, a liquid environment may be a limiting factor in the development of technology. The dominant concern in this context, though, is the location of these vast watery environments beneath tens or hundreds of kilometres of water ice. While there may be water geysers in some of these, the larger environments of Titan, Callisto and Ganymede in our own Solar System show no signs of escaping water since they are likely capped by an ice layer over 100 km thick. This probably presents an insurmountable obstacle to any intelligence dwelling there even knowing about the outside universe, let alone attempting to communicate with it.