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#### Private companies are funding missions to contact extraterrestrial life now

Metcalfe 11/24 [(Tom, writes about science and space for NBC News.) “The search for extraterrestrial life is going to look at our nearest galactic neighbor” NBC News, 11/24/2021. https://www.nbcnews.com/science/science-news/search-extraterrestrial-life-going-look-nearest-galactic-neighbor-rcna6313] BC

Scientists are starting to look for life in our galactic backyard.

Alpha Centauri, two stars that at just over four light-years (about 25 trillion miles) away are the closest sunlike stars to our solar system, is the focus of a new effort to find planets that could reveal signs of life. The project centers on building a small space telescope — dubbed TOLIMAN after a medieval name for the star — that will go into Earth’s orbit in about two years and could start detecting planets by about 2025.

Although Alpha Centauri is right next door in astronomical terms, no planets have been detected around its binary star system. If any are found, their atmospheres could be scanned for the “biosignatures” created by extraterrestrial life — a relatively new astronomical technique that could allow scientists to determine by telescope if there’s alien life, especially microbial, on distant planets.

More than 4,000 alien planets have now been confirmed, but they’ve been largely discovered thanks to lucky alignments, said project leader Peter Tuthill, a professor of astrophysics at the University of Sydney.

“There’s a little bit of a dark secret that astronomers have been keeping,” he said. “We’re not actually very good at finding planets.”

Most of the “exoplanets,” as they’re known, have been discovered by automated systems like the Kepler space telescope, which watches continuously for planets crossing in front of hundreds of thousands of stars.

But finding planets around a particular star system — such as Alpha Centauri — is much more difficult.

To improve their chances, the new space telescope will have a specially etched mirror to create what’s known as a “diffractive pupil” effect — spreading the incoming starlight from a tiny point into a much larger, flower-shaped pattern that can better reveal any of the very slight “wobbles” caused by the gravity of orbiting planets.

The Alpha Centauri system has two stars similar to the sun, orbiting each other at about 20 times the distance between the sun and the Earth, Tuthill said.

Each has its own so-called Goldilocks Zone — where rocky planets are at just the right temperature to have liquid water on their surfaces, which is thought to be necessary for life as we know it to evolve.

In 2016, two planets were discovered around what could be a third star in the system — the red dwarf Proxima Centauri, discovered by telescope in 1915 and slightly closer to us than the other two.

But they’re not thought to be suitable for life because Proxima emits dramatic flares that can be 100 times more powerful than flares from the sun, Tuthill said.

That means the sunlike stars of Alpha Centauri may be our best bet for locating signs of alien life.

“If we found an Earth-mass planet in the habitable zones there, that would constitute a Holy Grail — a true Earth analogue,” he said. “That would potentially be an environment that could have all of the same conditions that we know here on Earth.”

The TOLIMAN project is backed by Breakthrough Initiatives, a space exploration fund based in California.

The group has proposed exploring Alpha Centauri with Breakthrough Starshot, a project consisting of thousands of tiny space probes that can be propelled at very high speeds by lasers on Earth.

In theory, the Breakthrough Starshot “nanocraft” could reach Alpha Centauri in about 20 years — an epic voyage of 25 trillion miles that would take tens of thousands of years with the fastest spacecraft that now exist.

“Alpha Centauri is very close, so if people want to dream visionary dreams about interstellar flight one day, then Alpha Centauri has to be our first bus stop on the way out into the galaxy,” Tuthill said.

If the TOLIMAN telescope does find any planets, the next step will be to study them with other telescopes to determine the composition of their atmospheres — and perhaps even to find chemical “biosignatures” produced by life.

The latest astronomical techniques for studying the atmospheres of exoplanets only work well with very large planets orbiting close to their star, and studying the atmospheres of Earth-size planets is currently beyond their reach, said astrophysicist Chris Watson of Queen’s University Belfast in Northern Ireland.

But chemicals are being discovered on smaller and more “challenging” planets as scientists find new ways to analyze their data and as new instruments — such as the James Webb space telescope — become available, he said.

Watson, who is not involved in the TOLIMAN project, is part of a team that recently detected hydroxyl radicals — a component of water — in the atmosphere of a planet orbiting a star about 400 light-years from Earth.

Detecting chemicals and possibly biosignatures on Earth-like planets around the stars of Alpha Centauri will be difficult, but “observing the nearest and brightest planetary system is going to provide our most likely route to success,” he said. “The signals will be very faint, and so we will need every photon of light to make it work.”

#### The public has abandoned all SETI projects – the private sector is the future

Frank 20 [(Adam, an astrophysicist and the Helen F. and Fred H. Gowen Professor at the University of Rochester. He most recent book is “Light of the Stars. Alien Worlds and the Fate of the Earth”) “A new frontier is opening in the search for extraterrestrial life,” The Washington Post, 12/31/20. <https://www.washingtonpost.com/outlook/2020/12/31/breakthrough-listen-seti-technosignatures/>] RR

SETI researchers are used to negative results, but they are trying harder than ever to turn that record around. Breakthrough Listen, the $100 million, 10-year, privately funded SETI effort Siemion leads, is lifting a field that has for decades relied on sporadic philanthropic handouts. Prior to Breakthrough Listen, SETI was "creeping along" with a few dozen hours of telescope time a year, Siemion says; now it gets thousands. It's like "sitting in a Formula 1 racing car," he says. The new funds have also been "a huge catalyst" for training scientists in SETI, says Jason Wright, director of the Penn State Extraterrestrial Intelligence Center, which opened this year. "They really are nurturing a community."

Breakthrough Listen is bolstering radio surveys, which are the mainstay of SETI. But the money is also spurring other searches, in case aliens opt for other kinds of messages—laser flashes, for example—or none at all, revealing themselves only through passive "technosignatures." And because the data gathered by Breakthrough Listen are posted in a public archive, astronomers are combing through it for nonliving phenomena: mysterious deep-space pulses called fast radio bursts and proposed dark matter particles called axions. "There are untapped possibilities here," says axion searcher Matthew Lawson of Stockholm University.

Perhaps the most important consequence of Breakthrough Listen is that it has nudged SETI, once considered fringe science, toward the mainstream. "Journals are relaxing and letting good technosignature papers be published," says astrobiologist Jacob Haqq-Misra of the Blue Marble Space Institute of Science. "The giggle factor is reducing." After nearly 3 decades of eschewing SETI, NASA organized a technosignature workshop in 2018. In June, it awarded a grant to model the detectability of possible technosignatures in the atmospheres of exoplanets, its first ever SETI-related grant not involving radio searches.

But some astronomers worry the funding boon is distorting science. Fernando Camilo, chief scientist of the South African Radio Astronomy Observatory, says Breakthrough Listen's voracious appetite for time on large telescopes leaves him uncomfortable. "It leaves less time to do astronomy." Others say SETI's high-risk, rush-for-the-prize approach could distract funders from a more rational, stepwise search for extraterrestrial life. "We do have a really thoughtful process on what gets funded and what doesn't," says Harvard University astronomer David Charbonneau. "That doesn't happen with rich individuals."

But SETI proponents don't see themselves as separatists. They are increasingly working hand in hand with those searching for exoplanets and studying astrobiology. "Looking for intelligence is the logical conclusion of this search for life," says astronomer David Kipping of Columbia University.

SETI STARTED SMALL. In 1960, astronomer Frank Drake pointed a 26-meter radio telescope in Green Bank, West Virginia, at two nearby Sun-like stars. He scanned frequencies around 1.42 gigahertz, which correspond to wavelengths of about 21 centimeters—the part of the spectrum where clouds of interstellar hydrogen emit photons. This 21-centimeter glow is ubiquitous, and Drake supposed it might be a universal channel on the cosmic dashboard, a natural place for a clarion "We are here!" But his targets, Tau Ceti and Epsilon Eridani, were expressionless. The survey, called Project Ozma, saw no sign of artifice, such as an intense spike squeezed into a narrow frequency band.

With funding from NASA and the National Science Foundation (NSF), however, searches continued, with bigger telescopes to listen for fainter signals and hardware that could scan thousands and eventually millions of narrow frequency channels at once. Drake devised his now famous, eponymous equation that estimates how many communicative extraterrestrial civilizations may exist in the Milky Way. It depends on seven variables, from the rate of star formation to the average lifetime of a civilization. Even though only one of the seven factors—star-formation rate—was known with any certainty, alien hunters were on the prowl.

In 1992, NASA decided to look harder, only to quickly reverse course. It embarked on the Microwave Observing Project, a 10-year, $100 million SETI search using several large telescopes. But the following year, the project was ridiculed and cut by lawmakers focused on reducing the federal budget deficit. Ever since, NASA has mostly shied away from SETI.

#### It’s private appropriation:

#### The private sector uses chips on spaceships to send messages to extraterrestrials

Boyle 17 [(Rebecca, an award-winning freelance science journalist in Saint Louis, Missouri. She is a contributing writer for The Atlantic and a frequent contributor at FiveThirtyEight.) “Why These Scientists Fear Contact With Space Aliens,” NBC News, 2/8/17. <https://www.nbcnews.com/storyline/the-big-questions/why-these-scientists-fear-contact-space-aliens-n717271>] RR

That conversation is likely to heat up soon thanks to the Breakthrough Initiatives, a philanthropic organization dedicated to interstellar outreach that's funded by billionaire Russian tech mogul Yuri Milner. Its Breakthrough Message program would solicit ideas from around the world to compose a message to aliens and figure out how to send it. Outreach for the program may launch as soon as next year, according to Pete Worden, the Breakthrough Initiatives’ director.

“We’re well aware of the argument, ‘Do you send things or not?’ There’s pretty vigorous opinion on both sides of our advisory panel,” Worden says. “But it’s a very useful exercise to start thinking about what to respond. What’s the context? What best represents the people on Earth? This is an exercise for humanity, not necessarily just about what we would send.” Members of the advisory panel have argued that a picture (and the thousand words it may be worth) would be the best message.

Next comes “more of a technical expertise question,” Wordon says. “Given that you have an image or images, how do you best encrypt it so it can be received?”

Breakthrough Message will work on those details, including how to transmit the pictures, whether through radio or laser transmitters; how to send it with high fidelity, so it’s not rendered unreadable because of interference from the interstellar medium; which wavelengths of light to use, or whether to spread a message across a wide spectrum; how many times to send it, and how often; and myriad other technical concerns.

The scientific community continues to debate these questions. For instance, Philip Lubin of the University of California, Santa Barbara, has published research describing a laser array that could conceivably broadcast a signal through the observable universe.

Breakthrough is also working on where to send such a message, Worden adds. The $100 million Breakthrough Listen project is searching for any evidence of life in nearby star systems, which includes exoplanets out to a few hundred light years away.

“If six months from now, we start to see some interesting signals, we’ll probably accelerate the Message program,” he says.

The fact that there have been no signals yet does pose a conundrum. In a galaxy chock full of worlds, why isn't Earth crawling with alien visitors? The silence amid the presence of such plentiful planets is called the Fermi Paradox, named for the physicist Enrico Fermi, who first asked "Where is everybody?" in 1950.

In the decades since, astronomers have come up with possible explanations ranging from sociology to biological complexity. Aliens might be afraid of us, or consider us unworthy of attention, for instance. Or it may be that aliens communicate in ways that we can’t comprehend, so we’re just not hearing them. Or maybe aliens lack communication capability of any kind. Of course there’s also the possibility that there are no aliens.

But those questions don’t address the larger one: Whether it’s a good idea to find out. Some scientists, most notably Stephen Hawking, are convinced the answer is a firm “No.”

“We only have to look at ourselves to see how intelligent life might develop into something we wouldn’t want to meet,” Hawking said in 2010. He has compared meeting aliens to Christopher Columbus meeting Native Americans: “That didn’t turn out so well,” he said.

Others have warned of catastrophic consequences ripped from the pages of science fiction: Marauding aliens that could follow our message like a homing beacon, and come here to exploit Earth’s resources, exploit humans, or even to destroy all life as we know it.

“Any civilization detecting our presence is likely to be technologically very advanced, and may not be disposed to treat us nicely. At the very least, the idea seems morally questionable,” physicist Mark Buchanan argued in the journal Nature Physics last fall.

Other astronomers think it’s worth the risk — and they add, somewhat darkly, that it’s too late anyway. We are a loud species, and our messages have been making their way through the cosmos since the dawn of radio.

“If we are in danger of an alien invasion, it’s too late,” wrote Douglas Vakoch, the director of Messaging Extraterrestrial Intelligence (METI) International, in a rebuttal last fall in Nature Physics. Vakoch, the most prominent METI proponent, argues that if we don’t tell anyone we’re here, we could miss out on new technology that could help humanity, or even protect us from other, less friendly aliens.

“If we are in danger of an alien invasion, it’s too late."

David Grinspoon, an author and astrobiologist at the Planetary Science Institute in Tucson, says he first thought, "'Oh, come on, you've got to be kidding me.' It seems kind of absurd aliens are going to come invade us, steal our precious bodily fluids, breed us like cattle, 'To Serve Man,' " a reference to a 1962 episode of "The Twilight Zone" in which aliens hatch a plan to use humans as a food source.

Originally, Grinspoon thought there would be no harm in setting up a cosmic lighthouse. “But I’ve listened to the other side, and I think they have a point,” he adds. “If you live in a jungle that might be full of hungry lions, do you jump down from your tree and go, ‘Yoo-hoo?’”

Many have already tried, albeit some more seriously than others.

In 2008, NASA broadcast the Beatles tune “Across the Universe” toward Polaris, the North Star, commemorating the space agency’s 50th birthday, the 45th anniversary of the Deep Space Network, and the 40th anniversary of that song.

Later that year, a tech startup working with Ukraine’s space agency beamed pictures and messages to the exoplanet Gliese 581 c. Other, sillier messages to the stars have included a Doritos commercial and a bunch of Craigslist ads.

Last October, the European Space Agency broadcast 3,775 text messages toward Polaris. It’s not known to harbor any exoplanets, and even if it did, those messages would take some 425 years to arrive; yet the exercise, conceived by an artist, raised alarm among astronomers. Several prominent scientists, including Walkowicz, signed on to a statement guarding against any future METI efforts until some sort of international consortium could reach agreement.

Even if we don’t send a carefully crafted message, we’re already reaching for the stars. The Voyager probe is beyond the solar system in interstellar space, speeding toward a star 17.6 light-years from Earth. Soon, if Milner has his way, we may be sending even more robotic emissaries.

Milner’s $100 million Breakthrough Starshot aims to send a fleet of paper-thin space chips to the Alpha Centauri system within a generation’s time. Just last fall, astronomers revealed that a potentially rocky, Earth-sized planet orbits Proxima Centauri, a small red dwarf star in that system and the nearest to our own, just four light years away. The chips would use a powerful laser to accelerate to near the speed of light, to cover the distance between the stars in just a few years. A team of scientists and engineers is working on how to build the chips and the laser, according to Worden.

“If we find something interesting, obviously we’re going to get a lot more detail if we can visit, and fly by,” he says. “Who knows what’s possible in 50 years?”

But some time sooner than that, we will need to decide whether to say anything at all. Ultimately, those discussions are important for humanity, Worden, Walkowicz and Grinspoon all say.

#### Alpha Centauri contains life

Anderson 18 [(Paul Scott, has had a passion for space exploration that began when he was a child when he watched Carl Sagan’s Cosmos. While in school he was known for his passion for space exploration and astronomy. He started his blog The Meridiani Journal in 2005, which was a chronicle of planetary exploration. In 2015, the blog was renamed as Planetaria. While interested in all aspects of space exploration, his primary passion is planetary science. In 2011, he started writing about space on a freelance basis, and now currently writes for AmericaSpace and Futurism (part of Vocal).) “Life at Alpha Centauri? Maybe, NASA says,” EarthSky, 6/17/18. <https://earthsky.org/space/could-life-exist-at-alpha-centauri/>] RR

With the discovery of thousands of exoplanets orbiting other stars, the search for life elsewhere has entered an exciting new phase. So far, most of these worlds have been found many light-years away (largely due to the fact that the Kepler Space Telescope, which has discovered the majority of them so far, has focused on a specific patch of sky which contains very distant stars). But what about closer stars? Including, of course, Alpha Centauri, the closest star system to our sun, only just over four light-years away. According to Tom Ayres of the University of Colorado Boulder:

Because it is relatively close, the Alpha Centauri system is seen by many as the best candidate to explore for signs of life. The question is, will we find planets in an environment conducive to life as we know it?

Scientists had thought that there was too much X-ray radiation from the stars in the system for life on any planets to be likely. But now, as announced by NASA on June 6, 2018, there is new evidence from NASA’s Chandra X-ray Observatory, that, perhaps, conditions could be more life-friendly than previously assumed.

While the other two stars, Alpha Centauri A and B, are both similar to our sun, Proxima Centauri is a red dwarf, which emits much more deadly X-ray radiation. That is bad news for its one known Earth-sized planet, Proxima b. However, observations from Chandra since 2005 show that conditions around the other two stars are about the same or even better than around our own sun. In terms of the radiation, the prospects for life are actually better for habitable zone planets around Alpha Centauri A than our own sun, with lower doses of X-rays than similar planets in our solar system, and only slightly worse around Alpha Centauri B, by a factor of five. As Ayres noted:

This is very good news for Alpha Cen AB in terms of the ability of possible life on any of their planets to survive radiation bouts from the stars. Chandra shows us that life should have a fighting chance on planets around either of these stars.

It is not known yet if there are any rocky planets orbiting Alpha Centauri A or B, but if so, then there is an increased chance of habitable conditions, although other factors come into play as well, such as temperature, liquid water or lack of it, composition of any atmosphere, etc. One problem with searching for planets there is that both stars are bright and currently closer together because of their orbits, making detection more difficult.

For Proxima b however, the situation is different. It receives an average dose of X-rays about 500 times greater than Earth, and up to 50,000 times stronger during a large solar flare. Not exactly ideal conditions for life.

With so many exoplanets being discovered now, it is natural of course to wonder about the star system closest to us. Could life exist there? For the one planet known to exist there so far, the results are not encouraging. But if there are others, and most planetary systems appear to have more than one planet, then the odds are a bit more in life’s favor. We won’t know for sure until/if we find additional planets in the Alpha Centauri system. But even if we don’t, many other worlds are being discovered on a regular basis now, and a growing number appear to have conditions at least suitable for habitability, if not life itself.

The new results were presented at the 232rd meeting of the American Astronomical Society meeting in Denver, Colorado, and some results were published in January 2018 in the Research Notes of the American Astronomical Society.

Bottom line: The closest star system to our sun, Alpha Centauri, has at least one Earth-sized planet orbiting one of its three stars. Dangerous x-rays from that red dwarf star make life unlikely there, but the prospects may be much better for the other two sun-like stars, if any as-yet undiscovered planets orbit them.

#### Private companies use LEO satellites to make contact and explore—

Seti Institute 17 [(The Seti Institute, a non-profit research organization) “Project Blue and the Quest to Photograph Exoplanets,” Seti Institute, 10/20/17. <https://www.seti.org/project-blue-and-quest-photograph-exoplanets>] RR

The world’s collective imagination to answer the age-old question, “Are we alone,” has been reignited now that we understand exoplanets – planets in orbit around stars other than Earth’s Sun – are not uncommon. There’s an increased urgency to develop capabilities for directly photographing exoplanets around nearby stars and to characterize their surface conditions and, Alpha Centauri, being the nearest star system to our own, has understandably become a focal point of current scientific study.

Alpha Centauri features two Sun-like stars, each with the chance of having one or more exoplanets orbiting in its habitable zone - the range where temperatures would allow liquid water to exist on a planet’s surface - making it an even more compelling target. From a technical point of view, as our nearest neighboring star system, Alpha Centauri is also the easiest system for us to resolve important physical scales including better understanding the distance between a star and its habitable zone.

Being the closest neighboring system to Earth also makes Alpha Centauri our best prospect to eventually explore when we have the technology to travel across multiple light years in a reasonable amount of time. As a point of comparison, we’re still just beginning our exploration of Mars, and it’s typically only a few light minutes, or ~40 million miles, away at its closest approach from Earth. Alpha Centauri is the closest star system, but it’s still 4.37 light years, or ~25 trillion miles, away.

Project Blue Mission Concept

Until now, although we know that Earth-size planets are common in our Milky Way, the technologies to directly photograph them in light visible to the human eye has not been available. The challenge with capturing this kind of image has been figuring out how to effectively block the light of a star in order to view its orbiting planets. A star is over a billion times brighter, and needs to be suppressed in order to see and capture pictures of orbiting planets.

Since Alpha Centauri is a binary system, this challenge is even more complicated, as we have to suppress the light from two stars. Project Blue is a mission to put a special purpose telescope capable of suppressing starlight and capturing images of exoplanets into low Earth orbit The Project Blue telescope will use a technique called 'direct imaging' to dim the light from Alpha Cen A and B, enabling us to see any surrounding exoplanets in their orbits. The specialized starlight suppression system consists of:

An instrument called a coronagraph to block starlight, using either the Phase Induced Amplitude Apodization (PIAA) or Vector Vortex technique;

A deformable mirror, low-order wavefront sensors, and software control algorithms to manipulate the incoming light and achieve multi-star wavefront control (MSWC); and

Post-processing methods, called Orbital Differential Imaging (ODI), to enhance image contrast.

While every space mission is complex, difficult and takes time, Project Blue has a relatively short lifecycle of about six years. The Project Blue team, made up of technical experts and resources from BoldlyGo Institute, Mission Centaur, the SETI Institute, University of Massachusetts Lowell, and other institutions hope to launch the mission into low-Earth orbit by 2021 and observe the Alpha Centauri system for 2 years with its coronagraphic camera. By contrast, if we were to design a probe to send to Alpha Centauri and launch it today using conventional rocket technology, it would take approximately 75,000 years to get there before it could transmit images of any discoveries back to Earth.

Project Blue Timeline

Project Blue discoveries would be able to inform other missions, such as future large ground- and space-based telescopes, and even Breakthrough Starshot, which is in the early stages of developing technology to reach speeds of ⅕ light speed in order to send probes to Alpha Centauri. If successful, Breakthrough Starshot would still take decades to get to Alpha Centauri, and an additional 4 years for the first images to return to Earth. Project Blue might be able to provide a “roadmap” to help make sure future missions like these look in the right places.

Perhaps most important is the possibility that Project Blue identifies and captures the first image of a rocky blue exoplanet - a ‘pale blue dot’ - like the picture of Earth that the Voyager 1 spacecraft sent back to us on February 14, 1990, from a distance of 4 billion miles as it was leaving our solar system.

From a scientific standpoint, this discovery would be on par with other major discoveries of the past 500 years. It would enable us to learn about and study the composition of what could be another planet with oceans of water and a thick atmosphere capable of supporting life as we know it: A sister Earth.

#### Lunar bases and orbiters are being used to make contact

Oberhaus 20 [(Daniel, staff writer at WIRED, where he covers space exploration and the future of energy. He is the author of Extraterrestrial Languages (MIT Press, 2019) and was previously the news editor at Motherboard.) “Why Astronomers Want to Build a SETI Observatory on the Moon “ The Smithsonian, 10/2/20. <https://www.smithsonianmag.com/science-nature/why-astronomers-want-build-seti-observatory-moon-180975966/>] RR

On Monday, a group of researchers sponsored by Breakthrough Listen, the world’s largest program, submitted a paper to National Academy of Sciences’ Planetary Science and Astrobiology Decadal Survey that makes the case for establishing a SETI radio observatory on the farside of the moon. The decadal survey establishes scientific priorities for the next ten years and the new paper addresses one of the biggest problems facing the search for extraterrestrial intelligence today: The overwhelming amount of radio interference.

Our planet has become so “loud” in the part of the radio spectrum observed by SETI that it threatens to drown out any signal sent from an intelligent civilization. Not only would a lunar radio telescope not have to deal with terrestrial radio interference, it could also significantly increase our chances of hearing from ET by opening up parts of the radio spectrum that are blocked by Earth's atmosphere. While the idea of using the moon for radio astronomy is decades old, the researchers make the case that technological advancements have finally made a lunar SETI observatory truly feasible.

“The transportation infrastructure for getting to the moon is much cheaper than it’s been for the last few decades, so now it’s actually possible,” says Eric Michaud, an intern at the SETI Berkeley Research Center and the first author of the paper. “Maybe not today, but I think it’s going to get more and more feasible as time goes on.”

Radio interference has been a problem for SETI from the very beginning. In the spring of 1960, the planetary scientist Frank Drake trained the massive radio telescope at Green Bank Observatory in West Virginia on Tau Ceti and Epsilon Eridani, two stars a mere 12 light years from Earth. That summer, Drake spent his days studying the signals picked up by Green Bank’s giant mechanical ear in the hopes of receiving a message broadcast by an alien civilization orbiting those stars. Known as Project Ozma, Drake’s experiment marked the beginning of SETI, the scientific search for extraterrestrial intelligence.

Shortly after Drake started his observations, he was surprised to find what appeared to be a signal of intelligent origin. After days of watching a needle drift lazily over a spool of paper recording the random undulations of cosmic static, Drake and his colleagues were jolted awake when the machine started recording the frantic pulses of a strong radio signal picked up by the telescope. The timing and magnitude of the pulses clearly marked them as artificial; there was nothing in the natural world that could produce such a frenetic radio profile. It would have been an astounding stroke of luck to pick up an alien message after only a few hours of observation, but it was hard to argue with the data. “None of us had ever seen anything like it,” Drake recalled in Is Anyone Out There?, his autobiographical book about the early days of SETI. “We looked at each other wide-eyed. Could discovery be this easy?”

After doing somefollow up searches, it was clear that Drake had discovered an airplane, not an alien civilization.

It was a letdown, but the false detection turned out to be a portent for the future of SETI. In the 60 years since Drake’s pioneering experiment, researchers have conducted dozens of SETI searches across thousands of stars and turned up empty-handed. At the same time, the sources of radio interference on Earth—military radars, TV towers, cell phones, and satellites—have exponentially increased, which greatly increases the chances that an extraterrestrial signal will be lost among the noise.

Earth was never a particularly great place to do any kind of radio astronomy due to our thick atmosphere blocking a large portion of the radio spectrum. The proliferation of radio communication technologies has only made things harder. The moon, by comparison, has no atmosphere and its nights last for weeks on end, which limits radio noise from the sun. And as NASA discovered through a spate of lunar orbiter missions in the late 1960s, the moon also acts as a natural shield that blocks radio signals emanating from Earth. As the planetary astronomer Phillipe Zarka has put it, “the farside of the moon during the lunar night is the most radio-quiet place in our local universe.” It’s exactly the sort of peace and quiet you want if you’re searching for faint radio signals from solar systems that might be hundreds of light years away.

The new Breakthrough Listen paper proposed two main approaches to a lunar SETI observatory: an orbiter and a telescope on the surface. The basic idea behind a SETI lunar orbiter would be to scan for signals as it passed over the lunar farside and relay data back to Earth as it passed over the near side. One of the main advantages of an orbiter is cost. The proliferation of small satellites that are capable of accurate tracking combined with low-cost small launch providers like Rocket Lab means that a SETI orbiter could conceivably be sent to the moon for less than $20 million. This would be a valuable pathfinder mission that could pave the way for a more ambitious observatory on the surface, but without the risk and cost. As the ill-fated Israeli Beresheet lander mission reminded us, landing on the moon is extremely challenging even when the mission is backed by $100 million.

But a SETI lunar orbiter would also come with a lot of compromises. It would only be able to conduct observations during the brief stretches when it was on the lunar farside, which would make a sustained observation campaign more challenging. The upshot is that an orbiter would have access to the full sky, whereas a telescope on the surface would be constrained by the moon’s rotation. The biggest downside of an orbiter is that it might lose a lot of the shielding benefits of the moon and be more vulnerable to radio interference from Earth since it would be orbiting high above the lunar surface.

“The first SETI observations that are done from the lunar farside will be done from orbit, there’s no question about that,” says Andrew Siemion, the director of the Berkeley SETI Research Center and the second author on the paper. “I think eventually we absolutely want to do something on the surface because we want to build a very large aperture telescope, but even when we’re at that point I don’t think that would negate the utility of doing things from orbit as well.”

So what would a SETI observatory on the moon look like? One idea is to use the naturally parabolic lunar crater as a radio dish, much like the Arecibo telescope in Puerto Rico and the FAST telescope in China, which are built into natural depressions in the land. This idea was first considered back in the late 1970s by a group of scientists at the radio physics lab at the Stanford Research Institute. Their idea was to recreate Arecibo on the moon by suspending an antenna from the lip of a crater and using the basin as a reflector. The reduced gravity on the moon would allow for a radio telescope far larger than any on Earth, which could significantly enhance the sensitivity of SETI searches. Ultimately the researchers concluded that a lunar radio observatory was too expensive compared to SETI telescopes that could be built on Earth.

But 40 years later, Michaud says that building a radio dish in a lunar crater may finally be cheap enough to pull off. One of the main drivers of this cost reduction is the advent of commercial launch providers like SpaceX and Rocket Lab, which have dramatically lowered the cost of space access. Another driver is NASA’s push to establish a permanent human presence on the moon, which has subsidized the development of a fleet of commercial lunar exploration vehicles. “There’s so much interest in going back to the moon,” says Michaud, who cited Blue Origin’s lunar lander and Rocket Lab’s Photon Lunar satellite as examples of technologies enabled by NASA’s Artemis program.

A crux of the original vision for lunar SETI observatories was that it would require a human settlement on the moon to build and operate the radio dish. But robotic systems have improved enough that it may be possible to take humans out of the equation. This was clearly demonstrated in 2019 when China’s Chang’e 4 rover landed autonomously on the farside of the moon. These advancements in autonomous navigation have laid the foundation for a lunar radio observatory that is built entirely by robots.

It sounds like science fiction, but earlier this year NASA’s Advanced Innovative Concepts program awarded one of it’s prestigious grants to Saptarshi Bandyopadhyay, a researcher at the Jet Propulsion Laboratory, to figure out a way to make it happen. His idea is to use rovers to deploy wire mesh in a crater on the lunar farside and suspend a receiver over the dish. NIAC is all about funding high risk, high reward missions, and there’s no guarantee that Bandyopadhyay’s proposal will ever come to fruition. Still, addressing the technical problems associated with building a radio receiver on the farside of the moon is an important first step.

And Bandyopadhyay isn’t the only NASA-backed researcher contemplating a lunar radio observatory. Jack Burns, a radio astronomer at the University of Colorado, has also received a grant to study a mission concept for a radio telescope array called FARSIDE. Instead of using a crater as a dish, FARSIDE would deploy several smaller antennas across the lunar surface that would collectively form a large radio telescope. Both NASA studies are focused on radio astronomy rather than SETI, but Siemion sees the two disciplines as natural allies in the quest to establish an observatory on the lunar farside. SETI has piggybacked on other radio astronomy projects in the past—SERENDIP, for instance, opportunistically searched for ET signals during radio observation campaigns at a variety of telescopes—and it seems plausible that a similar arrangement could be made with an observatory on the moon

#### SETI is actively broadcasting Earth’s location – that ensures contact and conflict

Sigel 7/30 [(Ethan, a Ph.D. astrophysicist, author, and science communicator, who professes physics and astronomy at various colleges. I have won numerous awards for science writing since 2008 for my blog, Starts With A Bang, including the award for best science blog by the Institute of Physics.) “Ask Ethan: What Danger Is There In Actively Searching For Intelligent Aliens?” Forbes, 7/30/21. <https://www.forbes.com/sites/startswithabang/2021/07/30/ask-ethan-what-danger-is-there-in-actively-searching-for-intelligent-aliens/>] RR

Although we’ve been looking for other signs of intelligent life out there in the Universe for more than half a century — searching for extraterrestrial intelligence — we have yet to obtain robust evidence that it exists. Simultaneously, however, many have advocated broadcasting our location and presence aloud, hoping to attract the attention, and make contact with, a similarly advanced civilization elsewhere in the galaxy. Others think this is a horrible, potentially self-destructive strategy. What should we think, and more importantly, what should we do about it? That’s what Gary Davis wants to know, asking:

“I've been thinking about extraterrestrial intelligence for a long time. Everyone's a layperson here. But I was disappointed by [this] exchange between [Michio] Kaku and [Douglas] Vakoch... I'd be delighted to read your thoughtful sense of the issue.”

It’s a fantastic issue to explore, right at the limits of science and the interface of a risk/reward/hazard scenario whose odds are unknown. All of society, and indeed humanity’s very future, may be at stake.

The big hope — and fear — is of making first contact with an alien species. What will it be like? Moreover, what will they be like? Although we won’t know until we find them, there are five major possibilities for how this first discovery will someday occur.

We find simple, microbial-like life in our own cosmic backyard. This occurs by finding fossilized, dormant, or even active life forms of non-Earth origin elsewhere in, or passing through, our Solar System. Exploration missions, or getting lucky and having a chunk of life-containing material landing here on Earth, would lead to this discovery.

We find indirect signs of life on an exoplanet or exomoon around a foreign star. Through either direct imaging or transit spectroscopy, we’ll identify the signatures of a living planet, and conclude that the most likely explanation is that it’s inhabited.

We receive and decode a technosignature from an advanced extraterrestrial civilization. Whether it arrives in the radio band, another electromagnetic frequency, or via some signal we’ve yet to decode — from energetic neutrinos, perhaps — a scientific endeavor such as SETI would uncover this.

We receive a direct visitation from aliens. This is the hope of those investigating unidentified flying objects/aerial phenomena: that somewhere, lying in the gaps of what’s been identified and what’s been seen but not at sufficient resolution to uncover, a spacecraft of intelligent alien origin is waiting to be found.

Or, perhaps, there are aliens out there, waiting to be contacted, but that haven’t actively been broadcasting. They’re awaiting their first message from an alien civilization, and so it’s up to us to send it, so that they can receive it.

Scientists have long been pursuing the first three, and continue to do so. The fourth one continues to consist largely of pseudoscience and conspiracy theories, although a recent effort hopes to change that. But the fifth one, arguably, brings our greatest hopes and fears both to the forefront.

The hope, of course, is that at least one other intelligent civilization has arisen — at some point — within the Milky Way galaxy. Just like us, they became technologically advanced, and began to scour their own nearby neighborhood for what’s out there, curious about what they could or would find.

Perhaps they learned the answer to questions we’re still investigating, such as:

what is the secret to sustainable nuclear fusion, and the solution to our energy woes in general?

how their species overcame infighting, resource hoarding and overconsumption, and the perils of global war to sustain themselves on their home planet?

and just how abundant life actually is in our cosmic backyard: on planets, moons, and even smaller bodies in their own solar system, and even on worlds beyond their own home star?

But perhaps they already looked for technosignatures, exhaustively, and didn’t find any for a long period of time, which caused them to give up. Perhaps, then, the only thing stopping them from contacting us is that they don’t know we’re here, and they’re not actively broadcasting, failing to advertise their presence. If that’s the case, then perhaps all we need to do is announce, “we are here!”

Once our signal arrives at their location — anywhere from a few light-years to a few tens of thousands of light-years — they could send a signal or even a crewed mission back, answering our longstanding question affirmatively: yes, there are other intelligent aliens out there, and here they are.

Of course, for every hope we have, there’s an equal-and-opposite fear. The fear is not:

there’s no one out there to receive a signal,

that the aliens will hear us and ignore us, deciding not to respond,

or that our attempts will be futile, falling below the threshold to reach whatever alien civilization is out there before the signal we send drops below the cosmic noise background.

Instead, the fear is that aliens actually will receive that signal, and head this way with malicious intent. The fear is that, by announcing our presence to the Universe, a predatory, plunderous alien civilization — with technology likely far, far advanced beyond our own — will set out to conquer us.

Given the gap in technology that surely exists, as they’re likely hundreds, thousands, or even millions of years ahead of us, it will be a short, brutal war that ends in extinction or enslavement for humanity. Like the plot of many alien invasion movies, but without an unrealistic victory for us plucky humans, we could be sealing our own demise.

Of course, ever since the first broadcast radio and television signals were transmitted, powerful enough and of the proper frequencies to be capable of traveling beyond Earth’s atmosphere, ionosphere, and Van Allen belts, humans have — wittingly or unwittingly — been announcing our presence to any sufficiently advanced onlookers for over 80 years. If we were to draw a sphere around the Earth that’s approximately ~80 light-years in radius, we’d find that there are somewhere around 10,000 star systems, most of which remain undiscovered as of today, that could have received a surefire signal of humanity’s presence here on Earth.

There’s a difference, however, between what we’ve done, and continue to do, inadvertently, and making a concerted effort to reach out to whatever may be present in the galaxy beyond our own backyard. The leading idea falls under the umbrella of METI: Messaging Extraterrestrial Intelligence, which is sometimes referred to as “active SETI,” since it’s not simply passively listening, but is actively broadcasting, including targeted broadcasting at star systems of particular interest. It’s that very effort that has attracted so much attention, as well as criticism and concern.

As far as what’s known, we’ve come a lot farther than most of us could have imagined even a few decades ago. At the start of the 1990s, we only had speculative evidence that planets beyond our own Solar System existed. We didn’t know how common Earth-sized worlds around Sun-like stars were; we didn’t know what types of planets were common or rare in the Universe; we didn’t know whether our Solar System was typical, uncommon, or a cosmic rarity. Today, as of 2021, many of those things have changed.

Our own Milky Way has somewhere around ~400 billion stars, and we’re just one of about 2 trillion galaxies within the observable Universe. Of the stars within our galaxy:

80-100% of them have planets and planetary systems around them,

~20% of those stars are Sun-like, of either the K, G, or F-subtype,

10-20% of those planets are Earth-like in terms of size and mass,

and 20-25% of those systems have a planet in what we call the “habitable zone” around them, which means they’d have the right temperatures for liquid water on their surfaces if they had Earth-like atmospheres.

Putting all of those pieces together, we find that there are likely a few billion potentially inhabited worlds in our own galaxy: with the right conditions and ingredients for life to arise on them. That’s a lot of possibilities out there, but what we don’t know still remains substantial, and makes us greatly uncertain about the ultimate of questions: how many intelligent, technologically advanced civilizations are actually out there?

Everyone — including Michio Kaku and Douglas Vakoch, as reported in the New York Times — agrees that it’s naive to assume we must be the only game in town, as far as intelligent life is concerned. After all, we still don’t know the answer to three very, very big questions.

Of the worlds we identify as potentially habitable, how many of them actually have or had life arise on them?

Of the worlds upon which life arises, how many of them have life sustain itself over cosmological timescales, like billions of years, where it evolves to become complex, multicellular, and highly differentiated?

And of the worlds where life survives, thrives, and becomes complex, on how many of those worlds does life actually become intelligent and technologically advanced?

We have billions of possibly inhabited worlds in our Milky Way, as inferred from what we’re capable of measuring so far. But we have to be honest about our ignorance. If the answer to all three of these questions is something like 1%, then intelligent life has arisen within our galaxy thousands of times in the past. If the answer to all three of these questions is more like 0.01% or less, then we might be the first to make it this far in the entire galaxy.

The honest truth is that without more information, and better information about the Universe, we cannot know, but that if even one of these three steps is “hard” in the sense that it’s extremely unlikely, humanity may truly be alone.

So let’s imagine, for the sake of argument, that there are other intelligent civilizations out there. Should we attempt to contact them? Kaku says no, arguing — and I’m boiling this argument down terribly — the following:

“I think the idea of reaching out and advertising our existence is a catastrophically bad idea. In fact, I think it would be the biggest mistake in human history to deliberately try to make contact with an adversary that we know nothing about. The collapse of civilization as we know it could happen... it’s naive to assume that [aliens are] peaceful, that they want to give us the benefit of their technology, when they could be like Cortez.”

Assume, then, that aliens are like Cortez: out for conquest and riches. Not the riches of gold, but for the valuable resources we have here at our disposal. That, honestly, is the biggest problem with this argument: if an alien species can traverse the cosmos, having achieved technological mastery over as complex an endeavor as interstellar travel, what scarce resources could they possibly be after that exists abundantly on Earth and that is otherwise rare?

There are none. Nothing that we have here on Earth is unique to our planet that isn’t just as easily synthesized elsewhere, except for, perhaps, intelligent life itself. We’d have to assume that an advanced extraterrestrial civilization would only be interested in us because we announced our presence, and then would quickly act to wipe us out without a fathomable reason at all, perhaps other than the sociopathic, “maybe they find it fun to step on these technological infants” the same way a child might wantonly burn ants to death with a magnifying glass.

On the other hand, Vakoch argues the opposite point; that being a cosmic “lurker” is the only surefire way to remain isolated on our island world, rather than joining whatever inter-civilization conversations might actually be occurring. To summarize him in his own words:

#### Extinction – they will colonize the galaxy

Buchanan 6/10 [(Mark, a physicist and science writer based in Europe.) “Contacting aliens could end all life on earth. Let’s stop trying.,” The Washington Post, 6/10/21. <https://www.washingtonpost.com/outlook/ufo-report-aliens-seti/2021/06/09/1402f6a8-c899-11eb-81b1-34796c7393af_story.html>] RR

Chances are, though, that we should all be grateful that we don’t yet have any evidence of contact with alien civilizations. Attempting to communicate with extraterrestrials, if they do exist, could be extremely dangerous for us. We need to figure out whether it’s wise — or safe — and how to handle such attempts in an organized manner.

Some scientific circles have already been debating questions around whether to try to contact other civilizations. It’s a topic of profound importance for the entire planet. For 60 years, scientists have been searching with radio telescopes, listening in for possible signals coming from other civilizations on planets orbiting distant stars. These efforts have largely been organized by the SETI institute in California — the acronym stands for Search for ExtraTerrestrial Intelligence — and so far, they’ve had no success. Getting impatient, some other scientists are now pushing for a more active program — METI, for Messaging ExtraTerrestrial Intelligence — that wouldn’t just listen, but actually send out powerful messages toward other stars, seeking to make contact.

The search for aliens has reached a stage of technological sophistication and associated risk that it needs strict regulation at national and international levels. Without oversight, even one person — with access to powerful transmitting technology — could take actions affecting the future of the entire planet.

The military keeps encountering UFOs. Why doesn’t the Pentagon care?

That’s because any aliens we ultimately encounter will likely be far more technologically advanced than we are, for a simple reason: Most stars in our galaxy are much older than the sun. If civilizations arise fairly frequently on some planets, then there ought to be many civilizations in our galaxy millions of years more advanced than our own. Many of these would likely have taken significant steps to begin exploring and possibly colonizing the galaxy.

Hence, it’s a profound mystery — known as the Fermi Paradox, after the Italian physicist Enrico Fermi — why we haven’t yet seen any such aliens. Many resolutions of the paradox have been proposed, among them the suggestion that all civilizations, once reaching sufficient technological capacity, eventually destroy themselves. Or perhaps aliens are so alien and unlike humans that we simply cannot interact with them.

More alarming is the possibility that alien civilizations are remaining out of contact because they know something: that sending out signals is catastrophically risky. Our history on Earth has given us many examples of what can happen when civilizations with unequal technology meet — generally, the technologically more advanced has destroyed or enslaved the other. A cosmic version of this reality might have convinced many alien civilizations to remain silent. Exposing yourself is an invitation to be preyed upon and devoured.

I’ve written about METI in the past, suggesting such activity takes a huge risk for very little gain. But these concerns don’t convince supporters of trying it, who have some counterarguments. Douglas Vakoch of METI International argues that it’s unrealistic to worry about the danger of an alien invasion. We have, after all, been sending radio and television emissions into space for a century, and a civilization far more advanced than our own will probably have already detected these. If they wanted to invade, they already would have.

He also argues that, in assessing risks, it’s important not only to consider the risk coming from taking an action, but also from not taking that action. Our world faces a number of potentially existential threats, including global warming and destabilization of the environment, and it’s possible that far more advanced civilizations may have already faced these issues and found solutions. If we don’t send out signals, Vakosh writes, we risk “missing guidance that could enhance our own civilization’s sustainability.” It’s also conceivable, he suggests, that we’re making a spectacular misjudgment — and some super-advanced alien civilization may attack us precisely because we haven’t reached out.

For obvious reasons, much of the thinking about these issues has to be rather speculative. The best way forward, perhaps, is to broaden the discussion. If all of humanity is exposed to the possible consequences trying to contact alien civilizations, then more people should be involved in making decisions about what is wise and what isn’t. It shouldn’t be left to a handful of radio astronomers.

A new frontier is opening in the search for extraterrestrial life

One vocal critic of the idea of reaching out to aliens proactively — astronomer John Gertz of SETI — has developed proposals to move toward more inclusive public consideration of these activities. What we need, he suggests, are laws and international treaties to govern more explicit contact attempts. Without prior broad agreement from some globally representative body, Gertz says, contacting extraterrestrials should be considered “as the reckless endangerment of all mankind, and be absolutely proscribed with criminal consequences, presumably as exercised at the national level, or administered through the International Court of Justice in The Hague.”

Currently, no such prohibitions exist. Some informal protocols for interacting with alien civilizations have been adopted by researchers involved in SETI, but these are far from legally binding governmental regulations. That’s mostly because, up to now, talking about meeting or contacting aliens has seemed widely speculative — if not a little deranged — despite the apparent scientific plausibility of such an event.

It’s not easy to weigh the pros and cons of activities around which so much remains unknown. We don’t know if there are any aliens. They might be friendly. They might not be. Given the potential risks involved with trying to make contact, perhaps it would be safer and wiser to just wait — we can always reach out later, and meanwhile, our abilities to do passive listening are rapidly growing more powerful.

In 2015, SETI launched a new 10-year program called Breakthrough Listen, funded by a $100 million donation from Israeli-Russian billionaire Yuri Milner. As a result, SETI is now recording more signals than ever before, over a frequency range some tenfold larger, and bringing more computational power to bear on analyzing the recorded signals. It’s impossible to know how close or far from making a discovery we may be, but Gertz estimates that our chances are at least 100 times greater than they used to be.

The search is also benefiting from astronomers’ knowledge of exoplanets — planets in orbit around stars other than the sun. Since the first exoplanet was found in 1992, we’ve identified nearly 5,000 more, and the rate of discovery is accelerating. Each one give SETI researchers new promising targets to scrutinize.

Personally, all of this makes me dead-set against any experimentation with attempting to contact other civilizations. Why take cosmic risks when we may have a far safer pathway to discovering them, if they’re out there? Of course, even listening comes with some potentially fraught governance issues also: If and when someone really identifies an alien signal, we’ll need to decide if we should reply — and if so, how. Surely such an act — putting all of humanity at risk — ought to be the result of some collective decision. But there’s no mechanism to encourage that now. Any individual or nation could take the human response into their own hands.

Both paths — listening for aliens or trying to call them — have reached the stage where they require broader public discussion, with an eye to developing sensible regulation. That’s going to take the efforts of leaders from many nations, presumably coordinated through the United Nations or some similar international body. It should happen now. Or soon. Before it’s too late.

#### ETI exists – it’s statistically impossible that we’re alone

Ananthaswamy 20 [(Anil, an author, and science journalist, who is currently a Knight Science Journalism Research fellow at the Massachusetts Institute of Technology. He has been a deputy news editor and staff writer for the London-based New Scientist science magazine) “How Many Aliens Are in the Milky Way? Astronomers Turn to Statistics for Answers,” Scientific American, 7/16/20. <https://www.scientificamerican.com/article/how-many-aliens-are-in-the-milky-way-astronomers-turn-to-statistics-for-answers/>] RR

In the 12th episode of Cosmos, which aired on December 14, 1980, the program’s co-creator and host Carl Sagan introduced television viewers to astronomer Frank Drake’s eponymous equation. Using it, he calculated the potential number of advanced civilizations in the Milky Way that could contact us using the extraterrestrial equivalent of our modern radio-communications technology. Sagan’s estimate ranged from “a pitiful few” to millions. “If civilizations do not always destroy themselves shortly after discovering radio astronomy, then the sky may be softly humming with messages from the stars,” Sagan intoned in his inimitable way.

Sagan was pessimistic about civilizations being able to survive their own technological “adolescence”—the transitional period when a culture’s development of, say, nuclear power, bioengineering or a myriad of other powerful capabilities could easily lead to self-annihilation. In essentially all other ways, he was an optimist about the prospects for pangalactic life and intelligence. But the scientific basis for his beliefs was shaky at best. Sagan and others suspected the emergence of life on clement worlds must be a cosmic inevitability, because geologic evidence suggested it arose shockingly quickly on Earth: in excess of four billion years ago, practically as soon as our planet had sufficiently cooled from its fiery formation. And if, just as on our world, life on other planets emerged quickly and evolved to become ever more complex over time, perhaps intelligence and technology, too, could be common throughout the universe.

In recent years, however, some skeptical astronomers have tried to put more empirical heft behind such pronouncements using a sophisticated form of analysis called Bayesian statistics. They have focused on two great unknowns: the odds of life arising on Earth-like planets from abiotic conditions—a process called abiogenesis—and, from there, the odds of intelligence emerging. Even with such estimates in hand, astronomers disagree about what they mean for life elsewhere in the cosmos. That lack of consensus is because even the best Bayesian analysis can only do so much when hard evidence for extraterrestrial life and intelligence is thin on the ground.

The Drake equation, which the astronomer introduced in 1961, calculates the number of civilizations in our galaxy that can transmit—or receive—interstellar messages via radio waves. It relies on multiplying a number of factors, each of which quantifies some aspect of our knowledge about our galaxy, planets, life and intelligence. These factors include ƒp, the fraction of stars with extrasolar planets; ne, the number of habitable planets in an extrasolar system; ƒl, the fraction of habitable planets on which life emerges; and so on.

“At the time Drake wrote [the equation] down—or even 25 years ago—almost any of those factors could have been the ones that make life very rare,” says Ed Turner, an astrophysicist at Princeton University. Now we know that worlds around stars are the norm, and that those similar to Earth in the most basic terms of size, mass and insolation are common as well. In short, there appears to be no shortage of galactic real estate that life could occupy. Yet “one of the biggest uncertainties in the whole chain of factors is the probability that life would ever get started—that you would make that leap from chemistry to life, even given suitable conditions,” Turner says.

Ignoring this uncertainty can lead astronomers to make rather bold claims. For example, last month Tom Westby and Christopher Conselice, both at the University of Nottingham in England, made headlines when they calculated that there should be at least 36 intelligent civilizations in our galaxy capable of communicating with us. The estimate was based on an assumption that intelligent life emerges on other habitable Earth-like planets about 4.5 billion to 5.5 billion years after their formation.

“That's just a very specific and strong assumption,” says astronomer David Kipping of Columbia University. “I don't see any evidence that that's a safe bet to be making.”

Answering questions about the likelihood of abiogenesis and the emergence of intelligence is difficult because scientists just have a single piece of information: life on Earth. “We don't even really have one full data point,” Kipping says. “We don't know when life emerged, for instance, on the Earth. Even that is subject to uncertainty.”

Yet another problem with making assumptions based on what we locally observe is so-called selection bias. Imagine buying lottery tickets and hitting the jackpot on your 100th attempt. Reasonably, you might then assign a 1 percent probability to winning the lottery. This incorrect conclusion is, of course, a selection bias that arises if you poll only the winners and none of the failures (that is, the tens of millions of people who purchased tickets but never won the lottery). When it comes to calculating the odds of abiogenesis, “we don’t have access to the failures,” Kipping says. “So this is why we’re in a very challenging position when it comes to this problem.”

Enter Bayesian analysis. The technique uses Bayes’s theorem, named after Thomas Bayes, an 18th-century English statistician and minister. To calculate the odds of some event, such as abiogenesis, occurring, astronomers first come up with a likely probability distribution of it—a best guess, if you will. For example, one can assume that abiogenesis is as likely between 100 million to 200 million years after Earth formed as it is between 200 million to 300 million years after that time or any other 100-million-year-chunk of our planet’s history. Such assumptions are called Bayesian priors, and they are made explicit. Then the statisticians collect data or evidence. Finally, they combine the prior and the evidence to calculate what is called a posterior probability. In the case of abiogenesis, that probability would be the odds of the emergence of life on an Earth-like planet, given our prior assumptions and evidence. The posterior is not a single number but rather a probability distribution that quantifies any uncertainty. It may show, for instance, that abiogenesis becomes more or less likely with time rather than having a uniform probability distribution suggested by the prior.

In 2012 Turner and his colleague David Spiegel, then at the Institute for Advanced Study in Princeton, N.J., were the first to rigorously apply Bayesian analysis to abiogenesis. In their approach, life on an Earth-like planet around a sunlike star does not emerge until some minimum number of years, tmin, after that world’s formation. If life does not arise before some maximum time, tmax, then, as its star ages (and eventually dies), conditions on the planet become too hostile for abiogenesis to ever occur. Between tmin and tmax, Turner and Spiegel’s intent was to calculate the probability of abiogenesis.

The researchers worked with a few different prior distributions for this probability. They also assumed that intelligence took some fixed amount of time to appear after abiogenesis.

Given such assumptions, the geophysical and paleontological evidence of life’s genesis on Earth and what evolutionary theory says about the emergence of intelligent life, Turner and Spiegel were able to calculate different posterior probability distributions for abiogenesis. Although the evidence that life appeared early on Earth may indeed suggest abiogenesis is fairly easy, the posteriors did not place any lower bound on the probability. The calculation “doesn’t rule out very low probabilities, which is really sort of common sense with statistics of one,” Turner says. Despite life’s rapid emergence on Earth, abiogenesis could nonetheless be an extremely rare process.

Turner and Spiegel’s effort was the “first really serious Bayesian attack on this problem,” Kipping says. “I think what was appealing is that they broke this default, naive interpretation of the early emergence of life.”

Even so, Kipping thought the researchers’ work was not without its weaknesses, and he has now sought to correct it with a more elaborate Bayesian analysis of his own. For instance, Kipping questions the assumption that intelligence emerged at some fixed time after abiogenesis. This prior, he says, could be another instance of selection bias—a notion influenced by the evolutionary pathway by which our own intelligence emerged. “In the spirit of encoding all of your ignorance, why not just admit that you don’t know that number either?” Kipping says. “If you’re trying to infer how long it takes life to emerge, then why not just also do intelligence at the same time?”

That suggestion is exactly what Kipping attempted, estimating both the probability of abiogenesis and the emergence of intelligence. For a prior, he chose something called the Jeffreys prior, which was designed by another English statistician and astronomer, Harold Jeffreys. It is said to be maximally uninformative. Because the Jeffreys prior doesn’t bake in massive assumptions, it places more weigh on the evidence. Turner and Spiegel had also tried to find an uninformative prior. “If you want to know what the data is telling you and not what you thought about it previously, then you want an uninformative prior,” Turner says. In their 2012 analysis, the researchers employed three priors, one of which was the least informative, but they fell short of using Jeffreys prior, despite being aware of it.

In Kipping’s calculation, that prior focused attention on what he calls the “four corners” of the parameter space: life is common, and intelligence is common; life is common, and intelligence is rare; life is rare, and intelligence is common; and life is rare, and intelligence is rare. All four corners were equally likely before the Bayesian analysis began.

Turner agrees that using the Jeffreys prior is a significant advance. “It’s the best way that we have, really, to just ask what the data is trying to tell you,” he says.

Combining the Jeffreys prior with the sparse evidence of the emergence and intelligence of life on Earth, Kipping obtained a posterior probability distribution, which allowed him to calculate new odds for the four corners. He found, for instance, that the “life is common, and intelligence is rare” scenario is nine times more likely than both life and intelligence being rare. And even if intelligence is not rare, the life-is-common scenario has a minimum odds ratio of 9 to 1. Those odds are not the kind that one would bet the house on, Kipping says. “You could easily lose the bet.”

Still, that calculation is “a positive sign that life should be out there,” he says. “It is, at least, a suggestive hint that life is not a difficult process.”

Not all Bayesian statisticians would agree. Turner, for one, interprets the results differently. Yes, Kipping’s analysis suggests that life’s apparent early arrival on Earth favors a model in which abiogenesis is common, with a specific odds ratio of 9:1. But this calculation does not mean that model is nine times more likely to be true than the one that says abiogenesis is rare, Turner says, adding that Kipping’s interpretation is “a little bit overly optimistic.”

According to Turner, who applauds Kipping’s work, even the most sophisticated Bayesian analysis will still leave room for the rarity of both life and intelligence in the universe. “What we know about life on Earth doesn’t rule out those possibilities,” he says.

And it is not just Bayesian statisticians who may have a beef with Kipping’s interpretation. Anyone interested in questions about the origin of life would be skeptical about claimed answers, given that any such analysis is beholden to geologic, geophysical, paleontological, archaeological and biological evidence for life on Earth—none of which is unequivocal about the time lines for abiogenesis and the appearance of intelligence.

“We still struggle to define what we mean by a living system,” says Caleb Scharf, an astronomer and astrobiologist at Columbia. “It is a slippery beast, in terms of scientific definition. That’s problematic for making a statement [about] when abiogenesis happens—or even statements about the evolution of intelligence.”

If we did have rigorous definitions, problems persist. “We don’t know whether or not life started up, stopped, restarted. We also don’t know whether life can only be constructed one way or not,” Scharf says. When did Earth become hospitable to life? And when it did, were the first molecules of this “life” amino acids, RNAs or lipid membranes? And after life first came about, was it snuffed out by some cataclysmic event early in Earth’s history, only to restart in a potentially different manner? “There's an awful lot of uncertainty,” Scharf says.

All this sketchy evidence makes even Bayesian analysis difficult. But as a technique, it remains the best–suited method for handling more evidence—say, the discovery of signs of life existing on Mars in the past or within one of Jupiter’s ice-covered, ocean-bearing moons at the present.

“The moment we have another data point to play with, assuming that happens, [the Bayesian models] are the ways to best utilize that extra data. Suddenly, the uncertainties shrink dramatically,” Scharf says. “We don’t necessarily have to survey every star in our galaxy to figure out how likely it is for any given place to harbor life. One or two more data points, and suddenly, we know about, essentially, the universe in terms of its propensity for producing life or possibly intelligence. And that's rather powerful.”

#### Contacting ETI is a Pandora’s box – don’t put the future of humanity at risk to satisfy the curiosity of billionaires ­– view this as a decision rule

Buchanan 16 [(Mark, a physicist and science writer based in Europe.) “Searching for trouble?” Nature Physics, 8/2/16. <https://www.nature.com/articles/nphys3852>] RR

The search for signs of intelligent life elsewhere in the Universe has been underway since the pioneering efforts of Frank Drake in the 1960s. Most prominently, the privately funded SETI Institute has scrutinized radio signals for three decades and found nothing, despite widespread belief that the Universe must be teeming with other civilizations. Fermi's paradox — the conspicuous lack of any signs of other intelligences, despite belief that they must exist — lives on.

Of course, the SETI search has only looked at about one in 50 million stars in the Milky Way, and may have simply looked at the wrong ones, or at signals in the wrong frequencies. The programme has also limited itself to a passive search, scanning the sky with increasingly sensitive devices and processing the resulting volumes of data. Active efforts to make contact with extraterrestrials by signal transmission have been far less common. Drake himself sent out a weak message in 1974, and later (reportedly) regretted the act. A few other amateurs have sent out signals, but as yet humanity has not undertaken any serious programme of transmitting strong signals towards specific targets in the hope that someone, or something, might detect them and infer our presence.

Such an approach does seem inherently risky, given our complete lack of information about the kinds of civilizations that may be out there, and the attitude they may take towards us. Yet not everyone shares this view, and there's been a recent movement to initiate a technologically advanced effort to send out signals using, for example, the 305 metre radio telescope at Arecibo, Puerto Rico. The scientists behind the movement — they call it METI, for Messaging to Extra-Terrestrial Intelligence — argue that this is the logical next step now that a passive search has failed to find anything for so long.

“We have almost zero idea of whether aliens are likely to be dangerous.”

The idea is controversial, and rightly so. With access to the right transmitting devices, even one person could unilaterally take a momentous step affecting the future of all humanity, without any broad global discussion or agreement. At worst, the consequences could be catastrophic, as any civilization detecting our presence is likely to be technologically very advanced, and may not be disposed to treat us nicely. At the very least, the idea seems morally questionable. In a recent paper published on the arXiv (https://arxiv.org/abs/1605.05663), John Gertz of the Foundation for Investing in Research on SETI Science and Technology has tried to raise awareness of the issue — and to make the case for continuing with the more conservative passive approach.

You might think that active signalling isn't really risky because the radio waves we use for communications have already been leaving Earth and travelling out into space since the 1930s. As of now, as Gertz points out, such signals have swept over the nearest 7,000 stars. However, this leakage is quite weak; a telescope of Arecibo's sensitivity on a planet in any of those 7,000 star systems would not be able to detect it, although a more sensitive one, of course, might. If aliens' telescopes are like ours, then the chance of our leakage being detected could well dwindle over time as ever more of our communications take place through cables, or over directed satellite links, rather than through simple atmospheric transmission.

Hence, we may be at the end of a window of time during which our normal communications technology has emitted a significant detectable signal. Not so if we begin broadcasting a signal from Arecibo, as proposed by METI supporters Douglas Vakoch and Seth Shostak. Such a signal would be some 100,000 times stronger than the leakage signal of previous decades. It's true, as some METI advocates argue, that Arecibo in its operation as an asteroid-tracking radar has already sent out such signals. Yet these tracking signals wander over the sky, making them very much unlike a beam that would be focused over significant periods of time on a single star system.

It's hard not to see this as gratuitously risky, especially as it would be undertaken for no other reason than to satisfy our deep intellectual curiosity. We have almost zero idea of whether aliens are likely to be dangerous, although the single history of evolving biological life that we know of — here on Earth — carries a strong theme of violent conflict, perpetual battle for resources and the oppression of weaker groups by stronger ones. Yet, as Gertz points out, many METI enthusiasts follow a naive faith that any advanced alien civilization will also be morally advanced and will aim to interact with us peacefully.

In fact, one idea favoured by METI-ists is a version of the so-called zoo hypothesis put forward as one possible solution of the Fermi paradox. This idea holds that we've never seen aliens, despite their presence throughout the Universe, because the aliens have decided to leave us alone. As a result of their moral advancement, alien civilizations view lesser-developed parts of the Universe — those with still young civilizations — as wilderness areas or nature preserves to be protected and left undisturbed, at least until the intelligences within them reach out with signals showing their desire to make contact. Having made this assumption, METI-ists then assert that it's time for us to do so.

Gertz is right that this is nothing more than a grand and very dangerous assumption with absolutely no backing. And this is among the reasons that many scientists have strongly criticized the METI proposals, which have, so far, been roundly rejected. It seems far wiser to wait, and continue the developing passive search programme already established by the SETI Institute, which is due to accelerate in the near future. Just last year, businessman Yuri Milner donated US$100 million over ten years to help boost the project. One day it may even get public funding.

We have no understanding of how close passive SETI search may be to discovery. It could come with the next advance in sensitivity, as happened with the search for gravitational waves. Meanwhile, technology is driving rapid progress in computing resources, in the knowledge of the locations of exoplanets that are likely to be suited to life and in astronomical technique in general.

Patience must be among the qualities any mature and advanced civilization should possess. We would do well to exercise such patience, while ensuring that the least patient among us cannot access the technology that would let them take matters into their own hands.

### 1AC – Plan

#### Plan: The appropriation of outer space for the Search for Extraterrestrial Intelligence by private entities is unjust.

### 1AC – Solvency

#### Only legislative action can solve

Gertz 16 [(John, the president and CEO of Zorro Productions, Inc., which he founded in 1977.) “POST-DETECTION SETI PROTOCOLS & METI: THE TIME HAS COME TO REGULATE THEM BOTH,” JBIS, 2016. <https://arxiv.org/pdf/1701.08422.pdf>] RR

National legislative bodies could pass laws against METI, explicitly citing it as a violation of the Space Treaty, and explicitly enumerating criminal penalties. No other action could be stronger than this. In the United States, a METI-ist’s only recourse would be a court ruling, overturning the legislation, presumably on free speech grounds.

Such legislation might also specify that the fact of a detection can be made public by the scientists who made it, but the coordinates and content should go only to the President of the U.S., who, with his national security team, can determine from there whether and what information to release to the public. The advantage of national laws over international treaties is that criminal penalties are normally administered at the national level. So even in the presence of treaties, national laws can act as an enforcement buttress.

5.7 FCC, NSF and NASA Regulations Against METI

Relevant agencies of the Federal government, even in the absence of international agreements, can adopt rules proscribing METI and limiting unintentional METI along the lines already suggested. The FCC could ban METI transmissions; NSF could prevent facilities managed by it, such as Arecibo, to be used for the purposes of METI. NASA’s Office for Planetary Protection could also weigh in. This office has the authority to quarantine sample return missions so that they do not inadvertently contaminate our planet with unknown biohazards from outer space. It also oversees NASA’s efforts to avoid contamination of Solar System bodies by our landing craft. Clearly this office has an interest in the potential harm to planet Earth that METI might cause.

#### Only the aff can solve – spurs international discussion against SETI

Azuza-Bustos et al. 15 [(Armando, Astrobiologist Armando Azua-Bustos is the CEO of Atacama Biotech, where he's working to find and characterize species that are able to survive in the extreme conditions imposed by the Atacama Desert in Chile.) “ REGARDING MESSAGING TO EXTRATERRESTRIAL INTELLIGENCE (METI) / ACTIVE SEARCHES FOR EXTRATERRESTRIAL INTELLIGENCE (ACTIVE SETI) :” UC Berkeley, 2015. <https://setiathome.berkeley.edu/meti_statement_0.html>] RR

Messaging to Extraterrestrial Intelligence (METI), also called Active Searches for Extraterrestrial Intelligence (Active SETI), refers to the act of using high power communications equipment on Earth to transmit various messages to unknown extraterrestrial intelligences.

METI has been conducted sporadically in the past, but recently a surge of individuals and organizations have initiated or suggested new METI programs, both academic and commercial in nature. METI programs carry unknown and potentially enormous implications and consequences. We feel the decision whether or not to transmit must be based upon a worldwide consensus, and not a decision based upon the wishes of a few individuals with access to powerful communications equipment. We strongly encourage vigorous international debate by a broadly representative body prior to engaging further in this activity. We also note the following:

- ETI’s reaction to a message from Earth cannot presently be known. We know nothing of ETI’s intentions and capabilities, and it is impossible to predict whether ETI will be benign or hostile.

- Because we have just recently (in cosmic terms) attained an interstellar communications capability, it is likely that other communicative civilizations we encounter will be millions of years more advanced than us.

- The Search for Extraterrestrial Intelligence, the scientific effort to determine whether or not other advanced life exists in the universe, is still in its infancy. Even though SETI experiments have been ongoing for more than 50 years, scientists are still decades away from completing a comprehensive search for radio signals similar to those produced by our own technology. As a newly emerging technological species, it is prudent to listen before we shout.

- Although a nearby advanced ETI may have already picked up earth’s omni-directional radio leakage, e.g., early television transmissions, or the presence of industrial wastes in the atmosphere of the earth, such detections are far more difficult than detecting a focused radio or optical signal sent from a large telescope.

- It is not necessary to actually transmit powerful electromagnetic signals in order to study interstellar communication from the perspective of the transmitter, or to develop transmission techniques that might one day be used to respond to a message received from an ETI.

- Opponents of METI would vocally condemn METI transmissions, confusing the public about, and imperiling funding for, bona fide scientific endeavors related to extraterrestrial life.

Intentionally signaling other civilizations in the Milky Way Galaxy raises concerns from all the people of Earth, about both the message and the consequences of contact. A worldwide scientific, political and humanitarian discussion must occur before any message is sent.

### 1AC – Framing

#### You are biased against the existence of ETI – scenario planning about first contact is key to preventing extinction

Neal 14 [(Mark, Department of Financial & Management Studies, SOAS, University of London, Thornhaugh Street, Russell Square, London, WC1H OXC, UK.) “Preparing for extraterrestrial contact,” Palgrave macmillen, May 2014. <https://www.jstor.org/stable/pdf/43695437.pdf?refreqid=excelsior%3A4c26eb78e1dddad6797290065958b84a&ab_segments=&origin=>] RR

As current scientific research is suggesting, given the age of our universe there is the possibility that technologically advanced alien civilisations have arisen that have been able to identify distant planets with thriving ecosystems, such as our own. Indeed, there is, as Musso (2012) discussed, the possibility that extra- terrestrials have already identified and visited our planet; and many UFO enthusiasts, and general members of the public are convinced that they are still here (Harrison, 2005). The likelihood of previous alien visitation and current presence depends very much upon the rarity of planets with thriving ecosys- tems. As astrobiological research is demonstrating, it appears likely that many planets in our galaxy have ecosystems in various stages of development (Petigura et al, 2013). The larger the number of planets with ecosystems out there, the smaller the likelihood that ours would have been chosen for a probe or mission. We may be one of tens of millions of living planets in our galaxy alone (Atkinson, 2013). If aliens were venturing out for colonial, scientific or exploitative purposes, it is likely that they would target their nearest viable planets (Maccone, 2011).

Earth began to differentiate itself from these other living planets when humans began altering our atmosphere through industrialisation; and, later, began broadcasting electromagnetic information, about 70 years ago. With various probes going into space, we have sent out the message that Earth is not merely one of many living planets, but one hosting a technologically advanced civilisation. Whereas there may have been obscurity (and safety) in numbers before the industrial and telecommunications ages (amidst other living planets), our status and recognisability have radically changed. Although alien civilisa- tions may not have visited here already, we have increased the likelihood that a message or a visitation will be underway.

Whatever the absolute and relative likelihood of these five scenarios, it is important that they are critically discussed from a realist perspective within the social and managerial sciences. As our annunciatory electromagnetic bubble expands at the speed of light, ignoring these scenarios and the threats they highlight is plainly imprudent (see Bostrom, 2013) - of course, to what degree is a matter of debate. At the moment, we resemble pre-industrial inhabitants of an isolated island, who see the horizon as the end of the universe. As we know from history, when vast ships unexpectedly appear over the horizon, the prospects for such communities are not good (Hawking, 2010) - with the indigenous population often experiencing radical cultural and technological change, ethnic cleansing, colonialisation and/or disease through microbial incursion. As scientific evidence for extraterrestrial life increases, it becomes intellectually incumbent upon scholars in the social sciences to approach such issues not merely from social constructionist viewpoints, but from realist theoretical positions as well. Doing so will naturally raise issues of our preparedness (Perry and Lindell, 2003).

We have reached a stage in scientific research whereby exoplanets able to bear life have been identified, and major scientific programmes are seeking evidence of extraterrestrial life itself. At the same time, however, the prospects of contact, visitation or indeed the presence of aliens are still treated as peripheral, marginal issues by governments, policymakers and social scientists. However, a string of ones and zeros emanating from space will at a stroke reconfigure our understanding of our place in the universe (Tough, 2000). The evaluation of extraterrestrial risks will become a pressing priority, and will constitute a core focal concern for the fields of risk management, and disaster management and prevention. At present, the discipline is lagging behind the startling findings of natural scientific research, and is itself unprepared for the intellectual and theoretical implications of further scientific findings and developments. With the publication of this article, it is hoped that disaster prevention and management studies can begin a realist debate about the likelihood and implications of extraterrestrial contact.