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Imaginative Cosmos: The Impact of Colonial Heritage in Radio Astronomy and the Search for Extraterrestrial Intelligence

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NASA launched its first search for extraterrestrial intelligence (SETI),[1] the High-Resolution Microwave Survey (HRMS), on the five-hundredth anniversary of Columbus Day, October 12, 1992 (fig. 1). This article will show that astronomers' simultaneous embrace of this historical projection and unease with its implications illustrates the unsettled nature of the physical, social, and disciplinary grounding always implicit in their search. As one scientist put it, in celebration, "we are listening for voices across oceans of space just as we once sailed the high seas, not knowing what lands of peoples awaited us."[2] The SETI group had long been interested in learning from the history of "first contact" between foreign civilizations as a proxy for extraterrestrial (ET) contact, often employing frontier rhetoric and historical analogies in their pursuit of ET. As I will show, SETI scientists typically subscribed to a progressive social evolutionist understanding of alien as well as Earth civilizations and used such ideas to promote the categorization of cultures. Many assumed the "inevitable expansion" of civilizations, such as Soviet scientist Nikolai Kardashev, who created a "scale of civilizations" ranked by how much of their galaxy the extraterrestrials had conquered. Such a mentality sometimes led to extreme points of view—the astrophysicist Michael

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Figure 1. *Poster from Inauguration of High-Resolution Microwave Survey. Papers of Kenneth I. Kellerman, National Radio Astronomy Observatory Archives.*

Hart, for example, became famous for his SETI paper on "intergalactic colonization" that depicted the universe as necessarily subject to expansionist colonization from technologically progressive beings.[3]

My examination of the colonial rhetoric undergirding celebratory SETI helps show that even this most future-centered science was importantly historical. But there are two further senses in which I will argue that treating this branch of radio astronomy—SETI—as a settler science better enables us to recognize the determinist and orientalist nature of its foundations. The first is based on the physical locations of SETI sciences, the second on its disciplinary homes. The tools and techniques developed for SETI also required the use of colonized spaces on Earth. At the opening ceremony of the NASA SETI project in Goldstone, California, one astronomer commented on the challenge of communicating between California and the Arecibo Telescope in Puerto Rico: "We're trying to do some interstellar communication and at the same time we're trying to [speak] with a small island in the Caribbean."[4] Radio telescopes are generally located in remote locations, but this technical reality creates a social problem. This is the paradox of settlement in radio astronomy and SETI: the scientific and technical requirements necessitate a space that is unsettled (or, more significantly, *nearly* unsettled). Yet there is no true *terra nullius*; developing remote sites nearly always requires dealing with vulnerable populations, and often colonized land.

Many radio telescope projects have led to the displacement of local populations[5] or conflict with Indigenous peoples.[6]

Yet it would be too simplistic to argue that all SETI scientists uncritically utilized colonial rhetoric or imperial power. As this paper will highlight, there was instead an ongoing struggle within the discipline on how to contextualize this enterprise, with some scientists being deeply critical of others in their comparisons of SETI's mission to colonialism. In trying to combat their situated perspectives, some SETI scientists saw value in reaching across disciplinary boundaries, with the aim of fostering contact and communication between the sciences and with humanities scholars to create a SETI that aimed to represent a full picture of humanity. Nevertheless, even when attempting to synthesize interdisciplinary perspectives, SETI scientists' image of the exotic was shaped by the familiar, and when seeking to go beyond that they still often exhibited unconscious residues of their particular social power. Therefore, I will argue that the inability, or disinterest, in engaging with paradigms outside of the dominant Euro-American framework has hindered SETI's creative thinking, leading to searches and messages limited by their dependency on deterministic perspectives. A dependence on colonial, patriarchal, or racialized metaphors, as well as a failure in self-reflection, ultimately hampers SETI's ability to achieve its fundamental goal of identifying and communicating with other forms of life and intelligence.

The Cosmic Manifest Destiny

Before addressing the specifics of early SETI colonial discourse and its impacts on the products of the field, it is first important to recognize the broader rhetoric of astronomy and space science in the 1960s to contextualize the atmosphere in which SETI developed. It has been well established within historical and sociological literature that colonial rhetoric was utilized in the promotion of American science, especially government-funded science, in the mid-twentieth century.[7] The frontier myth was an especially popular tool employed to drive or justify government investment in science, particularly at the start of the Cold War, when the United States was crafting a new national narrative. One of the most notable early uses of the frontier myth in the promotion of science investment was Director of the Office of Scientific Research and Development Vannevar Bush's report to President Roosevelt in 1945, titled "Science—The Endless Frontier." Sometimes referred to as the "Magna Carta of American science," the report laid the groundwork for future American funding systems for the sciences, which were set to undergo tremendous change at the end of World War II.[8] Bush recognized that the "postwar" period was "a high-water mark for American trust in science" and aimed to cement this trust by crafting a manifesto that argued investment in science was fundamentally American, and central to the goals of the newly empowered United States.[9] He chose to evoke the frontier myth as justification for US investment in science, arguing that pioneering frontiers was intrinsic to American identity:

> It has been basic United States policy that Government should foster the opening of new frontiers. It opened the seas to clipper ships and furnished land for pioneers.

> Although these frontiers have more or less disappeared, the frontier of science remains. It is in keeping with the American tradition—one which has made the United States great—that new frontiers shall be made accessible for development by all American citizens.[10]

Bush's arguments parallel those made fifty-two years earlier by historian Frederick Jackson Turner. In his 1893 essay "The Significance of the Frontier in American History," Turner first introduced his "Frontier Thesis," which posited that colonization and the settlement of the frontier is the defining feature of "Americanization."[11] Turner defined the frontier as "the outer edge of the wave—the meeting point between savagery and civilization," and argued that this liminal space between European civilizations and "winning a wilderness" transformed the settler into something new—something purely American.[12] So intrinsic was the frontier to American identity, Turner argued, that although "the frontier is gone … the American energy will continually demand a wider field for its exercise."[13] The frontier became more than a physical location, operating instead as a powerful symbol of a specifically "American" imagination, strategically drawn on by many seeking to persuade others to invest in particular projects.

Historians have successfully interrogated the use of the frontier myth in twentieth century physics and space sciences and found that it was not used simply for patriotic embellishment; on the contrary, frontier rhetoric served a practical and utilitarian purpose. In *Fermilab: Physics, the Frontier & Megascience*, Hoddeson, Kolb, and Westfall argue that physicists continue to use colonial metaphors in proposals because "government funding bodies still respond well to frontier rhetoric."[14] This was especially true in the 1960s, when a new US myth was emerging, one that purported "that two superpowers—two civilizations—can have a standoff, but that eventually, one system will triumph and subsume the other," evoking the success of the United States against the frontier in its new standoff against the Soviet Union.[15]

What began with Bush's call for scientific investment in 1945 led to many further cases of scientists and politicians evoking frontier rhetoric for funding support. In 1962, for example, President Kennedy evoked manifest destiny in his renowned speech to Rice University in Houston, Texas to garner public support for the expensive moonshot, proclaiming "what was once the furthest outpost on the old frontier of the West will be the furthest outpost on the new frontier of science and space."[16] Even within contemporary space discourse, the frontier myth is still particularly effective in aiding those seeking funding. On July 15, 2018, during the US Congress Subcommittee on Space, Science, and Competitiveness, for example, Senator Ted Cruz supported investment in a crewed Mars mission by claiming, "I don't know what they will discover, or what they will accomplish, but I think it is every bit as vast and promising a frontier as the New World was some centuries ago."[17]

The "new world" narrative was similarly echoed in SETI funding struggles, of which there were many. Although contemporary SETI began in 1960, the first NASA-funded observing project, the High-Resolution Microwave Survey, did not begin its planning until the 1970s, perhaps due to what is sometimes called the "giggle factor." Because of its affiliation with science fiction, SETI has long struggled to gain

respectability in the scientific community at large, as well as among those responsible for providing funding for science projects. For example, in 1978, US Senator William Proxmire nominated the HRMS, initially named the Microwave Observing Project (MOP), for a "Golden Fleece Award," which was a derisive monthly list of research projects that received federal funding that Proxmire considered to be a waste of taxpayers' money.[18] Examples of other Golden Fleece awardees included a National Institute on Drug Abuse project that studied "marijuana's effect on sexual arousal" and a Pentagon study that aimed "to determine if people in the military should carry umbrellas in the rain."[19] Proxmire's ire and mockery resulted in lost SETI funding for that fiscal year.

In justifying the need for the funding to be reinstated, SETI scientist Frank Drake smartly evoked the frontier myth, claiming: "When Christopher Columbus left Spain, there was no evidence the New World existed." In doing so, he hoped this comparison would demonstrate that some theories only seem ridiculous until proven otherwise.[20] It was possibly an effective tactic; funding was reinstated the following year, and the rebranded and renamed HRMS capitalized on Columbus rhetoric in its promotional materials, which included the aforementioned poster. Yet in employing Columbus rhetoric to promote its mission, the project unwittingly betrayed a significant but probably unintended link between SETI and colonialism that I will show was manifest in both the spaces their instruments occupied and the metaphysical tools they employed in their search.

Physical Homes: "Before You Look into Space, You Need to Respect This Place"

The contemporary search for extraterrestrial intelligence is generally considered to have begun with the 1960 launch of Drake's Project Ozma, which used an eighty-five-foot telescope to observe two nearby star-systems, Tau Ceti and Epsilon Eridani.[21] Drake conducted these observations in a staff scientist position at the National Radio Astronomy Observatory (NRAO), which had been established several years prior as one of the first major investments by the newly created National Science Foundation (NSF). The site that had been selected for the observatory, and where Project Ozma was undertaken, was Green Bank, West Virginia. The decision to place the first US radio observatory in Green Bank was made for both technical and strategic reasons.[22]

Situated in a valley amidst the Allegheny mountain range, the National Radio Astronomy Observatory sat on 2,700 acres of land acquired by the US Army Corps of Engineers on behalf of the NSF in 1956.[23] When searching for a site for the observatory, the NSF was specific in its desire to find a location that was remote and radio-quiet. In the "site specifications" section of the "Plan for a Radio Astronomy Observatory" document, the NSF outlined that the most important factors in the siting were that the observatory "should be at least 50 miles distant from any city or other concentration of people or industries, and should be separated from more distant concentrations by surrounding mountain ranges."[24] Green Bank fit all the specification goals, with only 125 buildings and "a population in decline"; that the

location was economically depressed and vulnerable was in fact a draw, not a detraction, for the NSF.[25]

Astronomers have long sited their telescopes in remote locations. In optical astronomy observatories, a primary consideration in location is light pollution. Optical telescopes perform best when set in a dark, dry, and high-altitude environment, which minimizes interference from city lights, humidity, and atmospheric disturbance. Therefore, many optical telescopes are located in secluded areas, away from large cities. Although light is not much of a factor in the successful performance of radio telescopes, they too benefit from being located far away from large cities. This is because radio telescopes cannot perform meaningful observations with too much radio frequency interference (RFI) present. RFI is generated by sources that create a disturbance by generating changing electrical currents which are detected by radio telescopes. Such disturbances may appear simply as elevated "noise" or as a strong local signal that overshadows fainter cosmic sources. RFI can be caused by both man-made and natural sources, such as cellular networks, lightning, ignition systems, and radio towers. In the case of Green Bank and NRAO, to further isolate the observatory from RFI, in 1956 the Federal Communications Commission (FCC) established an area of about 13,000 square miles as the National Radio Quiet Zone (NRQZ), which placed restrictions on radio broadcasting in the area.[26] As a result, Green Bank and the surrounding area have limited radio stations, cellular signal, and Wi-Fi.

In part because of this radio silence, Green Bank occasionally makes the news as a unique place that embodies paradoxical dualities. Headlines describe Green Bank as "The Quietest Town in America" or "The Land Where Wifi Ends."[27] Against the backdrop of a rural country landscape, the people who live in Green Bank sometimes sound like they have time-traveled from a distant past when people used landline telephones and ethernet cables. Even the cars they drive are a blast from the past; since sparkplugs from standard gasoline engines generate RFI, retro-looking diesel trucks roam the site. Yet despite the appearance of being frozen in a time before technology consumed American life, Green Bank is also a window into a high-tech future. The Observatory is littered with posters that read "The Universe Is Whispering to Us", and images of aliens are scattered throughout the grounds. The Green Bank Telescope, silhouetted against the ancient Allegheny Mountain range, is a spectacular feat of engineering and technological innovation.

In addition to being the first observatory to conduct a radio search for extraterrestrial intelligence, the observatory is responsible for some of the greatest discoveries and accomplishments in twentieth- and twenty-first-century astronomy, ranging from discovering compact ionized hydrogen regions to making the first transcontinental observations using very long baseline interferometry—a technique that improves telescope resolution by correlating data from disconnected apertures located at great distances from one another.[28] These feats could not have been accomplished without the establishment of the NRQZ and the isolated, radio-quiet environment of the observatory site. Yet this technical reality creates a social problem in that developing remote sites nearly always requires dealing with vulnerable populations, and often, colonized land.

Figure 2. *A view of the Green Bank Telescope, Green Bank Observatory, Green Bank, West Virginia. Photo by the author.*

The needs of the space sciences community have always required the use of land that has been designated "unused" or "wild." In her article on the locality of space infrastructure on Earth, space archaeologist Alice Gorman has noted that although "the space enterprise [is] often represented as the ultimate in global culture: a profoundly human aspiration that unites all people in all places," the reality is that it "remains rooted in places on the surface of the Earth." Furthermore, because the science-technical requirements often necessitate remote locales, the "distribution of space installations does not necessarily coincide with the location of the principal financiers, users and scientists of space exploration."[29] Instead, she observes, "launch facilities tend to be located in areas regarded as underdeveloped and remote from the metropole: Algeria, New Mexico, Kazakhstan, Australia, French Guiana."[30]

The framework Gorman applies to aerospace similarly applies to astronomy. Green Bank, for example, is located in Pocahontas County, named for the daughter of the Powhatan chief who was later presented in England as an example of a "civilized savage."[31] The land was once the hunting grounds of the Iroquois, preserved by a 1758 treaty with Great Britain that forbade settlers from coming there.[32] A little over a decade later, however, with the start of the American War of Independence, the treaty was disregarded by the newly established United States, and the land was settled anyway. By the time the observatory settled in Green Bank in the 1960s, the Indian Removal Act, local violence, and disease had decimated the Indigenous population, and today there are no federally recognized tribes in West Virginia.[33]

Since Green Bank's colonial past is quite distant in time, and forced migration left no population to protest, the observatory does not typically experience conflict with the local community. On the contrary, due to its location in an otherwise economically depressed area, West Virginia is extraordinarily proud and supportive of the observatory. But this is not the case for many other observatories. Historian Leandra Swanner has written extensively on conflict arising from the siting of optical telescopes in places of cultural or spiritual significance to Indigenous communities—most

notably the Thirty Meter Telescope on Mauna Kea in Hawaii and the Mount Graham International Observatory in Arizona.

In the case of Mount Graham, the University of Arizona partnered with the Vatican, as well as several other European governments and American institutions, to build three telescopes, including one that was advertised to be "the world's largest telescope" on top of the mountain.[34] Due in part to the fact that the Italian government, as well as the Vatican, were involved in the project, the telescope was originally planned to be named "Columbus," drawing on his status as a symbol of Italian pride as well as the association with "discovery."[35] The local Apache community was infuriated by what they perceived as "the culmination of 500 years of cultural oppression inaugurated by the arrival of Columbus in North America."[36] Concerned that the observatory's presence would "[impede] the flow of prayers through the mountain," which had long served as part of a sacred tradition to the culture, they staged a protest on the University of Arizona campus on Columbus Day 1992—the same day the HRMS was being inaugurated, 600 miles away. Their concerns were not unfounded; although the telescope would later be renamed the Large Binocular Telescope (LBT), several years later in 1997, an Apache man named Wendsler Nosie was arrested for trespassing after climbing the summit of the mountain to pray for his daughter. After national outrage at the arrest, the university "developed a permit policy that required Native Americans . . . to submit a written request to the observatory 'at least two business days' in advance of the planned prayer on the mountain."[37] The "prayer permit" is just one example of the lack of historical insight and respect the observatory held for the Native community and the settled land it occupied, a recurring theme in the history of the relationship between observatory sites and their local populations.[38]

In a more recent case of conflict between colonized communities and a large observatory project, the construction of the Thirty Meter Telescope (TMT) on Mauna Kea in Hawaii has sparked protest and international media coverage. The TMT is just one of thirteen telescopes on Mauna Kea and as such is sometimes referred to by the Native community as "Too Many Telescopes."[39] Since several telescopes have occupied Mauna Kea since the early 1960s, when federal investment in large science projects led to the construction of many observatories and telescopes around the country, astronomers sometimes express confusion at the specific anger over TMT. Yet protesters claim the issue goes beyond a single telescope. Their concerns about the placement of the telescope are fueled by the perception of prolonged disrespect and lack of communication between the astronomers and the Indigenous population. As one Hawaiian activist, Joshua Lanakila Mangauil, asserted: "Before you look into space, you need to respect this place."[40]

The problem of settled land and community-technical conflict similarly applies to radio astronomy observatories, including those utilized by the SETI community. For example, in the late 1960s NRAO began planning the construction of the Very Large Array (VLA), which was to consist of twenty-seven twenty-five-meter dishes, arranged in three arms that would stretch approximately twenty-one kilometers long. A project such as that required not only the right environment, but an incredibly large stretch of land. A decision was made to site the telescope on the Plains of St. Augustine, a

remote desert location in New Mexico. Unfortunately, many ranchers used that land for grazing cattle, and objected to the government condemnation of their land.[41] All of the ranchers who owned land being seized at the end of each arm of the telescope sued the government, and the cases had to be settled in court.[42] Additionally, New Mexico itself was situated on settled land which historically belonged to several Indigenous cultures, including twenty-three sovereign nations that still today call New Mexico home.[43] Because of the recognition that "undeveloped" land in New Mexico might have once been the site of thriving civilization, New Mexico state law requires an archaeological inspection for any large project involving land, and the VLA project was forced to spend nearly $100,000 on an excavation that "uncovered more than 3,000 artifacts dating back as much as ten thousand years."[44] Nonetheless, the VLA's construction was subsequently approved and the telescope was formally dedicated in 1980.[45] The VLA has been used for SETI and is perhaps most famous for its appearance in the science fiction film *Contact* (1997), based on the novel by Carl Sagan, in which an alien civilization from the Vega star system succeeds in communicating with radio astronomers on Earth.[46]

Other SETI-affiliated telescopes have faced problems with the local community. One of the key radio telescopes used in NASA's HRMS project, the Arecibo Telescope at the Arecibo Ionospheric Observatory, is located in Puerto Rico, often considered one of the oldest colonies in the world, having been under some form of occupation or settlement since shortly after Columbus landed there in 1493.[47] Once a Spanish territory, Puerto Rico came into US possession after its victory in the Spanish-American War in 1898, fueling its newfound imperialist aspirations. Unlike previously acquired lands, however, the US deemed Puerto Rico "full of 'alien races' who couldn't understand 'Anglo-Saxon principles.'"[48] Therefore, instead of statehood, the Supreme Court Insular Cases of 1901 decided Puerto Rico would become "unincorporated territory" and its inhabitants would have no automatic path to citizenship.[49] Sixteen years later, however, during World War I, President Wilson signed the Jones-Shafroth Act, which gave Puerto Ricans statutory citizenship, and soon after Puerto Rican men were drafted for the war effort. Their bodies, which because of their "alien" nature were seen as more capable of fighting in tropical environments, would be used to defend the Panama Canal, but they would not be given constitutional citizenship.[50] To this day, Puerto Rico has no representation in Congress, even though the nation-state utilizes their bodies in war.[51]

In part due to this deleterious history, protests against the US military are common in Puerto Rico, where the United States maintains several bases. Some Puerto Ricans protested the Arecibo Observatory in the 1990s because of perceived affiliation with the US military, with protesters making claims that "scientists are doing military experiments" at the observatory site.[52] The observatory denied the claims, but Puerto Rican concerns about military projects in Arecibo were not unfounded, given the significant connection between radio astronomy facilities and the military and intelligence communities. In fact, when the Arecibo telescope was in development in the late 1950s, the Advanced Research Projects Agency (ARPA) of the US Department of Defense expressed an interest in the telescope, as studies of the ionosphere aided

in the agency's DEFENDER assignment, which sought to develop "technologically advanced defense against extra-atmospheric offensive vehicles, including space vehicles and ballistic missiles."[53] Given the long history of military occupation of the island, many Puerto Ricans are understandably hostile to US military activities on their land. Clearly, the siting of telescopes concerns not only the necessary technical and scientific specifications, but is immersed in politics, cultural tensions, and power.

Of course, this is not to suggest that conflicts exist between all local communities and observatories. As Alice Gorman points out, "space installations involve the creation of technological enclaves, isolated from local life, but promising benefits from participation in the global economy."[54] To some extent these benefits are genuine; like much of West Virginia, Green Bank and the surrounding area is economically depressed, with the observatory providing much-needed jobs and tourism. And although some Puerto Ricans protest against Arecibo, others find it a point of tremendous pride. In an NSF public comments report on Arecibo, Kalpana Arun, a high school teacher in Arecibo stated, "[The telescope] is a proud badge of distinction that the USA has bestowed on its last colony. It is the 'world's largest'; it is the place where a Nobel prize was won. . . . My students kept track of any news about 'El Radar' and expressed pride over the geographic proximity of such great happenings."[55]

Furthermore, many observatories make great strides to create benefits and connections with the local communities. The planned Square Kilometre Array in Western Australia's Murchison Desert, for example, highlights bringing economic gains to a remote and impoverished area, with their website taking care to note under the "Opportunities and Benefits" section that the "Wajarri Yamaji people" are the titleholders for the land the project will occupy.[56] Regardless of positive impact, however, the observatories are still enshrouded in a legacy of colonialism; in regard to SETI, that colonial heritage sometimes shapes the character of the search and message. The Arecibo telescope, for example, is best known in the SETI community for the message Drake sent from the telescope in 1974, aimed at globular star cluster M13.[57] The message was designed to send basic information about Earth and its population to extraterrestrial intelligence. It included a symbolic depiction of a human figure, with a height of 5 feet, 9.5 inches tall—the height of the average United States man.[58] The island, which had only sixty years earlier been declared filled with "alien races," became the first on Earth to attempt to make radio contact with the truly alien, but with a representation of humanity that defaulted to that of an American man.

Disciplinary Homes: Imaginative Cosmos

As the US-male-centric theme of the Arecibo message demonstrates, the connections between SETI and colonialism existed beyond their occupation of settled land or use of frontier rhetoric borrowed from the space race. These connections are also embedded within the disciplinary homes of SETI and specifically manifest in the misapplication of humanistic assumptions and theories that have been subsequently questioned by humanities scholarship. In *Orientalism* (1978), Edward Said argued that nineteenth-century studies of "the Orient" created "imaginative geographies"—that

is, they envisioned peoples and civilizations that were more defined by their sense of "otherness" than any empirical reality about land, space, and people.[59] These imaginative geographies were based "on a very unrigorous idea of what is "out there," beyond one's own territory."[60] Stemming from this idea, Said claimed that "all kinds of suppositions, associations, fictions [appeared] to crowd the unfamiliar and strange space outside one's place."[61] In that sense, these imaginative geographies were mental playgrounds, where Europeans could superimpose their fantasies, desires, and fears upon landscapes and peoples they had never encountered.

There is perhaps no better illustrative example of this phenomenon than the odalisque in art history. The odalisque was a representation of a woman, or concubine, in a harem setting, as imagined by European men who, by and large, had never visited the Middle East, but had heard salacious and titillating rumors of these spaces reserved for women from colonial officers returning to Europe. When French artist Jean-Auguste-Dominique Ingres painted *La Grande Odalisque* (1814), he presented a serpentine woman, nude, with a largely European appearance, lying exposed to the viewer, surrounded by items of luxury such as silks and a peacock feather duster. *La Grande Odalisque* is an image imbued with eroticism and fantasy—so much so that the woman in the painting could not exist as she is portrayed. Her limbs are extended, and her spine is curved in an unnatural manner. The side of her breast is on view, but in such an unnatural position it would have been located in her underarm if she were a real woman. This non-naturalistic depiction of the female form was not the product of a lack of anatomical skill on Ingres's part; rather, that the viewer is shown the titillating parts of a woman regardless of anatomical and cultural realism demonstrates the allure of this depiction of these imaginative geographies.

Just as Orientalism produced formative imaginative geographies, SETI also created a mental playground, an "imaginative cosmos," in which astronomers could superimpose their cultural fantasies and predictions of an exotic other which may or may not exist. After all, no extraterrestrial civilizations have been discovered, yet there are scores of publications speculating how to search, what we might find, and how we might communicate with what we might find. The extraterrestrial is the ultimate Odalisque, a vision of possibilities upon which SETI scientists could project their desires and fantasies, and as we shall see, as with the Odalisque, SETI scientists' strategies often reflected common assumptions about power and gender.

As illustrated earlier in this article, many of the SETI scientists, both implicitly and explicitly, positioned themselves as Columbus-like figures. Yet the Columbus metaphor, although popular in early SETI discourse, was sometimes used in an interestingly inverted sense, imagining the extraterrestrial aliens as "super civilizations" with technological abilities far beyond current human capacities. This phenomenon is perhaps best seen in the work of Soviet astronomer Nikolai Kardashev, whose concept of the cosmic "scale of civilizations," now referred to as the "Kardashev Scale," became a popular tool within SETI. The scale was first described in a 1963 paper titled "The Communication of Information by Civilizations On Other Worlds" in the major Soviet astronomy journal, *Astronomicheskii Zhurnal*.[62] Kardashev, a young scientist working at the Shternburg Astronomical Institute in Moscow, sought a method for

identifying artificial extraterrestrial sources. He did so by addressing the matter of transmission power, which he believed would be a hallmark of any technologically advanced civilization.

In any given civilization, Kardashev assumed, the rate of transmission of signals would be dependent on the amount of power available to that civilization.[63] He decided to chart this in a scale that outlined three types of extraterrestrial civilizations that could be searched for. Type I was designated as a civilization with a "technological level close to the level presently attained on the earth."[64] Type II was a "civilization capable of harnessing [all of] the energy radiated by its own star."[65] In this part of the description, Kardashev made a reference to what he called a "Dyson sphere." In postulating upon the "largest feasible technology" SETI scientists could look for, the British-American physicist Freeman Dyson had earlier imagined a biosphere built around a star, exploiting the whole energy output of the star—a high-tech extension of the natural resource extraction economies on Earth.[66] Kardashev pushed the concept of large-scale extraction technology a step further with his Type III description: "a civilization in possession of energy on the scale of its own galaxy."[67] In creating this scale, Kardashev attempted to argue that SETI searches should be largely dedicated to looking for "super civilizations" instead of Earth-like ones. Carl Sagan later applied the Kardashev scale to Earth, giving it a 0.7 ranking.[68] In doing so, he demonstrated how SETI scientists projected their understanding of technological and cultural evolution onto both Earth and alien civilization.

In applying the scale of civilizations to Earth, Kardashev and Sagan made an assumption about the nature of civilization that was both highly deterministic and unmarked, and the presence of both those qualities reveals the Orientalist agenda doing its political work at the heart of SETI. The Kardashev scale is not overtly imperialistic; it does not assign value to expansionist and extractionist civilizations, nor does it explicitly state that human society should strive to conquer the galaxy. But just as Said noted in *Orientalism*, Orientalist scholars did not normally begin their works by claiming their motivation was to ensure European powers dominate the Middle East; that they say nothing explicit about it is precisely what betrays the political-imperial resonance of their works. The same applies to SETI; these things do not need to be said, they are unveiled in the quietly established deterministic framework. SETI scientists were not supremely conscious of the colonial qualities of their theories—quite the opposite. They simply assumed that this was the way the universe works because it was how the world as they knew it worked.

One potent manifestation of this determinism is astronomer Michael Hart's influential 1975 paper, "An Explanation for the Absence of Extraterrestrials on Earth."[69] In this paper, Hart attempted to address the Fermi Paradox. The Fermi Paradox derives its name from the physicist Enrico Fermi who, according to popular myth, queried the apparent emptiness of the universe during a lunch at the California Institute of Technology (Caltech) in 1950, asking "Don't you ever wonder where everybody is?"[70] If the universe is teeming with extraterrestrial civilizations, the paradox posits, humans surely would have found evidence of them by now. SETI as a discipline has dedicated much effort to responding to the Fermi Paradox, with Hart's attempt being an early

and notable example.[71] In his paper, Hart, then an active-but-skeptical member of the SETI community, argued that SETI scientists should extrapolate from the "only evidence concerning the behavior of technologically advanced civilizations . . . the human species."[72] Hart claimed that since the one available data point, humanity, "has explored and colonized every portion of the globe it could," then one can assume at least one alien civilization, if they existed, would have colonized the galaxy by 1975.[73] Since there was no evidence this had happened, Hart argued, SETI was probably a "waste of time and money," though noting humanity would someday "probably occupy most of the habitable planets in the Galaxy."[74] In making this claim, Hart assumed that because some cultures on Earth engaged in colonialism, the inevitable unilineal evolutionary track would lead humanity someday to conquer the cosmos.

SETI anthropologist Kathryn Denning has explored the popular reliance on unilineal evolution in early SETI thought and noted that ideas "about extraterrestrial Others [were] deeply infused with thought about social evolution on Earth."[75] As a result, scientists "tend to develop syntheses that pull all human experience together in to a single narrative," leading to unilineal ideas like the Kardashev scale.[76] Furthermore, because of the damaging role unilineal evolution has played in upholding or justifying oppressive acts such as eugenics and slavery, Denning argues that in SETI, "the subject of social evolution is not a harmless intellectual playground."[77] In other words, it should be emphasized that there have been real-world consequences in validating unilineal evolutionary concepts, even abstractly or in a cosmic sense.

This danger can perhaps best be illustrated by once more addressing Hart's ideas on cosmic progress and colonialism. Later in his career, Hart became involved in a white supremacist organization, New Century Foundation, a think-tank organization that focuses on research that supports the claim that the various human races are irreconcilably different from one another (with the implication that white people are superior) and would be best segregated from each other.[78] In an interview about his own beliefs, Hart described himself as a white separatist, and at one point in his career helped organize a conference called "Preserving Western Civilization" that aimed to address the following concerns: "Problems caused by Third-World immigration into Western countries," "Racial differences in intelligence and how to deal with them," and "The islamic threat."[79] Because of the nature of the discipline of SETI, which investigates the loaded subjects of intelligence and civilization, its proponents run the risk of reinventing harmful ideas, some of which were responsible for justifying the great horrors of the nineteenth and twentieth centuries.

"Let Philosophy Go to Hell"

Some SETI scientists thought they could avoid those pitfalls by including social scientists in their pursuit. In 1971, the Soviet Academy of Sciences and the US National Academy of Science jointly sponsored a US-USSR conference on the subject of communicating with extraterrestrial intelligence.[80] Prior to this conference, several other SETI conferences had been held in the respective countries. What made this one unique, however, was the convergence of cultures—not only Soviet and American, but

science and humanities. At the conference, not only was there the challenge of communicating across language and national barriers, but also across disciplines.

It was Carl Sagan who primarily pushed for the inclusion of humanities and social science scholars at the conference, and one such scholar he personally invited was William McNeill, a historian at the University of Chicago best known for the publication of his popular book, *Rise of the West* (1963). McNeill's work was seen at the time as a revolutionary approach to history; rather than focusing on a particular nation-state or point in time, *Rise of the West* became an early example of what would later become known as "global history" or "transnational history, which focused on the interrelations between civilizations over great spans of time. McNeill's main thesis in *Rise of the West* was that contact and communication between cultures were the primary drivers of history, and Sagan saw a connection between McNeill's work and the aims of SETI. He hoped that a historian with expertise in communication between cultures might provide some insight into how SETI might approach the problem of communication with alien intelligence. Unfortunately for the SETI scientists, McNeill was unimpressed by this proposition. His participation in the conference was largely critical, and he later wrote an article in the *University of Chicago Magazine* titled "Journey From Common Sense," in which he described his experience at the conference as largely bewildering.[81] McNeill had been invited in hopes that he would synthesize Earth civilization and history with a cosmic projection. But as George Basalla, a historian of science and major critic of SETI, has noted about the 1971 conference, "McNeill, the historian, saw complexity, contingency, and accident, where the scientists saw deterministic paths leading to technological civilizations in the Galaxy."[82] By and large, humanities scholars have balked at this notion. Stephen Jay Gould, an evolutionary biologist and historian of science with expertise in the measurement of intelligence, is quoted as having condemned the superficial use of history and anthropology in SETI, claiming:

> I must confess that I simply don't know how to react to such arguments. I have enough trouble predicting the plans and reactions of people closest to me. I am usually baffled by the thoughts and accomplishments of humans in different cultures. I'll be damned if I can state with certainty what some extraterrestrial source of intelligence might do.[83]

Despite the inclusion of humanities scholars in the 1971 conference, there was a reticence on the part of many scientists to engage seriously in their work. Kardashev, for example, opposed the inclusion of humanities scholars, referring to them as "windbags."[84] Similarly, Lev Gindilis, an astronomer on the organizing committee for the Soviet side of the conference, recalled in an oral history interview that at one point during the conference, after a presentation by a Soviet philosopher, British-American physicist Freeman Dyson (one of the few American attendees who spoke Russian), "took a piece of chalk and wrote on the blackboard in Russian, 'Let philosophy go to hell.'"[85] This reticence to seriously engage in humanities scholarship, coupled with the unwitting utilization of nineteenth-century social scientific modes of knowledge, is perhaps an example of a phenomenon novelist and physical chemist C. P. Snow

has called "the two cultures" problem.[86] At a dinner talk in 1956, Snow argued that communication between the traditional humanities and scientific disciplines had become inhibited, resulting in poor comprehension and synthesis between what Snow designated "two cultures." Snow believed the "infiltration" of humanities subjects to the general scientist was poor, with subjects such as philosophy being "[viewed] with indifference."[87] This lack of engagement with social science encouraged the ahistorical and deterministic bias in SETI, to the detriment of the field.

Sagan, arguably the main enthusiast for incorporating social science into SETI, was also the most significant critic of employing colonial metaphors in SETI. Towards the end of the NASA HRMS inauguration, for example, Sagan rebutted earlier attempts to evoke Columbus and European colonization:

> This inauguration is occurring on the five hundredth anniversary of Columbus arriving in this part of the world, hardly the discovery of America because there were hundreds of thousands of people here already, and as you know there is substantial controversy about the wisdom of celebrating this event. . . . there are many other aspects of that voyage which we could properly have reasons to regret.[88]

Despite his greater mindfulness on the negative implications of utilizing colonial rhetoric, however, Sagan still reproduced a classical portrayal of humanity in his SETI endeavors. In 1972, Sagan was working at NASA on the Pioneer program, which was set to launch two probes, *Pioneer 10* and *11*, that would be the first spacecraft to reach Jupiter and Saturn.[89] Living up to their names, *Pioneer 10* and *11* would not only explore new worlds but attempt to serve as ambassadors to any intelligent life they might encounter. This was accomplished by the placement of a gold-plated aluminum plaque on each probe with a message from Earth, designed by Sagan and Drake (fig. 3).[90] The plaque contained a variety of symbols, including a pulsar map intended

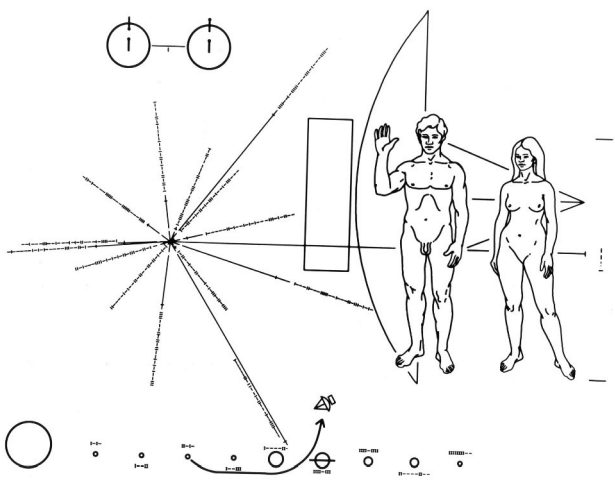

Figure 3. *Pioneer Plaque symbology attached to the* Pioneer 10 *and* 11 *probes launched in 1975. From NASA on the Commons, https://solarsystem.nasa.gov/resources/706/pioneer-plaque/.*

to illustrate the solar system's position in the galaxy and a representation of the trajectory of the Pioneer probes. Most notable, however, are illustrations of two human beings, a man and woman, standing nude, with the man waving "hello." Sagan aimed to generate an inclusive portrait of humanity. He claimed he tried to make the man and woman look "panracial," even though the figures were modeled after the classical Greek idea—iconography that would have seemed familiar to anyone at that time who had taken a university course on western civilization.[91]

Using the classical Greek ideal to represent all of humanity presented problems. Feminist groups were especially angry; while the depiction of the man was anatomically correct, the woman's genitalia were conspicuously missing. Sagan later explained, "the decision to omit a very short line in this diagram was made partly because conventional representation in Greek statuary omits it. But there was another reason—our desire to see the message successfully launched on Pioneer 10."[92] By this, Sagan meant there was concern that a depiction of the more-taboo female genitalia might prevent the plaque from being approved by what he called NASA's "scientific-political hierarchy."[93] By modeling the figures of the Pioneer plaque after Greek conceptions of the body, as well as acceding to puritan taboos concerning the depiction of women's reproductive organs, NASA unintentionally projected thousands of years of Hellenistic gender baggage as our first handshake to the universe.

One might reasonably argue that because the Pioneer plaque was designed by white American men in the 1970s—a period and culture in which men were generally viewed as more dominant than women, and when white people held more power and visibility than other racial groups—the plaque understandably represented their perspective of Earth culture. After all, humans commonly centralize and prioritize the familiar. We would not be surprised to travel to an Ethiopian Orthodox Tewahedo church and discover icons of Jesus Christ depicted as an Ethiopian man, for example. Viewing the Pioneer plaque as an artefact of a moment in time and place would be a fair historical perspective. Yet because SETI aims to represent not a single culture, but an entire species, it behooves scientists to interrogate critically their situated perspectives. Just like the Kardashev Scale, what is being universalized is assumed to already be universal at the start; there is no introspection into how they came to possess their frame of reference. Assuming that their situated worldview was universal was not just harmful in that it blinded the scientists to conflicts between the sites of their instruments and the communities that inhabit them, but it additionally hindered their science goals. The highly specific sociological placing of SETI culture—which in the 1970s was characterized as white, male, technocratic and technologically driven, and exceptionally deterministic—placed limitations on the imagination of its practitioners.

Consider the aforementioned Fermi Paradox, for example. While some astronomers like Hart argued the apparent absence of signals from and colonization by extraterrestrial intelligence was evidence of an empty universe, more recent evaluations of the problem have looked to other possible solutions. Michael Marchand, a philosopher and chairman of the Confederate Tribes of the Colville Reservation, researches the sustainable practices of various Native American nations, and argues that in response to colonialism and "based on their traditions and culture, [many

Indigenous cultures] have promoted sustainable growth and development more in harmony with ecological systems."[94] A SETI paper that took inspiration from such sustainable practices, titled "The Sustainability Solution to the Fermi Paradox," attempted to question "the assumption of faster (e.g. exponential) civilization growth" and instead drew "on insights from the sustainability of human civilization on Earth" to suggest intelligent civilizations may be sustainable and localized.[95] Just as not all civilizations on Earth engage in colonization and extraction economies, neither might intelligent extraterrestrials. The greatest sign of intelligence may be a species that preserves and cultivates its planet, rather than recklessly consumes and exploits endless worlds.

Another way that considering alternative ontologies may benefit SETI scientists concerns the search for a "universal" language. SETI scientists are particularly fond of citing mathematics as a potential cosmic language any intelligent civilization could understand, since in theory the nature of math and physics is constant throughout the universe. While it may be the case that the behavior and composition of matter in the universe are uniform, the "laws" of physics themselves are a human language; variation exists even within mathematical and physical systems in different cultures on Earth. For example, cognitive scientist Rafael Nunez researches conceptual systems, abstraction, and inference mechanisms in isolated cultures and Indigenous groups. His work has demonstrated that some cultures, such as Indigenous groups in Papua New Guinea, have concepts of mathematics radically different from that of the dominant scientific culture. In his research, he found that the Yupno people have no concept of a number line, which is a foundational concept in mathematics that "maps numbers to unidimensional space."[96]

Without this concept, Nunez argues that "number line mapping, although ubiquitous in the modern world, is not universally spontaneous, but rather seems to be learned through—and continually reinforced by—specific cultural practices."[97] If mathematics as a language is not universal on Earth, it can hardly be said to be cosmic. Science and technology studies scholar Bruno Latour notes in *Science in Action* (1987) that although scientific predictions may be successful within the networks they operate, "no one has ever observed a fact, theory, or machine that could survive outside of the networks that gave birth to them."[98] And, like the tree that falls with no one to hear it, what good is a representation of a number without a human from a culture that understands the function of a number to interpret it?

Furthermore, although because of their situated perspectives SETI scientists assumed universality in science and math, those in the humanities have long disagreed about inherent objectivity and universality in science. Latour emphasized how cultural and political systems are aspects of the universe and physical reality that scientists often ignore in their attempts to find universality within the scientific worldview. The example Latour cites in *Science in Action* is that of the planned solar city in Crete in the 1980s. Prior to the launch of the project, the scientists and engineers had done their due diligence to understand everything they thought they needed to know about Crete—from the weather to the demographics—and had developed the optimal configurations and plans for the project. All that was left to do was "go 'out there' and

apply their calculations."[99] Yet when they traveled from Athens to Crete to begin the project, "they were met with a totally unexpected 'outside'" when they discovered that the local inhabitants were not willing to have their land expropriated.[100] The Platonic universe in which they had been operating was not the real universe, and their planning and theories could not be applied. As with the solar city, engaging settled land and local communities has always been an aspect of siting astronomical observatories, but one by and large underappreciated by scientists and funding bodies, resulting in many of the conflicts seen today.

Conclusion

Colonial heritage marked and limited how SETI scientists listened and how they spoke, both to each other and to extraterrestrials. That marking was complex: as with the nineteenth-century odalisque, SETI scientist's image of the exotic was shaped by the familiar, and in seeking to communicate with other beings, offered an image of humanity that attempted to convey universality but did so in ways historically coded by the intellectual and cultural colonization enacted by Europe and the United States, leading to a highly deterministic perspective. In examining two dimensions of SETI's early development—the establishment of both its physical and disciplinary homes—we discover this cosmic science was distinctly Earth-bound.

The aim of this article is not to argue that we must entirely reject astronomy or SETI because they are implicated, either passively or actively, in settler colonialism and white supremacy. After all, most sciences are entangled in violence, oppression, and tragedy in some form or another. Nor does this article attempt to argue that SETI is an unworthy pursuit. In fact, even if extraterrestrial life were never discovered, SETI might be a valuable endeavor regardless, even if only for the reflectivity it can potentially engage in scientists who choose to grapple with existential and abstract questions in its pursuit. For in addition to the imaginative cosmos and alien odalisque conjured by scientists, SETI has also offered representations of the self, as seen in the figures on the Pioneer Plaque and Drake's Arecibo message. In that sense, SETI also presents the inverse of the odalisque: in addition to making the alien familiar, it attempts to reproduce the self as alien.

The notion that considering one's own culture from the eyes of the "other" can bring newfound clarity and insight is not a new one. In *Orientalism*, Said also claimed that "the more one is able to leave one's cultural home, the more easily is one able to judge it . . . the more easily, too, does one assess oneself and alien cultures with the same combination of intimacy and distance."[101] To be clear, as we have seen, the self-reflection of SETI often entails a shallow replication of the practitioner's situated perspective—it does not necessarily grant insight into universal representations of humanity. It was a challenge to define the alien because it was difficult to define ourselves, so SETI scientists described the alien by insinuating who *we* are, and the history of colonial expansion surreptitiously defines our world. And therein lies the potential value of the project; with a critical eye, analysis of SETI concepts and messages can help reveal truths about power and culture.

As the SETI and astronomy communities are now slowly coming to terms with their colonial heritage, some astronomers are actively seeking ways to integrate or synthesize Indigenous perspectives with their own, with some prominent astronomers now actively advocating for the relocation of telescopes such as the Thirty Meter Telescope. While some observatories face greater economic and social consequences due to the legacy of colonialism than others, there is a clear moral and technical imperative to consider the history, culture, and needs of the local communities as part of the environment in which telescopes are operated, just as ionospheric conditions and RFI are considered. Furthermore, it behooves SETI scientists to communicate across borders—interdisciplinary, national, and cultural—in their pursuit of cosmic communication. A true universal synthesis of human experience might not be possible, but the inclusion of more voices and perspectives in the search will bring SETI closer to its goal of finding and understanding the complexities of cosmic culture. To this day, it is overwhelmingly white American men who have been responsible for crafting messages that aim to represent the whole of humanity. Even without a cosmic consequence, this monopoly reveals who controls the land and tools that send the messages and unveils a highly situated and undemocratic portrayal of our world.

Notes

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